November 2017

Supporting a Smarter Electricity System

Scottish & Southern Electricity Networks

Supporting a Smarter Electricity System

Our Transition to DSO

Contents

The aim of this document

At Scottish and Southern Electricity Networks (SSEN) we know we must make swift progress toward a smarter electricity system if we are to meet our customers' expectations. We must be ready to adapt to a rapidly changing environment, which means focusing on innovation, learning by doing and making smarter investment decisions.

Rather than producing a plan that assumes we know what the future holds, the intention of this publication is to outline the principles we will adhere to in transitioning from a Distribution Network Operator (DNO) to a Distribution System Operator (DSO), a key aspect of the smarter grid, and what that means for our wider network and most importantly our customers.

Following this we will continue to engage with stakeholders, directly and through the ENA's Open Networks project, to achieve a phased transition that is customer focused, cost efficient and collaborative with other stakeholders in the industry.

Throughout the document we invite you to take a **TimeOut** and consider whether we are on the right track. We would welcome feedback and our contact details are at the end of this document. Or join us at one of our stakeholder events when we will discuss our strategy in more detail.

This document will cover:

Our transition principles

The principles that will guide SSEN's transition to a DSO.

Drivers for change

This is the context for the DSO transition and why it is in our customers' interests to move to a more flexible energy system.

Functions of a DSO

This outlines the responsibilities we believe a DSO will require.

New flexibility on the wider system

This looks at the role of the transmission network and interconnection in providing system flexibility alongside the DSO.

What DSO means for our customers

This outlines the opportunities that the DSO transition will offer and underlines our commitment that no one is left behind.

Our action plan

This details the material changes you will see as we transition to a smarter electricity system and highlights the benefit to customers and the efficiencies created.

Foreword

Scottish & Southern Electricity Networks

After what could be described as a renewables revolution we are now embarking on a flexibility revolution. Distributed generation, electric vehicles, demand side response and energy storage are transforming our energy system, giving customers access to new products and services from a new range of providers.

As outlined in BEIS' Smart Systems and Flexibility Plan, network companies such as SSEN will be key to this new decentralised system as our traditional DNO businesses transition into active DSOs. We must build on our use of non-network solutions such as flexible demand to make the most of existing network assets and, ultimately, take on the role of a neutral facilitator that helps unlock local solutions.

The smart, flexibility transition is not limited to the distribution network – our transmission business is also transforming. To achieve the best outcomes for customers, all sources of flexibility must be used optimally including larger generators, DSR, storage and interconnectors. A whole system approach will ensure a level playing field between potential providers of flexibility that accounts for both system needs and network capabilities.

This is an exciting time to be involved in the industry but we also have a clear responsibility to make sure the transition takes place in the best interests of all. While technology is driving this change, network companies need to act as the engine rooms of the flexibility revolution. If we look after customers, manage costs, and collaborate across the industry, we can meet this ambition.

The needs of customers must be central as we transition to a smarter grid. As well as expecting efficient and reliable energy supplies, domestic customers, businesses and communities want more from their energy systems, seeking choice over where they source, produce and store their energy and the markets in which they sell it. It will be important to evolve the market framework in a way that doesn't result in unintended consequences, such as some groups falling behind through no fault of their own.

Cost is paramount and the transition must be efficient for all bill payers. We have seen network charges related to electricity distribution reduce by 17% since privatisation alongside significant investment in network infrastructure. We must continue to strive for efficiencies as we deliver a new flexible system to ensure that unnecessary complexity, and the costs that come with it, don't become part of the plan.

Collaboration cannot be underestimated and will be vital to achieving the goal of efficient local DSOs. We strongly support the ENA's Open Networks Project and welcome BEIS and Ofgem highlighting it as a "key initiative." This collaborative project brings together industry and policy makers in the aim of realising a managed transition to DSO through a unified approach, where new systems, trials and learnings can be shared. This has been in addition to our wider engagement with stakeholders locally, nationally and across our industry through our sector-leading innovation projects.

This engagement has already helped to shape the principles set out in this document, but we are committed to keep listening every step of the way. To that end, we would welcome your views and feedback to further inform our transition and help deliver a smarter electricity system for all.

Colin Nicol
Managing Director,
Scottish and Southern Electricity Networks

What's in a name?

The ENA definition of a DSO states that:

" A Distribution System Operator 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.

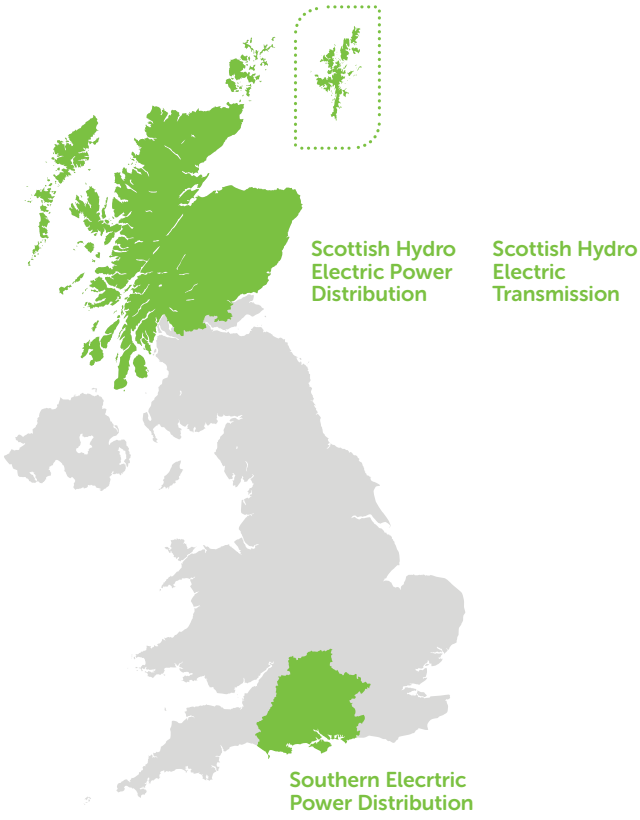
"A DSO enables customers to be both producers and consumers; enabling customer access to networks and markets, customer choice and great customer service."

1. About us

SSEN is part of SSE, the UK's broadest-based energy provider. SSE is a UK-listed company that employs more than 20,000 people, supports the jobs of 120,000 more and its activities and investments contribute around £9bn to the UK economy every year. As well as having one of the largest portfolios of renewable generation in the UK, SSE provides electricity to millions of UK homes and businesses. Our first priority is to provide a safe and reliable supply of electricity to our communities. We do this by making sure our employees and contractors work safely while ensuring the network is able to function properly and meet electricity demand now and in the future.

SSEN[1] is responsible for maintaining and operating the electricity distribution networks across central southern England and the transmission and distribution networks north of the central belt in Scotland. Our operating area in Scotland is home to vast renewable energy resources, which has led to the connection of significant volumes of wind, hydro and marine generation that is transported to consumers across the UK and beyond. This is achieved by working closely with the GB Transmission System Operator, National Grid, and the developers who are seeking connection capacity.

We are regulated by Ofgem as a natural monopoly and legally separated from other parts of the SSE group, which operate in open markets. This publication has been developed by SSEN, but it is our firm belief that the transition to a more active Distribution System Operator is in the interests of all GB customers and electricity market participants, including the wider SSE Group.



SSEN is both the Transmission Owner (TO) and Distribution Network Operator (DNO) in the North of Scotland, which includes the main Scottish island groups. In England, SSEN is the licenced DNO in an area that covers West London to Bournemouth on the South Coast and as far North as Oxfordshire. Including SSEN, there are six DNOs in Great Britain and between them they hold 14 distribution licences. In England and Wales National Grid Plc is the only licenced TO, whereas SSEN shares this responsibility in Scotland with Scottish Power Energy Networks Plc who is the TO in the Southern region of Scotland.

1 SSEN is a trading name of: Scottish and Southern Energy Power Distribution Limited Registered in Scotland No. SC213459 Scottish Hydro Electric Transmission plc Registered in Scotland No. SC213461 Scottish Hydro Electric Power Distribution plc Registered in Scotland No. SC213460 Southern Electric Power Distribution plc Registered in England & Wales No. 04094290

Our story in numbers

3.8m customers served by our networks

3.1m customers in Southern England

770,000 customers in the north of Scotland

4000+ SSEN employees working across our business

85 depots located in the heart of the communities they serve

5 major office hubs at Glasgow Reading, Portsmouth, Perth and Inverness

550,000 calls received from our customers last year

490,000 vulnerable customers identified through our Priority Services Register

£1.5m contributed to local community projects through our Resilient Communities Fund

130,000km of overhead lines and underground cables

106,000 substations

100+ subsea cables, powering island communities

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2. Our priorities and principles

As SSEN transitions to a smarter electricity system it is essential that we continue to meet our customers' existing requirements whilst adapting to their new expectations. We have developed a set of five clear transition principles based around our three priorities: **customers, costs and collaboration.**

Customers

Principle 1: A DSO must work for all customers. We want greater choice and opportunity for customers, whilst ensuring the service we provide remains reliable, efficient and resilient, particularly for vulnerable customers.

Principle 2: Learning by doing will give the best outcomes for customers. SSEN has a wide portfolio of innovation projects that test the credentials of new technologies and solutions with respect to de-carbonisation, resilience and affordability. The best outcomes for customers will be realised through listening to their needs, practical evaluation and scaling up success.

Costs

Principle 3: Our transition to DSO must be coordinated and cost efficient. We will use our experience to focus on ensuring that the total costs charged to our customers are fair and proportionate to the benefits, all the while listening to their short and long-term needs.

With regards to access for services, the standardisation of procurement and service arrangements will make it simpler to participate, and will ensure that the interests of GB consumers are protected.

Collaboration

We think a cost-effective system that meets customer needs is best achieved by collaborating with other network operators, as is happening through the Energy Networks Association (ENA), and working with all stakeholders to ensure flexibility. Indeed, this is a pre-requisite if we are to achieve an efficient whole system outcome.

Principle 4: Neutral facilitation is paramount. As a DSO we will embed flexibility to improve the operation of our network. We will facilitate local and national markets by identifying and providing the visibility necessary to allow markets to function and trade energy throughout our network. This responsibility hinges on enabling neutrality, meaning a DSO must provide a level playing field for technologies and solutions to engage.

Principle 5: A DSO should unlock local solutions. Our aim is to remove any barriers and empower local solutions in a way that benefits the whole system to reduce losses, improve network utilisation, decarbonise and provide economic stimulus. We will work with other actors in flexibility markets to allow this aspiration to become a reality.

TimeOut — Do you agree with the principles we have listed? Which ones should we be prioritising if any?

3. The drivers for change

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Change is inevitable in the energy industry but the evolving technology mix, emerging business models and rate of customer adoption remain unpredictable. It is SSEN's responsibility to be prepared for all plausible scenarios to enable technologies to compete on a level playing field and for government policy to be developed and evolved. BEIS and Ofgem have set a clear direction in their recent Smart Systems Plan[2] that prioritises a customer-led energy system in which network users who operate Distributed Energy Resources (DER) can trade local energy and flexibility with ease. SSEN recognises the potential customer benefits that can be realised by moving to this smart energy system and it is now up to us and our industry peers to work together to achieve this.

SSEN aims to work with all stakeholders to maximise these opportunities that bring new value to customers

Ten years ago few could have predicted that the UK Government would announce a ban on the sale of petrol and diesel cars from 2040. But the pace of technological change and increased awareness of issues such as air pollution meant the announcement was no surprise. Britain took the global lead with the Climate Change Act committing the UK to reducing 80% of carbon emissions by 2050 from 1990 levels. This led to an unprecedented growth in distributed generation, which now stands at over 28GW. However, as technology costs come down and people get more choice, de-carbonisation and innovation can be increasingly customer-led. To empower customers, DSOs and the Transmission System Operators must develop platforms and arrangements that will facilitate and join together new markets.

If the UK de-carbonises by electrifying heat and transport, electricity networks will have the challenge of accommodating significant volumes of new demand whilst keeping costs down. However, the integration of localised low carbon generation with new demand can in fact reduce system losses and benefit communities who want to take charge of their energy supply. SSEN aims to work with all stakeholders to maximise these opportunities and bring new value to customers.

In their Smart Systems Plan the Government and Ofgem articulated a vision of parties interacting in the emerging electricity system. Ofgem stated that network companies should not own or operate storage. Ofgem sees storage as a form of flexibility that should be treated similarly to other forms of DER. SSEN acknowledges this position and will now work with DER including storage developers to help them operate and locate their assets in a way that benefits the electricity network and avoids creating additional costs. This will also help DSOs become neutral facilitators.

SSEN welcomes the development of a new Smart Systems Forum that can oversee the regulatory changes required as part of the DSO transition. Due to the scale of regulatory change being undertaken, which includes major reform to charging arrangements, settlement and new standards on smart appliances, it is vital that there is collaboration and these interlinked parts of a smart system are coordinated.

DER

Distribution Energy Resources describe assets that generate electricity on the distribution network and that are typically less than 50 MW in size. This can include anything from a battery in an electric vehicle connected to the grid to a combined heat and power plant.

Balancing

The Wholesale market balances the vast majority of energy requirements by allowing parties to trade ahead of time. In order for the electricity supply system to remain reliable, supply and demand need to be balanced up until real-time; this is referred to as system balancing and is the responsibility of the TSO. The last form of balancing is for network capacity, which is the infrastructure required to trade energy between supply and demand points. The DSO will play a key role in managing distribution network capacity.

2 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/633442/upgrading-our-energy-system-july-2017.pdf

The emerging electricity system

The GB electricity system is experiencing a fundamental shift from passively serving a one way flow of electricity from transmission generation with predictable levels of demand, to the emerging system that facilitates a much more dynamic flow of energy within and between communities, individuals and businesses.

The energy market of today is almost unrecognisable from the market that our networks were built to support. Coal has seen a dramatic decline and has been replaced with solar and wind generation, a lot of which is small scale and distribution connected. Demand Side Response and batteries are competing, and beginning to win against traditional fossil fuel generators.

Customer adoption of new technologies means that in part of our network the way SSEN is operating the distribution system has already started to change; the transition is already well under way. Overall, the emerging system is one of increasing interconnectivity, data and real time operation. Figure 1 summarises the key components of this smarter system and we explore them in more depth on the opposite page.

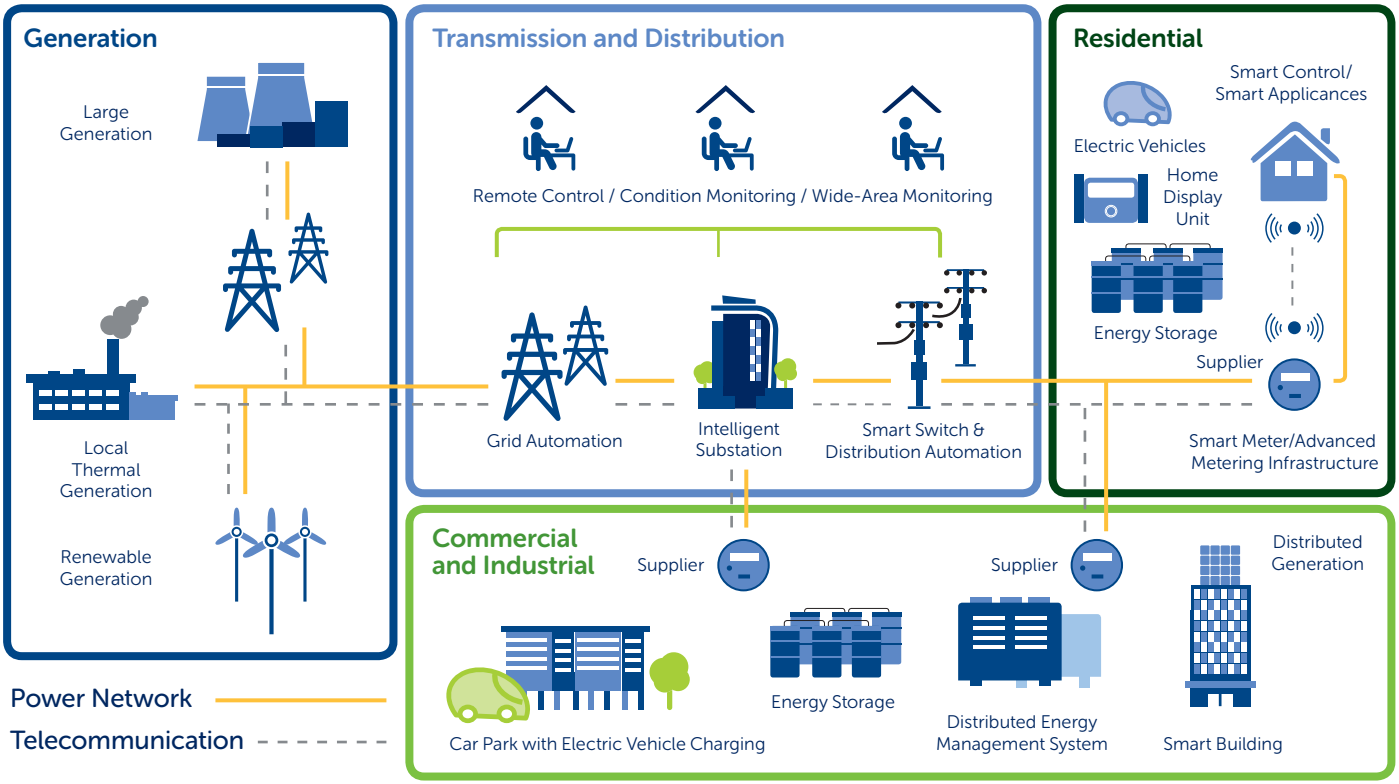

Figure 1: The emerging electricity system contains increasing DER and requires greater information flows

Large Generation

Centralised thermal generation has typically been the engine room of UK plc but has reduced in scale with the growth of distribution generation. Whilst large generators typically use coal, gas or nuclear, the GB system also has several Pumped Storage hydroelectric stations.

Renewable Generation

Renewable energy produces more than 20% of the UK's electricity. The profile of renewable generation is generally variable changing with time of day or season depending on technology. SSEN has connected over 3GW of wind to its networks, 99% of which is in our Scottish region. SSEN has also helped connect over 2.2GW of Solar capacity to its network, 98% of which has been in our Southern DNO region.

Local Thermal Generation

These are dispatchable generators often run on gas or diesel and often provide power reserve for the TSO through ancillary service arrangements.

Commercial and Industrial

As well as utilising dispatchable behind the meter generation, industrial users may shift or reduce their electricity use in response to price signals. e.g. supply costs by lowering their peak demand.

Residential

A significant proportion of households still have electric storage heaters that switch on at off-peak times. e.g. using an Economy-7 tariff. In addition to using solar, domestic users may want smart appliances that can be remotely switched in response to price signals. Community-led energy efficiency and DSR schemes can provide DSO-level benefits such as deferring capital investment, which will translate customer benefits.

Electric Vehicles

Whilst the number of EVs on SSEN's network is currently estimated to only be 25,000, it is expected to grow rapidly. It is estimated that EVs will increase GB peak demand by up to 5GW by 2025. However Vehicle to Grid technology could allow EV users to provide supply services to the wider network.

Energy Storage

Significant volumes of new electricity storage, both small and large scale, are applying to connect to SSEN's network. This will help balance local and national renewable supply.

Transmission and Distribution

- TOs own and maintain onshore transmission assets, which are the high voltage 'motorways' of electricity.
- DNOs distribute electricity between the high voltage transmission grid to the low voltage distribution grid system, which connects homes and businesses.
- TSO is responsible for operating the GB transmission system in real time to ensure that supply and demand is balanced. Whilst 97% of balancing happens in the market the TSO acts as a residual balancer closer to real-time.
- Interconnectors have allowed generation to be imported and exported outside of GB.
- In the emerging system TOs will have to develop a new relationship with the TSO and DSOs to ensure that network planning and operation is aligned. The growth of distributed generation means that there are now two-way power flows between T&D networks. A number of SSEN's Grid Supply Point were exporting for most of 2016/17. DNOs are moving away from a 'fit and forget' approach of managing network assets to a more active role that ensures local distribution remains reliable and affordable, whilst facilitating innovation in smart systems.

Suppliers

These are the customer facing parties responsible for buying electricity from the wholesale market to meet their customers' demand. In a smart grid they will be joined by aggregators and other entities that supply electricity under local arrangements offering customers greater choice and diversity.

SSEN has helped connect over 5GW of solar and wind capacity to our network

Up to now the GB electricity system has coped remarkably well with the significant uptake of small-scale generation and the associated decline of coal generation. For example, SSEN has helped connect over 5GW of solar and wind capacity to our network alone. However, it is increasingly clear that to continue to facilitate the emerging electricity system, regulatory and commercial frameworks need to be evolved. SSEN sees this as a great opportunity for the UK to take a global lead in demonstrating the benefits of smart grid technology. Particularly as the UK is experiencing these challenges before other major economies, due to the fact it has an island network with relatively high penetrations of inflexible generation from renewables and nuclear resources.

Figure 2 shows the requirements of key parties involved in the supply and distribution of electricity, which are summarised as affordability, reliability and flexibility. The first two requirements are well understood, whereas the third, labelled flexibility, describes the requirement for a DSO to manage the consequences of de-carbonisation, digitalisation and de-centralisation. Importantly, this does not undermine sustainability, but rather places emphasis on the operational role and neutrality of DSOs. To meet sustainability objectives environmental regulations and pricing of environmental externalities such as CO_2 that are outside of the DSOs remit, will affect the competitiveness of flexible resources. To summarise, balancing affordability, reliability and flexibility requirements will be fundamental to the DSO transition and will require collaboration between stakeholders, which traditionally may not have worked closely together.

In the emerging electricity system, customers will increasingly be able to choose whether they are willing to trade their flexibility for a cheaper or more reliable service. This will be facilitated neutrally by DSOs who will help increase competition, and is particularly important as the lines become blurred between consumers and generators.

TimeOut – In your opinion how can SSEN best support new technology and business models in the emerging electricity system?

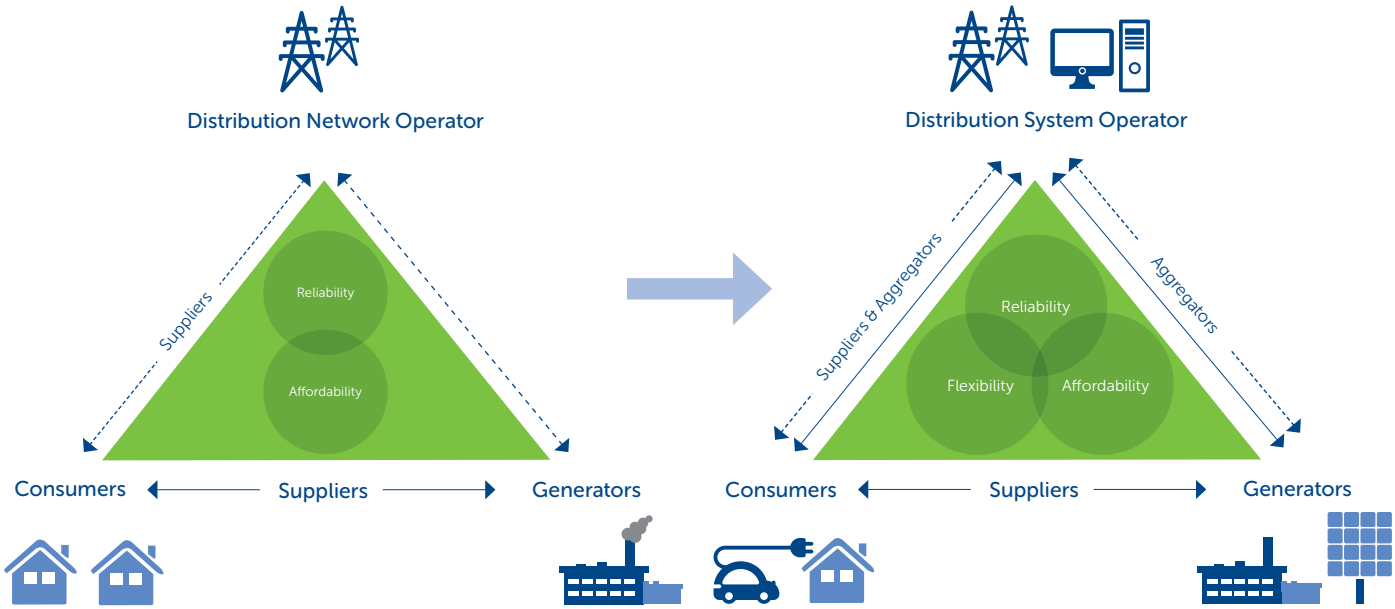

Figure 2: The changing priorities as part of the emerging electricity system

4. Functions of a DSO

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The functions of a DSO essentially describe the new requirements associated with the active management of DER and facilitating local energy solutions. SSEN believes that collaboration is crucial in determining the core functions of a DSO and ensuring they are robust enough.

The Open Networks Project, led by the Energy Networks Association, is a major initiative that is responding to the challenges laid out in this publication. The Government and Ofgem highlighted the importance of the Open Networks initiative in their Smart Systems Plan.

SSEN see the Open Networks project playing a key role in mapping out and specifying the transition from to DSO. The project brings together experts in the UK energy industry, including representation from all of the electricity network operators. Through its Advisory Group the project is also engaging with a broad range of stakeholder groups representing views across society and commerce.

It is vital that Network Operators work together on the DSO transition in order to avoid conflicts and promote standardisation. To this end SSEN believes an industry-wide collaboration is essential for an efficient, effective and coherent system in the UK.

SSEN fully supports the work of the ENA and the Open Networks project, which will provide the focus for the evolution of DSO

SSEN fully supports the work of the ENA and the Open Networks project, which will provide the focus for the decisions on the direction of the evolution of DSO through consultation. An important part of the Open Networks project involves defining the main functions of a DSO, which can help DNOs turn DSO into business as usual.

Costs

The transition must be coordinated and efficient

Case Study: SGAM

The Smart Grids Architecture Model (SGAM) is a three dimensional model which captures electricity network information within five interoperable layers: Business, Function, Information, Communication and Component.

It is a tool developed by the Smart Grid Coordination Group in Europe, which is now being adopted by ENA members to help with the transition to cost-efficient DSOs. As well as presenting the existing state of the electrical grid, the SGAM can also enable development of future smart grid scenarios. The architecture it provides means we can better manage the scale and nature of deploying a DSO and manage the myriad facets we need to address such as systems, processes and the inevitable costs.

The SGAM representations will provide a common understanding of DSO scope, support new business models, identify interoperability and help coordinate DSO related systems. (See Figure 3 overleaf).

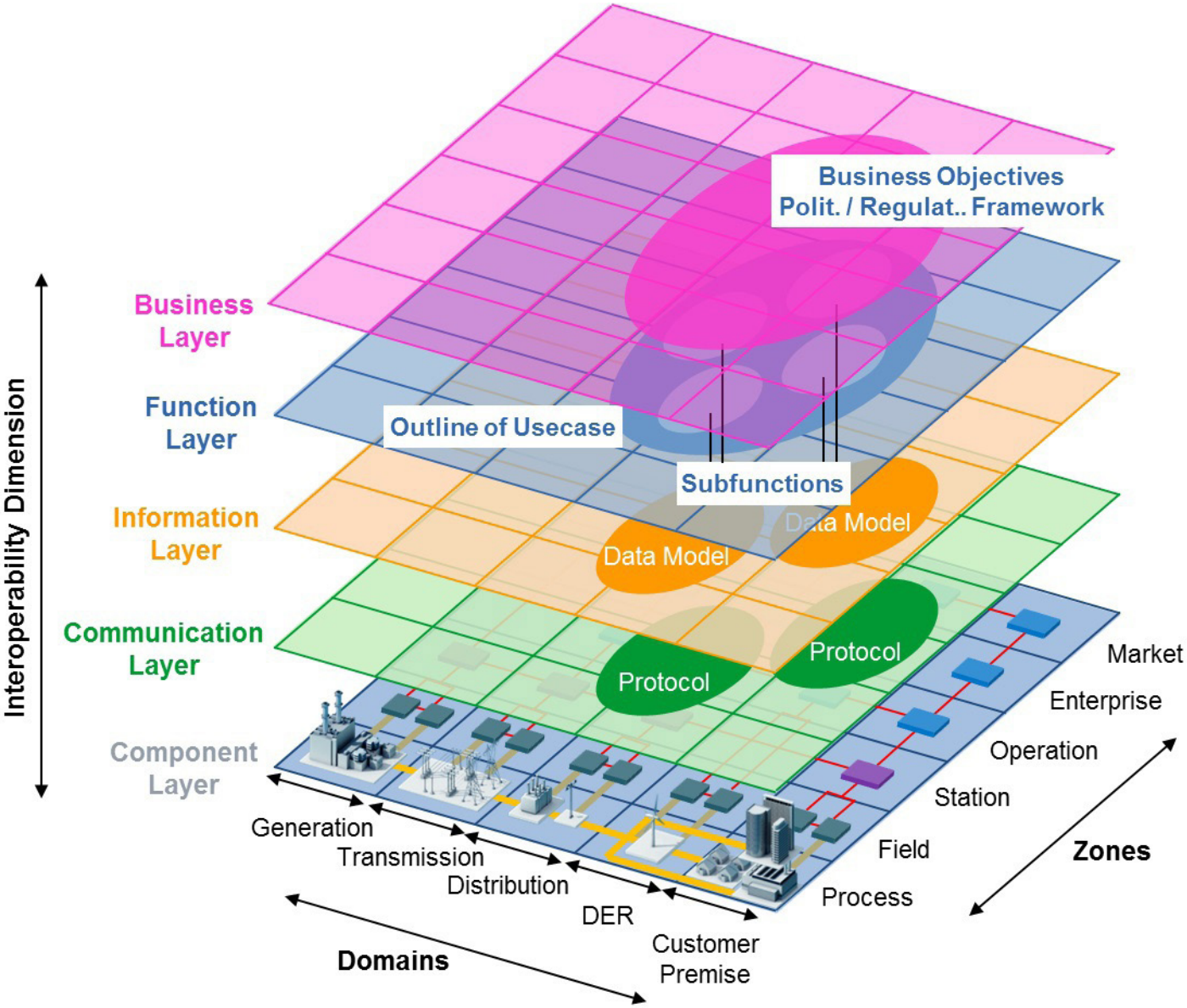

Figure 3: Diagrammatic representation of the Smart Grid Architecture Model

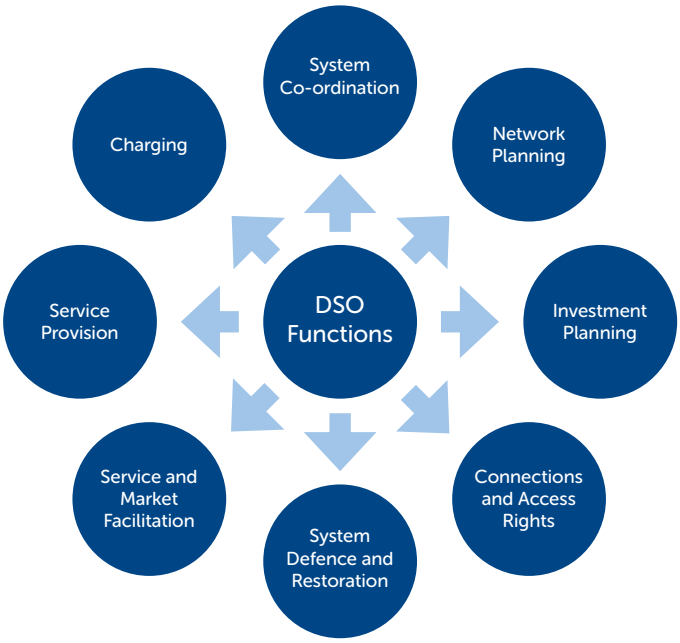

Figure 4: The key functions of a DSO as identified by the ENA

The connection and operation of DER is currently the driving force of the transformation to a smarter grid system. These assets can be used to both satisfy local demand on the distribution network or their dispatch can be used to help balance national supply and demand via the transmission network.

Without efficient coordination of real-time DER dispatch, network congestion occurs. Clearly this is not a sustainable situation and network operators have to find new ways of managing their grids. This move to a smarter, low-carbon grid coupled with changing societal expectations means that maintaining a reliable electricity supply in the UK will require the new functions outlined in this section to be undertaken by network operators.

DSOs will need to develop a three-stage process to operate their networks efficiently and deliver the key functions outlined here in Figure 4; this will include:

1. Planning
2. Procurement
3. Operation and dispatch

The initial stages are focused on making investment decisions based on the available options ahead of time.

By getting these decisions right, DSOs can have less involvement in the third stage, which involves taking actions closer to real time. For example, if flexibility is procured in advance to help manage a constraint this lowers the risk of curtailment. It also defers reinforcement and could result in a significant cost saving for customers.

System coordination

A DSO will be capable of operating local and regional balancing areas to meet customer needs and promote whole system integration. This could include taking local actions for managing local constraints, working with the TSO to procure ancillary services, and/or minimising losses. Importantly, constraint management will use a robust risk-based assessment to contribute to maintaining the national energy balance, which is increasingly dependent on accurate information on local energy flows.

In the short term, there will be greater alignment between planning, procurement and operation of transmission and distribution networks. This is already happening between our Transmission and Distribution businesses, as well as with the TSO. In the medium to long term we are keen to develop whole system planning approaches across energy vectors such as heat. This will help meet wider policy objectives and the aspirations of our customers and communities.

Network operation

The DSO will operate the electricity distribution network to maintain a safe and secure system, which will include identifying and managing risks. This will be primarily achieved by working more closely with the TSO to avoid potential conflicts and support whole system optimisation. SSEN currently issues 'heat maps' in order to show where there are constraints on our network. Our objective is to advance these maps in order to offer more data to customers, allowing them to make more informed investment decisions.

Investment planning

The DSO will identify capacity requirements on the electricity network and will secure the most efficient means of capacity provision to customers. Coordination with the TSO and Transmission Owners will help to identify whole system options. These will include commercial DER options as well as conventional network investment.

Connections and connection rights

The DSO will provide fair and cost effective distribution network access that includes a range of connection options in order to efficiently meet customer requirements and system needs. SSEN's priority is to deliver connections more quickly and once accepted deliver them as soon as practically possible. Flexible connections will help us achieve this whilst keeping costs down. SSEN is keen to work with customers and other network operators to evolve connection arrangements as levels of DER grow, because we acknowledge that current arrangements may not be fair or efficient. For example, it will be necessary to develop connection capacity arrangements which allow more efficient utilisation.

SSEN recognises the use of price signals and open markets as being the optimal way of procuring flexibility

System defence and restoration

The DSO will maintain whole system security through the provision of local and regional flexible services. This will provide system resilience to very low probability, but high consequence events using a risk-based approach. Due to the increased uncertainty associated with increased DER participation this is very important. In addition to this the DSO will provide the means to re-establish the wider synchronous area in the event of widespread disruption. Ensuring security of supply for our customers is already one of our foremost requirements as a TO. As the transition progresses we must ensure that new flexible arrangements and provision of flexibility services are delivered in a way that does not compromise the integrity of the wider system.

Service and market facilitation

A DSO interface with the TSO (including information and control infrastructure) will enable the development of distribution capacity products, development of local network service markets, and enables DER access to wider balancing services for whole system optimisation. By working together, DSOs and the TSO can facilitate local and national markets through co-ordinating procurement, data platforms and price signals across the GB system, thereby ensuring conflicts are avoided. As demonstrated by the TSOs evolution of national balancing services, contracting approaches can help increase participation and liquidity, however, SSEN recognises the use of price signals and open markets as being the optimal way of procuring flexibility. Going forward the DSO will have a central role and responsibility in developing platforms that aid this.

SSEN will actively support wider market development through the task forces on Access Rights and Forward Looking Signals as part of Ofgem's Charging Futures Forums (see section on Charging, below)

Service provision

A DSO could, if required to, coordinate services on behalf of the wider network in order to maximise whole system efficiency. This does not mean that the DSO will compete with market participants; in contrast the DSO will focus on promoting and protecting competition. Within our network area we will contract with services to manage capacity and ensure resilience, where necessary.

Charging

Working with Ofgem and other stakeholders we are keen to develop charging arrangements which enable the market to efficiently respond to physical constraints ahead of any need for DSO intervention. Charging arrangements cover both cost and benefits, rights and obligations, and extend through the life cycle of a connection from initial works through to the ongoing use of system. It also requires careful treatment of any residual costs so as to avoid market distortion. Clearly the interaction between transmission and distribution systems will intensify and as such charging arrangements for either system must complement each other.

Further details of the functions are available on the ENA Portal:

http://www.energynetworks.org/electricity/futures/open-networks-project/open-networks-project-overview/

TimeOut – Do you think SSEN should be prioritising the development of particular DSO functions over others?

5. New flexibility on the wider system

Supporting a smarter electricity system is not only about facilitating flexibility and connecting DER through a DSO transition, it is also about considering the role and requirements of the wider electricity system. This section puts the DSO transition into context by examining some of the key changes taking place in transmission system planning and operation, and how these will also lead to a smarter or more flexible system.

The role of Transmission capacity and bulk flows

The transition to greater flexibility is having an impact on SSEN's transmission network and the wider system. In the past ten years, we have seen dramatic changes in our transmission network area, as set out in our North of Scotland Energy Trends publication[3]. We delivered capacity to accommodate a doubling of renewable energy generation on our system, supported the TSO in managing the implications of a reduction in the share of generation from traditional thermal generation stations and worked collaboratively across transmission and distribution to facilitate the significant increase in distributed generation connected to our Scottish networks.

The high proportion of generation from renewable and distribution connected sources on our Scottish network is in line with the TSO's 'Two Degrees' future energy scenario for the GB system in 2050[4]. This means that we are already delivering and operating a network which is both decarbonised and decentralised. Consequently this provides us with first-hand visibility of the challenges that GB is facing.

We are already delivering and operating a network which is both highly decarbonised and decentralised

Source of Flexibility	Examples		Network Parties involved
Transmission Connected Assets	CCGTs, Pumped Storage, Wind Power		TSO, TOs
Interconnectors	IFA (GB-France) Moyle (GB-Northern Ireland)		TSO, TOs
Smart Network Solutions	Fault Level Management, Voltage & Power Flow Management, Dynamic Line Rating	Active Network Management, Flexible Connections, Export & Import limits	DSO, TSO, TOs
Distributed Energy Resources	Batteries and Vehicle to Grid, Solar PV, Reciprocating Engines		DSO, TSO, TOs
Demand Side Response	Industrial processes e.g. aluminium smelters Commercial demand e.g. air conditioning Domestic demand e.g. electric vehicles		DSO, TSO, TOs

Table 1: Summary of flexibility sources

3 https://www.ssen-transmission.co.uk/media/2226/energy-trends-august-2017.pdf
4 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/568982/An_analysis_of_electricity_flexibility_for_Great_Britain.pdf

New flexibility services and markets have the potential to ensure that further development of low carbon generation and new sources of demand, like the electrification of transport, are delivered efficiently for customers while ensuring network reliability.

Despite the transition to a decentralised energy system, there will be a continued requirement for bulk energy flows to deliver a low carbon energy system. Networks play an essential role in connecting locations where low carbon supply is best suited, which are often relatively far away from urban areas, to areas of demand. This not only includes the domestic GB network but also extends to supply and demand in neighbouring regions and countries. For example, analysis by Imperial College and the Carbon Trust estimated that increasing interconnection between the GB and other jurisdictions can offer significant benefits in terms of providing flexibility if cross border markets are functioning efficiently.

On the other hand, higher uptake and coordination of DER should reduce the need for transmission capacity to accommodate local distribution peaks, because of distribution constraint management. Given the significant uncertainty associated with energy scenarios, both in terms of supply and demand, which demonstrates the requirement for whole systems thinking. For example, the decision to commission new interconnection will have significant impacts on the GB wholesale market and the revenue that domestic-based flexibility can access. This could be either positive or negative depending on the jurisdiction GB is connecting to, as factors such as regulatory structures, carbon prices and the generation mix will change the dynamics within flexibility markets. This also assumes that resources will be able to compete together across interconnected regions, which is partly being addressed in Project TERRE (Trans European Replacement Reserves Exchange)[5].

Future Interconnector Capacity

As part of the transition to a smart, flexible system, planning for interconnection will be a major factor for TOs such as SSEN. Whilst GB only has 4GW of interconnection, fourteen interconnector projects totalling 15.4GW are in planning or development. There are three proposed projects that will connect within the SSEN transmission area; NorthConnect (1.4GW), Icelink (1GW) and Maali (0.6GW) with expected connection dates ranging from 2022 to 2027.

Enabling these interconnectors to act as flexibility in the GB market will require sufficient infrastructure on the main integrated transmission system to accommodate the bulk flow of energy that arises when the interconnectors are importing or exporting. The system requirements for this and potential future interconnector capacity are considered as part of National Grid's suite of system planning documents (the Future Energy Scenarios, Electricity Ten Year Statement and Network Options Assessment) which are used as an input into SSEN's system planning processes[6].

New interconnectors are expected to be bi-directional, allowing electricity to be imported and exported. This will require transmission owners to manage the operational challenges of these variable flows and the potential adverse interactions between HVDC interconnectors and other HVDC schemes. SSEN's new National HVDC Centre will allow us to test these effects using real-time simulation capability to perform in-depth analysis of interactions across complex HVDC schemes. Unlike network infrastructure located on mainland GB, interconnectors are DC and not AC, meaning they are not synchronised with GB's grid frequency. This results in a further decrease to GB system inertia which increases the Rate of Change of Frequency (RoCoF) when supply and demand is out of balance. Whilst new frequency response can help manage higher RoCoF, a certain amount of system inertia from synchronous generation is required to maintain a stable grid frequency.

The export of generation from SSEN's North of Scotland network is increasing year on year and recently exceeded 2GW. Whilst electricity demand in our area may increase due to economic growth, it is likely that SSEN's Scottish network will continue to be a net exporter of electricity for the foreseeable future. In theory new interconnectors could reduce generation curtailment due to constraints and thereby increase the volume of generation-exported electricity from our network area.

5 https://consultations.entsoe.eu/markets/public-consultation-document-for-the-design-of-the/
6 National Grid, 2016 Electricity Ten Year Statement, http://www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=8589938717

System Planning

Delivering a smart flexible energy system in an economic manner and ensuring that it meets the needs of customers will require a whole systems approach to system planning. This section provides a brief overview of how system planning requirements and associated standards can be evolved to facilitate a smarter electricity system.

Coordinated system planning and Future Energy Scenarios

Optimising investment across the whole system using flexible energy services will require increased information sharing between transmission and distribution networks. To provide the required signals of need to flexibility service providers, the DSO alongside TOs and the TSO, must provide visibility and transparency of the flexibility requirements on the network, taking account of both distribution and transmission constraints. To enable this, we will need to adopt new approaches to assessing network capability.

Coordinated system planning will require a common set of drivers for transmission and distribution planning, as well as a shared set of Future Energy Scenarios that address local, regional and national developments. Currently the Electricity Ten Year Statement[4] provides this analysis for transmission, and a similar process will be required for distribution to determine the best whole system solution.

The use of future energy scenarios in the system planning process is increasingly important, allowing us to consider the wide range of outcomes that could be realised given the current levels of uncertainty over the requirements of the network in the longer term. While the TSO's suite of system planning documents provide an essential guide in this, SSEN has recognised that developments on our transmission network do not fit a GB standard. Within our North of Scotland area, almost all of our Grid Supply Points (GSPs) are exporting due to the significant renewable generation (50% of which was embedded on the distribution network in 2015). To address this, we are developing localised future energy scenarios with increased granularity in the assumptions based on our local knowledge, which will allow us to best meet our customers' needs. This should allow us to identify the range of potential requirements on our network and to identify the least regret investments. It should also allow us to identify where alternative flexible and temporary solutions may be suitable.

In 2016, SSEN's transmission development team introduced a regional network development approach which considers existing generation and demand, as well as connections activity at both a transmission and distribution level. These regional dashboards are regularly updated to capture changes and developments that will affect our investment plans. This regional approach captures whole system development and has already led to investment deferral to reduce the risk of stranded assets. Collaborative planning between SSEN's transmission and distribution business as well as the TSO, has allowed us to design a solution for distribution customer connections that avoided the need for a new Grid Supply Point (GSP). This has the potential to save customers in the region of £9 million.

Taking a whole system approach relies upon transparent, evidence-based cost-benefit analysis that accounts for both capital expenditure and ongoing operations and maintenance costs. It will also require network companies to work towards shared objectives to ensure that the best solution is adopted, whichever network it is located on. SSEN now has experience in taking such an approach to accommodate flexible connections. We believe that these approaches can be further encouraged through the setting of targeted outputs and incentives in future price controls.

Standards and Frameworks

A new planning framework will be needed that includes alternative approaches such as storage and demand side response. Current network planning approaches are delivered based on standards and assumptions set out in the Security and Quality of Supply Standard (SQSS), network codes and network planning standards. These standards ensure that the interests of customers are protected in the planning and operation of the electricity network. However, they have been designed based on separate requirements for transmission and distribution networks due to their separate ownership, and in their current form they do not fully recognise flexibility from demand side resources. For example, the SQSS and the network planning requirements in Engineering Recommendation P2/6 are currently separate security of supply standards between transmission and distribution respectively.

Transmission owners currently use derogations from these standards to accommodate alternative approaches, such as flexible solutions, on the system. As the application of flexible solutions increases, this approach is likely to become impractical. To enable whole system planning and increased use of alternative solutions, revisions will be required to these standards and frameworks to remove the barriers that currently exist.

SSEN's system planning team is regularly reviewing our system planning approaches, in addition to collating and analysing system data to inform the treatment of different actors on the system in our modelling. SSEN is working with the other TOs and the TSO through the Joint Planning Committee (JPC) to present our findings and to share plans for how planning approaches may need to change to efficiently accommodate the variability that a smart flexible energy system will bring. Without revised standards and frameworks, network reinforcement will continue as the default solution, even when alternative flexible solutions may be more appropriate.

Additionally, to optimise the network and its capacity, it will be necessary to change planning standards to allow connections based on recorded network power flows rather than contracted capacities. This is particularly relevant when there is a high level of generation with a variable export profile. Adopting this new approach could enable additional connections before reinforcement is required.

System Operation

One of our foremost requirements as a TO, in collaboration with the TSO, is ensuring network reliability for our customers. As our network changes, further operational challenges are being recognised, particularly as variable and inflexible low carbon energy replaces traditional thermal plant. It is up to the market to provide these services via fair and transparent procurement exercises. Nevertheless the transition from contracting with a small number of centralised providers for balancing towards the procurement of flexibility from a large and diverse range of providers will be complex.

SSEN advocates collaboration between industry stakeholders to ensure that System Operation evolves in an efficient and appropriate manner. Two industry-led consultations in 2017 have started this process. The first was the TSO's System Needs & Product Strategy[7], which outlined ways that they could simplify and adapt their suite of national balancing services. The second was the ENA's consultation on 'Commercial Principles for Contracted Flexibility'[8], which described the different options balancing services could be procured regionally as well as nationally.

In addition to ensuring network reliability SSEN's objective is to keep costs down for customers whilst facilitating the low carbon transition. To achieve this, we intend to work with stakeholders in industry to open flexibility markets to all potential providers in a way that will reduce total costs, whether this is for balancing in real-time or reducing capital spends in longer time frames. Whilst there will be a continued role for national balancing, akin to what the TSO does now, increased DER uptake necessitates a greater role for localised system operation. Regardless of the commercial structure around it, local and national balancing can and should work in harmony with each other. As a neutral facilitator SSEN intends to take a technology agnostic approach, which avoids giving preference to types of providers eg whether they are big or small.

With the advent of smart meters and new technology network pricing can be made more cost reflective

and therefore play a more significant role. Naturally this leads to stronger locational charging as the cost of transportation is reflected into supply costs. SSEN's development of Constraint Managed Zones (CMZs), which are location specific tenders to procure flexibility, are a step towards this. Consideration is required as to how other price signals such as connection charges can be harmonised with new flexibility markets such as CMZs.

Future Roles and Responsibilities

Whilst SSEN agrees with the principle that flexibility from generation, storage and demand side response should be able to defer or avoid traditional network upgrades, we do not agree that currently there is a case for system operation to be separated from network ownership at the distribution level. To the contrary, if this separation was enforced in the short-term it would lead to a delay in customers' reaping the benefits of a smarter, more flexible system. This is because the complexity and hence costs of separating distribution network ownership and system operation would invariably be higher. As distribution networks are critical national infrastructure the significant risks that a fragmented ownership and operation structure presents would also need addressing.

Unlocking new flexibility at the distribution scale is a central pillar to SSEN's DNOs to DSO transition. As a DSO, SSEN will be empowered to optimise the use of infrastructure and services in a way that encourages competition and maintains network reliability at least cost. It is up to industry and ultimately the regulator to shape arrangements in a way that avoids distortions between different solutions. SSEN believes this will require strong collaboration and views the SGAM work described in the previous section as a key part of this process.

As the contribution of DER to system security and stability increases, operational balancing and ancillary service signals will need to take account of distribution and transmission constraints so that services called to address a need at a national level do not create problems at a local level, and vice versa. These signals should take account of transmission constraints, and visibility of these will be essential for developers looking to make investment decisions that include provision of these services. In lieu of this, SSEN is further developing its network capacity mapping system[9] (often referred to as heat maps) to provide more visibility to the market of how much generation and demand headroom is left across our network.

Importantly, these system operation issues go beyond electricity transmission and distribution conflicts and increasingly have implications across different energy vectors. For example, calling on a large volume of distributed small scale gas generators at short notice to meet an electricity system need could put the gas distribution network under strain. This demonstrates the need for network companies and policymakers to broaden their stakeholder engagement. For example we believe there is a need for greater coordination across multiple energy vectors as part of a whole systems approach.

Notwithstanding the requirement to develop a whole systems approach, the following sub-sections focus on shorter term changes to services relating to GB electricity system balancing that SSEN has a role in supporting. As a principle we would like to work with industry and the TSO to simplify balancing services in order to make them more accessible and transparent.

7 www2.nationalgrid.com/WorkArea/DownloadAsset.aspx?id=8589940795
8 http://www.energynetworks.org/assets/files/electricity/futures/Open_Networks/ON-WS1-P4%20Commercial%20Paper%20(Final%20Draft)-170816-final.pdf
9 https://www.ssen.co.uk/generationavailability/ and https://www.ssepd.co.uk/ContractedDemandMap/?mapareaid=2

Black Start

Black Start is the procedure to recover from a total or partial shutdown of the transmission system which has resulted in an extensive loss of supply. This procedure is currently managed by the TSO based on a zonal approach that entails isolated transmission connected power stations being started individually and gradually being reconnected to each other in order to form an interconnected system again. Only once the national transmission system is energised, the distribution network is restored.

As thermal plant that currently provides Black Start services closes or changes its mode of operation away from baseload, a new Black Start approach will be necessary. This could involve provision of services from different sources or renewable technologies in combination with electricity storage installations. With increases in DER it may also be appropriate for the current zonal approach to be revised, with the DSO taking a more active role in system restoration using DER and building the system by starting with the lower voltage networks via a "bottom up" approach.

This could mean the DSO taking on responsibility for restoration within their licence area and developing local restoration plans. This would effectively create isolated systems that would then need to be synchronised with the wider network in a system restoration process; a responsibility that would be retained by the TSO. Alternatively, it could mean the DSO agreeing to operate on behalf of the TSO until the system is reconnected, similar to the current arrangements with TOs in Scotland.

If provision of Black Start services by DER is considered potentially beneficial then the requirements for Black Start communications should be included in the development of DSO communications standards. A bottom up approach could also be beneficial for customers as it should result in earlier re-connection, however the relative costs of a bottom up approach in comparison to other approaches must be considered.

Whichever approach is adopted, opening up the provision of black start to DER would increase the potential pool of

Collaboration

Case Study: VISOR Project

SHE Transmission is collaborating with SP Transmission and National Grid to monitor the operability of the network in real time. The VISOR project (Visualisation of Real Time System Dynamics using Enhanced Monitoring) has been funded through Ofgem's Network Innovation Competition and looks at system operability.

Phasor Measurement Units and Waveform Measurement Units have been installed on our network at Beauly and Kintore to monitor voltage, current and frequency, with highly accurate time-synchronised information sent to a Wide Area Monitoring System Server, installed at SSE head quarters, and the information is then forwarded to SP Transmission and NGET System Operator to improve visibility of dynamic system behaviour and enhance network resilience, increase network capacity and deliver savings to customers.

It will provide the system operator with the ability and confidence to utilise the full capacity of the network where increasing volumes of wind generation lead to more volatile system flows, resulting in greater operating margins to maintain and manage network security. This information is being used to better manage system instability risks which can particularly arise between Scotland, Wales and England and could be used to increase network capacity and deliver savings to customers.

The VISOR trial will demonstrate a potentially avoided investment benefit of £45m for every 100MW capacity realised. It will provide the system operator with the ability and confidence to utilise the full capacity of the network where increasing volumes of wind generation lead to more volatile system flows, resulting in greater operating margins to maintain and manage network security.

providers, which is particularly important as the number of traditional transmission connected black start service providers is declining.

Voltage Control

Voltage control is currently provided by transmission connected generators or else through the installation of reactors and capacitors on the transmission network. Due to changes in demand characteristics and the increase of variable generation such as wind power on SSEN's transmission network area, high voltages are becoming more frequent and widespread in operational timescales.

With around half of the installed generation in our north of Scotland area connected to the distribution network and very limited transmission connected demand, a need for additional voltage control equipment was identified to ensure the effective management of voltage requirements. While this need could be met by additional infrastructure on the transmission system, provision of voltage control services by DER could be a viable alternative. The development of a market for provision of voltage control from DER will need to take account of locational sensitivities and will require the barriers that currently prevent DER from providing reactive power to the transmission system to be overcome. These issues are currently being explored by the TSO and wider industry as part of a review of balancing services. For example, UKPN have a joint project with the TSO in the South East of England to demonstrate the capability of DER to provide reactive power services in a way that controls voltage levels on the transmission system[10].

Frequency Response

Frequency response is required to balance system frequency in real time. For example, if there is a sudden loss of a power station, frequency response ensures that the electricity system remains stable. Traditionally frequency response has been largely provided 'for free' by large thermal stations that use synchronous generators and therefore provide inertia to the electricity system i.e. they maintain a stable grid frequency. Frequency response is currently managed by the TSO through a combination of mandatory requirements and tendered services that are open to the market.

In broad terms, new approaches to frequency response procurement are required due to the decrease in system inertia caused by a reduction in large synchronous generation on the system, which has in large part been replaced by renewable asynchronous generation. Further, if as expected, new nuclear generation connects and raises the largest single feed in loss[11], this will create a step change increase in frequency response requirements. The increasing number of generators connected to the distribution system, which are not required to meet the mandatory frequency response requirements, is also a factor in the increasing need for frequency response services.

Already DER is increasingly providing frequency response services to the TSO. This creates a wider pool of service providers, encouraging the procurement of the most economic services from the market. As these arrangements are developed it is vital that the DNO, TOs and the TSO work together to ensure stability on the network, as well as a level playing field for resources to compete.

10 http://www2.nationalgrid.com/UK/Our-company/Innovation/NIC/Power-Potential/Technical-Solution/

11 The largest single feed loss (currently Sizewell B)is the most significant unit connected to the network in MW terms, and therefore has potentially the largest impact on grid stability if a fault is experienced.

6. What DSO means for customers

A DSO is not only about developing markets and systems; it is about empowering people and communities. Whilst the DSO transition represents a business transformation, with associated costs and risks, we believe the potential customer benefits justify the change culminating in simpler, quicker and cheaper access to the network. Two of our guiding principles – a 'DSO must work for all customers' and 'learning by doing' - will drive the realisation of these benefits and ensure the best outcomes for customers.

Estimating the costs and benefits of the DSO transition is crucial to ensuring customers' receive value for money. The Government-sponsored report into the benefits of a smart energy system provides a useful benchmark to begin with. The report, largely based on modelling by Imperial College, assessed different options for providing flexibility on a 'least-worst regrets' basis. The rationale is that delivering new flexibility provides valuable optionality and helps avoid investment in infrastructure and assets that could become stranded.

Analysis by Imperial College estimates that the cost benefit of increased flexibility via a smart energy system will be between £17bn and £40bn by 2050[12]. We believe these savings will be highly reliant on DSO capabilities being in place and therefore a significant proportion of the benefits will be directly dependent on SSEN

Flexible Connections

In response to stakeholder feedback, and in anticipation of the smart grid, we continue to move forward with delivering flexible connections as business as usual across our networks.

The opening of the Orkney Smart Grid in 2009 made us the first UK DNO to implement Active Network Management (ANM) as an alternative to a traditional approach to network reinforcement. This was a step change in the design, construction and operation of the network. It allows significant volumes of new renewable generation to be connected, benefiting the network, renewable developers and the local community. We have continued to build on this initial success and plan to offer a wide range of potential flexible connections as business as usual in the near future, including:

- Single Generator Active Network Management
- Active Network Management
- Third Party Active Network Management – Shared Capacity
- Third Party Active Network Management – Demand Management
- Export Limitation
- Timed Export Limited

All of these connection types allow generators to connect using capacity that is released over and above traditional planning standards. To enable this involves a range of measures including defining new planning methodologies, system designs and connection processes.

This has allowed us to focus on how best to provide our customers potentially faster and lower cost access to our networks.

To support future deployment we have undertaken a robust procurement process to identify the most economic suppliers of the equipment required.

Going forward we will continue to develop the range of flexible connections we offer and will continue to focus on cost reduction. This could involve initiatives such as new systems architecture to make more use of virtualisation, or evaluating alternative telecoms solutions. Currently flexible connections are designed specifically for generation connections, however SSEN are developing a range of demand and storage specific flexible connections for release in 2018.

It is our intention to make flexible connections available across all of our networks in the near future. This will follow a consultation process carried out by SSEN, and seeking approval from Ofgem on elements of our proposed approach. Once complete, customers will be able to have a flexible connection anywhere on our transmission and distribution networks where it is technically feasible to do so.

taking action in our network areas. For example, if we can procure flexibility offered by demand side measures to help reduce capital expenditure on generation and network infrastructure.

Whilst the DSO transition is focused on developing new functionality, the value of flexibility on the distribution network has already been proven to deliver benefits to customers and provides valuable learning. Time of Use Tariffs such as Economy 7 and the Radio Tele-Switching (RTS) system have been in operation for more than twenty years, and remain critical to managing network capacity by shifting significant domestic electric heating load to off-peak periods. Analysis led by SSEN and EA Technology estimated that if RTS controlled electric heating load reverted back to the evening peak in our off-mainland SHEPD network area, it would cost customers £160m to build the extra generation and network capacity[13]. However as it is, customers with RTS controlled electric heating are able to benefit from paying a lower network charge to reflect the fact they are helping to defer network investment. This further demonstrates the value that our customer's flexibility provides.

The estimated cost benefit of increased flexibility via a smart energy system is between £17bn and £40bn by 2050

The rollout of smart meters and the increase of DER are already changing the way customers interact with utilities. Innovators with smart technology and new commercial models are starting to offer customers services that go beyond simply supplying electricity. For example, the digitalisation of electricity infrastructure is enabling companies to use data to provide new services, such as heat and mobility, in a tailored way for individual customers.

One of the key potential advantages of accessing new data is that it enables optimisation of assets and services, which can benefit all stakeholders. Network companies will be the bedrock of the emerging electricity system. Our duty will be to ensure that new technologies and practices do not put network resilience at risk or result in higher than necessary infrastructure costs. Despite our increasing remit and responsibility, it is important to state that as a DSO we will be facilitating new commercial services rather than aiming to develop our own.

What a DSO will do is protect customers by ensuring their data is secure and network resilience remains uncompromised; provide new visibility by developing platforms that show available network capacity; and improve connectivity by ensuring that customers can access the network and markets in an efficient way that suits their needs.

Further to this, the DSO will provide new revenue streams for customers who are willing to offer flexibility. This is already under way as part of our Constraint Managed Zones, which will be key to unlocking new opportunities for customers.

Constraint Managed Zones

One of the first steps towards being a DSO has been the development of Constraint Managed Zones (CMZs), which has the potential to deliver significant benefits to customers by deferring the need for traditional network reinforcement. The CMZ concept relies on the ability to commercially procure services from a third party to manage a network constraint. This approach can potentially free up network capacity more quickly and at a lower cost than traditional methods. The CMZ approach is the culmination of learning gathered from across our existing portfolio, and SSEN is already applying the CMZ solution to areas with high cost reinforcements. More broadly, CMZ tenders will be deployed in the following three scenarios:

1. **Managing uncertainty in load growth rates;**
2. **Managing faults and outages;**
3. **Short-term management of unexpected changes such as localised EV uptake.**

Our CMZs use a relatively straightforward tendering exercise to procure and contract flexibility from any provider that can demonstrate they have the capability to deliver when required. The procurement of flexibility through the CMZ tender process will be transparent and offered to the lowest cost provider. Following feedback

12 BEIS Smart Systems Plan
13 http://www.yourfutureenergynetwork.co.uk/smart_meters2014.pdf

Collaboration

A DSO will unlock local solutions

Case Study: Project ACCESS

We are collaborating with Community Energy Scotland, V-Charge (an aggregator) and the Mull and Iona Community Trust on a project called 'Assisting Communities to Connect to Electric Sustainable Sources' (ACCESS).

This project puts customers at the heart of the solution by investigating the use of smart electric heating for balancing local low carbon generation in a way that optimises network capacity and end user comfort. Due to their understanding of local network flows and the needs of their customers and communities, we believe DNOs are best positioned to work with aggregators and communities to realise the full benefits of their flexible resource.

The learning from ACCESS has focused on the technical management of the exchange of energy locally. A gap in the realisation of this model at scale has been the absence of appropriate market arrangements and network visibility. DSO and new markets that facilitate peer-to-peer trading offer the opportunity to allow the concepts demonstrated in ACCESS to be applied across UK.

ACCESS is just one example of new technology working to deliver outcomes that our stakeholders welcome. Through various projects we are gaining an understanding of the goals, aspirations and drivers of community groups, commercial organisations and individuals. It is clear from this learning that the missing piece of the jigsaw is the platform and regulatory arrangements to allow the true value of these technologies and initiatives to be realised.

We see the move to DSO as the first significant step to unlocking the value of flexibility to our stakeholders and the wider energy system.

www.accessproject.org.uk

from our stakeholders we intend to initially offer four-year contracts to provide longer-term certainty.

CMZs are a 'business-as-usual' funded mechanism and a demonstration of our "learning by doing" approach. Currently we are only incentivised through regulatory arrangements to issue CMZs for import constrained networks; however, this may change. We expect the experience from these tenders will lead us to develop more advanced ways of procuring flexibility, such as the use of real time price signals. Establishing price signals and markets for flexibility is a long-term objective, but in the short term new providers appear to favour standardisation and simplification via contracted flexibility as the best route to market.

TimeOut – What other aspects of the DSO would you like to see implemented in the short term

New ways of buying and selling energy

In the emerging electricity system, customers will have an unprecedented level of choice to actively engage in the energy market; offering them the opportunity to manage their consumption and trade any onsite generation. A DSO will provide the level playing field to enable this to happen at scale.

Peer-to-peer trading – akin to an eBay for electrons – will require the DSO to provide network visibility of available capacity to allow transactions to happen efficiently. This will ultimately enable thousands, if not millions, of consumers and producers to buy and sell as they please.

Replacing Statement of Works

Together with UKPN and WPD, we have been trialling a new process to replace the traditional Statement of Works submissions. Connected and contracted generation is captured in a new Appendix G that forms part of the Bilateral Connection Agreement for all our Grid Supply Points at the interface between SEPD and National Grid. Working to a predefined materiality limit agreed with National Grid we can make offers to customers with a greater degree of confidence about the transmission impacts that may affect their connections.

As a result, customers have greater visibility over possible constraints and can receive a timely response on whether transmission works are needed. The learning from these trials is likely to form the basis of Connection and Use of System Code (CUSC) modifications that will be submitted later this year.

It will be the role of the DSO to ensure that the network information customers require is available and visible to enable fair competition

+Market design is not ultimately our decision and we support a collaborative approach to designing those markets so that they are easy for customers to use, but, under any marketplace, it will be the role of the DSO to ensure that the network information customers require is available and visible to enable fair competition.

This will require a step change in the level of information

Collaboration

Learning by doing can drive the best outcomes for customers

Case Study: My Electric Avenue

SSEN's My Electric Avenue was a £9m innovation project supported by Ofgem's Low Carbon Networks Fund. It ran between 2012 and 2015 in partnership with EA Technology. The Project replicated streets of the future in both SSEN's southern network area and Northern Powergrid's network areas by recruiting 10 groups of 10 customers in a single street to drive electric vehicles (EV) for 18 months. The trial allowed us to trial a new technology that monitored demand on the network, and automatically smoothed the charging of EVs whenever the network was congested and therefore at risk.

The key finding was clustering of EVs will cause issues long before market saturation (32% of all GB circuits will experience issues when EV uptake on a street exceeds 40% of households).

To resolve this, technology can be used to manage EV charging, to not only protect networks, but also to facilitate the connection of more load such as EVs. It is therefore recommended that there is need for localised managed (either through control or shifting) EV charging during periods of peak demand on a network.

Since completing My Electric Avenue we are now working with a diverse range of stakeholders through the Smart EV Project in order to develop standards, which will provide a way for EV users to access smart charging.

www.myelectricavenue.info/about-project

www.eatechnology.com/projects/smart-ev/

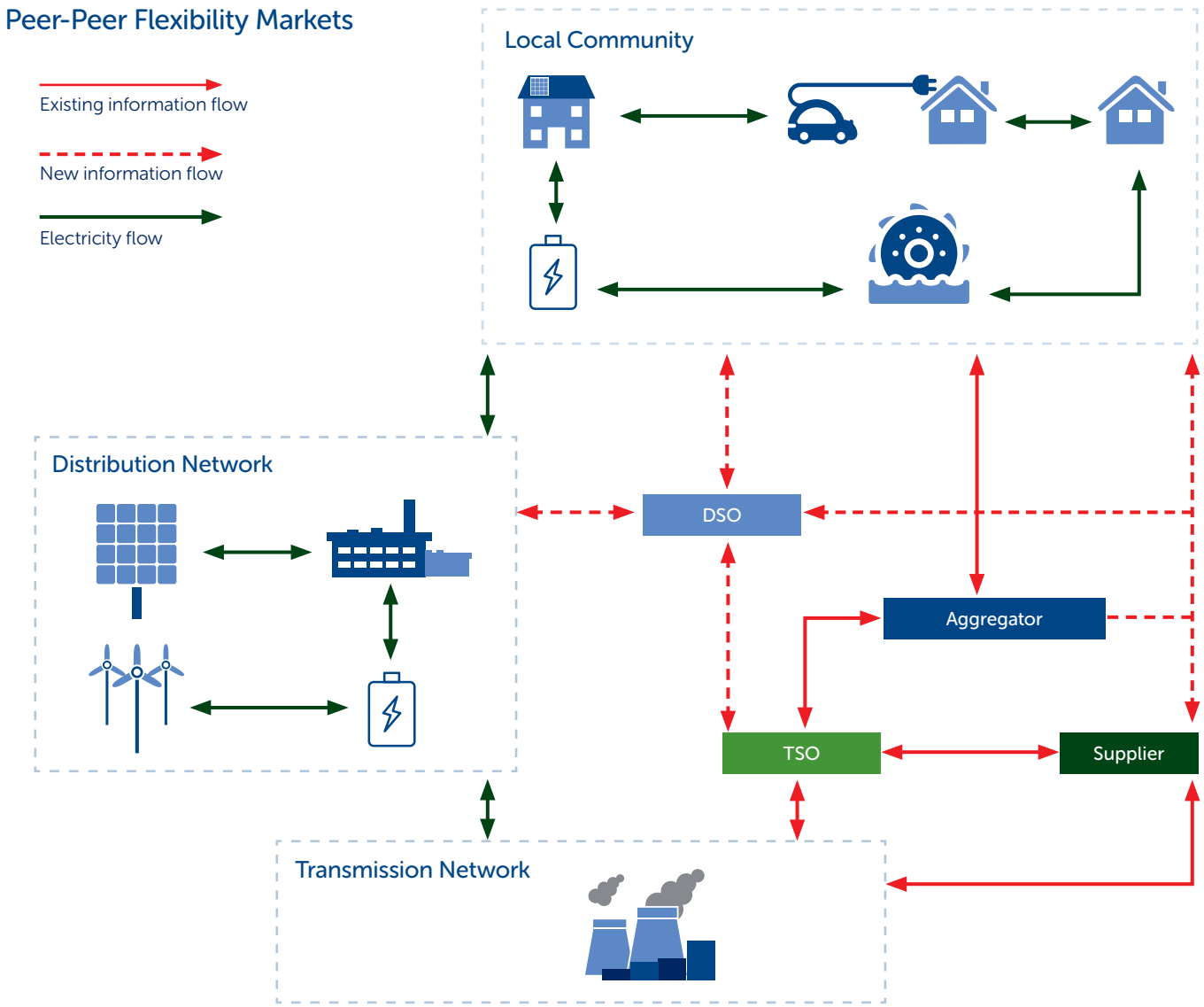

Figure 5: Graphic showing the real-time flows of electricity and information in the emerging system. The real-time information flows are shown in red.

Figure 5 shows how real time peer-to-peer markets can be facilitated in the emerging electricity system. While the existing system sees a one way flow from transmission down to distribution and local communities, the new system is characterised by two-way power flows due to the growth of DER. With unlimited network capacity it would be theoretically possible for customers to trade their flexibility across the whole GB system without DSO involvement. But all network circuits have a limit in terms of how much electricity they can import and export at any time. When it is forecast that there is no headroom capacity left, this should help market participants adjust their positions and provides a signal for local DER to dispatch to ease congestion and reduce curtailment; this is the basis of local flexibility markets. Local flexibility procurement can also defer network reinforcement and lower network losses. For example a peer-peer platform can allow customers with Solar PV to sell excess generation to neighbours with plug in EVs in a way that co-optimises network capacity and customers requirements.

These scenarios, as part of a peer-peer market, are achieved by suppliers and aggregators. Currently DNOs do not provide real-time information on available network capacity, however, it is envisaged that they will become the central coordinator of real-time data on local networks as part of the DSO transition. Rather than conflicting with the TSO who has responsibility for balancing the GB network, the DSO will assist by providing new visibility of what is happening on the local network. If, for example, there are no constraints the TSO can access DER flexibility for national requirements.

TimeOut – What do you think the barriers are for peer-to peer transactions and how can SSEN help to remove these?

Table 2: Scenarios of where a DSO can provide customer benefits

Example	SSEN Case Studies	Scenario	Potential Customer Benefits	Association with DSO Transition Principles
Off gas grid customer with electric storage heating	NINES (page 31)	The local Network is import constrained due to high penetration of electric heating and lack of interconnection	The DSO ensures that the customer's supplier or aggregator has visibility of when there is network capacity so that heat is delivered with minimal inconvenience and cost	1. A DSO must work for all customers.
Commercial customer with flexible demand	New Thames Valley Vision	A commercial customer has flexible demand and there is no network congestion	The DSO allows the customer to provide TSO services without any disruption and continues to monitor network capacity	2. Learning by doing will give the best outcomes for customers.
Social housing retrofit programme	SAVE (page 30)	The local Network is import constrained due to steady growth of peak demand	The DSO rewards the housing association for helping to lower peak demand through their energy efficiency measures	3. Our transition to DSO must be coordinated and cost efficient.
Community Renewable Energy Scheme	ACCESS (page 26)	The local Network is export-constrained due to the high volume of distributed generation	The DSO provides visibility of network capacity to enable the community to reduce generation curtailment by using DSR measures	4. Neutral facilitation is paramount.
Customer with a Plug In Electric Vehicle	My Electric Avenue (page 27)	The local Network is import constrained due to the rapid uptake of Electric Vehicles in the neighbourhood	The DSO works together with suppliers and aggregators to ensure that charging is coordinated and battery resource is efficiently utilised	5. A DSO should unlock local solutions.

Ensuring network resilience

One of the most significant responsibilities of a DSO for our customers is market facilitation. At the same time, customers will expect efficient, reliable energy supply and excellent customer service.

Through the transition we must ensure that this expectation is met and exceeded. As well as mitigating the risks of cyber threats to critical national infrastructure, the DSO will have an important role in managing network resilience in a system with potentially millions of new interconnected electronic devices. In the conventional system the use of electricity is reasonably predictable because of the natural diversity between different customers. Smart technology and Time-of-Use Tariffs could remove this diversity and increase the risk of supply interruptions and damage to electrical infrastructure.

The mass rollout of smart devices risks removing load diversity as more appliances are controlled by agents or aggregators responding to price signals eg set in 30 minute (settlement) periods. This issue was dealt with when the transition to Radio-Tele-Switching of electric heating occurred in the 1970s. A key learning was to ensure areas or 'zones' were staggered to create stepped changes to the ramp and eliminate large peaks and therefore network capacity issues.

The DSO will have an important role in managing network resilience in a system with potentially millions of interconnected electronic devices

Collaboration

A DSO must work for all customers

Case Study: SAVE

SSEN's 'Solent Achieving Value from Efficiency' (SAVE) is a collaborative multi-million pound project running between 2014 and 2019. The main objective of the SAVE project is to produce a Network Investment Tool that will allow DNOs to compare and assess different options for managing network constraints.

Engaging more than 8,000 domestic customers, SAVE is investigating the impact of energy efficiency measures such as LED lightbulbs and price signals in managing peaks in demand, as an alternative to traditional reinforcement. SSEN is partnering with Southampton University, DNV GL and Neighbourhood Economics whose expertise can ensure quality in testing the projects various energy efficiency measures with consumers and local communities. The Network Investment Tool will therefore be underpinned by field trial data as well as scenario modelling.

While avoided network reinforcement through energy efficiency measures may be limited to specific areas, the business case grows when stacked alongside other benefits, particularly in locations that can provide the most value to third parties. The use of energy efficiency is another demonstration of how DSOs can access non-network solutions to the benefit of customers.

www.ssen.co.uk/save/

By working together with stakeholders, such as appliance manufacturers, DSOs are best placed to resolve these issues on behalf of all customers. This will involve developing robust standards that meet the needs of Network Operators. This is already taking place with the connection of plugin EVs via SSEN's Smart EV Project. Our aim is to bring key stakeholders together to ensure that EV chargers have basic functionality to ensure network resilience. Without this a rapid increase of EVs connecting in the same street could cause disruption to surrounding customers.

Helping the vulnerable

SSEN is aware that not every customer will want to, or is able to take advantage of the benefits of DSO transition.

We have a long history of helping customers who have particular dependencies on the network. Through our Priority Services Register (PSR) we currently have identified 490,000 such customers, devoting significant time and resource to pro-active communication and support when our networks are at risk of storm damage and other disruptions. This includes for example prioritising treatment during a power cut and working with local emergency services to provide extra support.

This experience has shown us that care will be needed to ensure nobody is left behind in the transition to DSO. Vulnerable customers will be a particular focus, as will those living in fuel poverty and those isolated from modern communications infrastructure.

Going forward we see the DSO transition as providing an opportunity to enhance our services to vulnerable customers. For example new smart meters should help us improve our PSR database and fault detection. Increased data monitoring will allow DSOs to better identify vulnerable customers, which is already underway as part of a new mapping tool we are developing with the University of Dundee[14].

TimeOut – How can SSEN ensure that all of our stakeholders interests are fairly represented as part of the DSO transition?

Customers

A DSO must work for all customers

Case Study: NINES

The £18m Northern Isles New Energy Solutions (NINES) project took place between 2010 and 2017. The project took place in Shetland, where large and small scale energy storage solutions were deployed combined with a new monitoring and control system developed by Smarter Grid Solutions.

This helped deliver Active Network Management, which was tested for the first time on the SSEN network. In this case ANM enabled a 200% increase in renewable energy contribution on Shetland by helping to manage grid constraints more efficiently in real time. Due to its isolation from the mainland (GB) grid, the NINES project was able to demonstrate a new approach of increasing renewable energy in a cost efficient and secure way.

The installation of a 1MW battery at Lerwick Power Station was used to help to provide a stable electricity network and to reduce demand peaks. In addition to this, by working with Hjaltland Housing Association, new storage heaters and hot water tanks were installed, along with communication devices to provide DSR capability within 234 domestic homes. The battery stored the renewable generation at times of low demand so it could be used at a time when it was needed to supply people with electricity or heat. When operated through the ANM this combination of storage and DSR has directly resulted in the reduction of diesel used at the station by about 10%.

14 More info found here: http://news.ssen.co.uk/news/all-articles/2017/03/knowledge-transfer-partnership/

Learn by Doing

We expect SSEN's investment and operational decisions to both influence, and, be influenced by local circumstances beyond the traditional remit of a DNO; this includes transport plans, local storage resource or community-owned generation. This will require a step change in the way we work with our stakeholders. Our experience in places such as Shetland, Orkney, Thames Valley and the Isle of Wight has given us insight of what this will involve, and evidently new approaches need to develop on a local basis.

The future remains uncertain and will involve unproven concepts and techniques. SSEN has a strong record of "learning by doing" when it comes to translating ideas and concepts into working solutions. This approach has served us well by providing evidence to inform our future decision making. The transition to DSO will follow the same path; incrementally testing and proving each step while working to a long term goal of realising a smart energy system. The case studies highlighted in Table 1 demonstrate how we are applying our learnings to the DSO transition.

Our view of what customers require from a DSO is informed by our innovation portfolio, the knowledge shared by other Network Operators, and extensive stakeholder feedback

Our view of what customers require from a DSO is informed by our innovation portfolio, the knowledge shared by other Network Operators, and extensive stakeholder feedback. We have been innovating, developing and deploying aspects of the DSO across our network with a range of organisations and stakeholders. Our projects are demonstrating the technical viability and customer acceptance of a range of solutions; from domestic Demand Side Response in remote parts of Scotland, to the value of Energy Efficiency investment for networks in the Solent.

Having successfully utilised our Network Innovation Allowance (NIA) and Network Innovation Competition (NIC) funding to prove many of the technical aspects of using non-networks related flexibility, we are now focused on scaling up the procurement of this flexibility and ensuring that we enable wider system integration.

Subject to Ofgem approval, our 'Project Transition' will start to test the commercial aspects of becoming a DSO at the start of 2018. This will be linked to the ENA's Open Networks Project, and in conjunction with other Network Operators will trial a range of possible market models, with the objective of developing a platform to facilitate neutral market access for DER.

7. Our action plan

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The transformation taking place in electricity supply and distribution is an opportunity for new sectors, technologies, and services to flourish. SSEN intends to remain at the forefront of implementing change that facilitates access to markets for DER. This will be done in a manner that enables DER to compete fairly and to ultimately reduce costs for customers. The transition to DSO aims to increase competition, improve coordination across the system and enable customers to realise the true value of their energy resources.

The significant investment we are making during RIIO ED1 on DSO-related capabilities is an indication of SSEN's commitment to the transition and Figure 6 details developments already under way.

DSO deployment team established and supported by SMEs from across the business

We are making an investment of over £100m in upgrading our IT systems in preparation for the needs of DSO

We are already making Flexible Connections available across our networks

An Active Solutions team has been in place for two years transitioning innovative solutions to business as usual

Our Network Innovation Bid this year is focused on accelerating and de-risking the transition to a smarter grid

We are currently rolling out a new communications infrastructure that improves the capture of network asset data

Figure 6: Smart Grid developments we have already implemented

TimeOut – What do you see as the main opportunities of the DSO transition?

Whilst we are committed to being early adopters, our timeline will be aligned with the ENA's Open Networks project, as we believe collaboration is key to a successful transition. Nevertheless, SSEN will continue to trial and deploy DSO capabilities as and when they are suitably defined. Our commitments overleaf details the areas that we have already identified where progress needs to happen to achieve a smarter grid for customers.

Opportunities exist for new sectors, technologies, and services to flourish and SSEN intends to remain at the forefront of implementing change that improves access to markets for distributed energy resources. We will do this in a manner that will enable them to compete fairly and ultimately will reduce costs for consumers. SSEN will open up new markets, improve coordination across the system and enable these businesses to realise the true value of their services.

Today, at the outset of this shift, the DSO transformation appears complex and highly technical. We have no illusions about this. But with a customer-focused approach that maintains resilience, efficiency in our costs, and collaboration across the industry, we and the industry will be well placed to ensure our electricity networks successfully fulfil the major role they now have in our energy future.

Our Action Plan Commitments

	Commitments	How does it benefit customers?	How does it improve efficiency?
Delivered	Flexible generation connections available.	Reduces connection cost provides shorter connection timescales by allowing SSEN to manage the connection.	Reduces reinforcement costs and improves asset utilisation.
	Constraint Managed Zone tender.	Provides faster connection times and opportunities to earn income from flexible assets.	Avoids reinforcement costs and provides optionality value.
	Provide continued substantive input to the ENA's Open Networks project.	Ensuring that the learning from our innovation portfolio is fully utilised by the ON project, providing a solid evidence base to help inform the transition.	Accelerates the realisation of the benefits and reduces the risks associated with the transition to DSO.
	Regional development plans for transmission system development.	Ensures whole system view of changes and developments that could alter investment decisions.	Supports identification of alternative, flexible solutions and reduces risk of stranded assets in immediate investment plans.
	Installation of additional voltage control equipment on the transmission network.	Ensures management of voltage requirements across Scotland, protecting system security.	Manages voltage requirements with reduced large synchronous generation plant.

	Commitments	How does it benefit customers?	How does it improve efficiency?
2017 – 2018	Complete delivery of our Asset Management systems to provide the base on which the DSO platform can be built.	Prepares our legacy IT systems to support the transition to DSO to reduce expense and delay of a transition.	Brings operational efficiency and informs improved investment decision making.
	Implement the first Live CMZs.	Provides opportunities for those in CMZ areas to gain early experience of providing flexibility services to DSOs and facilitate new commercial DER solutions.	Avoids reinforcement costs and provides optionality for the DSO.
	Submit a collaborative bid for NIC funding to allow a DSO market platform to be trialled with new market models.	Accelerates the development of DSO bringing forward the implementation of new markets.	Accelerates the realisation of the benefits assigned to the DSO transition.
	Development of north of Scotland local energy scenarios.	Improves visibility and accuracy of future network requirements to inform system planning.	Supports identification of alternative, flexible solutions and reduces risk of stranded assets in long term investment planning.
	HVDC system modelling.	Ensures system security with integration of additional HVDC including interconnectors.	Manages voltage requirements with reduced large synchronous generation plant.
	Deliver the dynamic Line Rating innovation project.	Information is used to better manage system instability risks which can particularly arise between Scotland and England.	Will ensure that only those services that are actually required are requested based on live data.
	New Appendix G process being trialled at 12 GSPs in the South as a precursor to Transmission Impact Assessment.	New Appendix G process being trialled at 12 GSPs in the South as a precursor to Transmission Impact Assessment.	Reduces the time taken to provide customers with the relevant information.

Scottish & Southern Electricity Networks

2018 – 2019	Commitments	How does it benefit customers?	How does it improve efficiency?
	Migrate our Active Network Management environment to a centralised scalable architecture in readiness for DSO.	Reduces the customer cost and time to implement flexible connections throughout our network.	Brings operational efficiency and reduced IT infrastructure costs.
	Establish and trial a bottom up whole system planning methodology.	Informs our customers and stakeholders of the opportunities that whole system planning can provide allowing preparation for the transition to DSO.	Provides an informed RIIO-ED2 submission based on new models of flexibility allowing realistic assessments of the availability of flexibility and interaction with underlying network investment needs.
	Provides an informed RIIO-ED2 submission based on new models of flexibility allowing realistic assessments of the availability of flexibility and interaction with underlying network investment needs.	Accelerates the development of DSO bringing forward the development of new markets and opportunities to sell flexibility.	Accelerates the realisation of the benefits assigned to the DSO transition.
	Transmission Impact Assessment rolled out to selected GSPs in the North and South replacing SoW.	Customers will have clarity at offer stage on whether their site will have a transmission impact and the associated costs and timescales of works.	Transmission and distribution will have visibility of network capacity at the GSP. Customers are able to make timely investment decisions rather than entering a complex and lengthy process.

2019 – 2020	Commitments	How does it benefit customers?	How does it improve efficiency?
	Continued deployment of CMZs as an interim means of utilising flexibility.	Provides faster connection times and opportunities to earn income from flexible assets.	Avoids reinforcement costs and provides optionality value.
	Completion of the upgrade of our core IT systems to support DSO operation.	Accelerates the development of DSO bringing forward the development of new markets and opportunities to sell flexibility.	Accelerates the realisation of the benefits assigned to the DSO transition.
	Subject to NIC bid approval, build a DSO market platform based on the ON project SGAM.	Accelerates the development of DSO bringing forward the development of new markets and opportunities to sell flexibility.	Accelerates the realisation of the benefits assigned to the DSO transition.
	Subject to NIC bid approval, trial DSO neutral market enabling platforms with third party market operators and participants.	Accelerates the development of DSO bringing forward the development of new markets and opportunities to sell flexibility.	Accelerates the realisation of the benefits assigned to the DSO transition.
	Completion of a range of trials in association with the ENA Open Networks project.	Accelerates the development of DSO bringing forward the development of new markets and opportunities to sell flexibility.	Accelerates the realisation of the benefits assigned to the DSO transition.
	Continued expansion and evolution of CMZs as an interim means of use of flexibility.	Accelerates the development of DSO bringing forward the development of new markets and opportunities to sell flexibility.	Brings operational efficiency and informs improved investment decision making.
	Prepare RIIO-ET2 submission based on a smart flexible systems model.	Customers will benefit from an informed RIIO-ET2 plan that maximises the savings achievable from flexibility and the opportunities for customers to trade energy in new ways.	Ensures that a realistic and rigorous application of flexibility and the impact of market developments is integrated fully into our RIIO-ET2 submission.

2020 and beyond	Commitments	How does it benefit customers?	How does it improve efficiency?
	Prepare of RIIO-ED2 submission based on a DSO model.	Customers will benefit from an informed RIIO-ED2 plan that maximises the savings achievable from flexibility and the opportunities for customers to trade energy in new ways.	Ensures that a realistic and rigorous application of flexibility and the impact of market developments is integrated fully into our RIIO-ED2 submission.
	Localised deployment of DSO in place of CMZs.	Flexibility becomes a valuable commodity with means to access the markets for all. New third party market models are available allowing genuine customer choice.	Flexibility plays a major part in the operation of the network optimising the utilisation of assets on a whole system basis and as a result reducing relative costs.

TimeOut – Are there any other commitments that we should be making?

8. Feedback

Scottish & Southern Electricity Networks

SSEN takes all stakeholder feedback seriously and would really like to hear any views you have on the content within this document. Hopefully the **TimeOut** prompts have stimulated questions or challenges. If you have any comments or questions you can get in touch with us by email at: **futurenetworks@sse.com**

Please check our website **https://www.ssen.co.uk/** for updates and information on events that will discuss the transition to DSO in more detail.

Notes

9. Glossary

ANM Active Network Management	**CMZ** Constraint Managed Zone	**DER** Distributed Energy Resources	**DNO** Distribution Network Operator
DSO Distribution System Operator	**DSR** Demand Side Response	**DUoS** Distribution Use of System	**ENA** Energy Networks Association
GSP Grid Supply Point	**NETSO** National Electricity Transmission System Operator	**NIA** Network Innovation Allowance	**NIC** Network Innovation Competition
NINES SSEN's Northern Isles New Energy Solutions project	**SAVE** SSEN's Solent Achieving Value from Efficiency project	**TO** Transmission Operator	**TSO** Transmission System Operator

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Notes

Contact us:

+44(0)345 300 2315

future.networks@sse.com
www.ssen.co.uk/Innovation
@ssen_fn

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