SPEN – DSO VISION

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ABSTRACT

To meet the challenges implicit in transitioning to a low carbon Smart Grid it has been recognised in the UK that Distribution Network Operators (DNOs) need to develop towards becoming Distribution System Operators (DSOs). In an effort to understand the implications of this transition SP Energy Networks instigated a collaborative industry steering group to develop a vision of SP Energy Networks as a future DSO.

INTRODUCTION

As the UK builds towards a low carbon future, the nature of the electricity grid is changing. We no longer rely solely on centralised energy generation supplying all of our demand customers. We are experiencing increasing volumes of Distributed Generation and Distributed Energy resources (DER), Smart Meters being installed in our customers' homes and the adoption of electric vehicles. There is a need for network operators to adapt to meet these challenges whilst maintaining low cost, reliable energy distribution for UK customers. In addition as customers increasingly become 'prosumers' there is a need to facilitate a fair market for the services that they could provide to the electrical network.

If network operators are to facilitate the transition to a low carbon future in a cost effective way they need to maximise the existing electrical infrastructure. The evolution of the energy sector towards a smarter system will only be possible if the Distribution Network Operator's (DNOs) play an active coordinating role between all market participants, facilitating the markets and services in a neutral and non-discriminatory manner. This will be achieved by extending the current role of the DNOs to that of Distribution System Operators (DSOs). An effective DSO model will reduce system balancing costs whilst enabling the flexible networks necessary to facilitate low carbon technologies. A DSO would aim to optimise customer engagement, minimise costs, improve customer service, reduce losses and optimise investment at a local level.

In an effort to understand and explore the role of a UK DSO SP Energy Networks created a DSO Steering group which included a wide range of industry stakeholders to inform a DSO Vision. This vision document was released in October 2016 for public consultation and will be used to inform thinking within SP Energy Networks and the wider UK utility industry.

This paper summarises the findings and recommendations of the SP Energy Networks DSO Steering group and the published SP Energy Networks DSO Vision document.

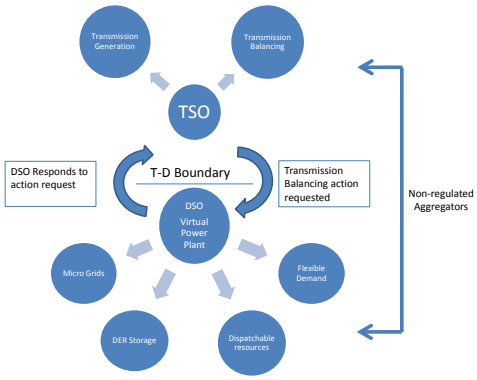
DSO PRINCIPLES

SP Energy Networks DSO Vision identifies a number of high level principles that govern our proposed DSO model:-

Our Vision is that SPEN will transition towards becoming a full DSO which will facilitate an open and inclusive balancing services market at the Transmission/Distribution interface. The DSO will also carry out local system balancing, efficiently utilising the Distribution network

Distributed Energy Resources (DERs) will be aggregated into Virtual Power Plant (VPP) or Virtual Balancing Mechanism Units (VBMUs) which will interface with the UK System Operator (SO), to act on balancing instructions. This aggregation will require the DSO to facilitate a market and as such a mechanism will need to be developed to remunerate Distributed Energy Resources (DERs) for the services they provide and/or provide pricing signals for DERs without direct control (e.g. groupings of domestic electric vehicle charging points) to react to system requirements.

We believe that this approach will be critical to ensure that the market is prepared for the emergence of new participants.



Potential interaction between DSO, SO and DERs

In addition the DSO will balance the local distribution network, making effective use of the existing Distribution network and where practical matching local generation with local demand. The increased information on the system utilisation will also act as an investment driver identifying where additional network reinforcement is required.

We will continue to improve the level of customer service and manage system security in line with our current role as a DNO. We will ensure that the expansion of our role as a DSO continues to deliver value for money to our customers.

In moving to our new role as a DSO we must also balance our existing commitments to customers and the regulatory and licence commitments we have as a UK DNO.

A critical element of this will be maintaining system security on an increasingly decentralised network. With the closure of large scale thermal plant and an increasing volume of intermittent generation being connected to the network, the DSO will need to carry out a co-ordination role to ensure that UK customers continue to experience the high level of system security currently provided by the UK electricity network.

Our DSO model will be capable of enacting system balancing actions from the SO within timescales that best meet the needs of the SO and the capabilities of the DERs connected to our network areas.

Critical to realising our DSO vision will be a communication infrastructure that provides a seamless interface between the SO, our control facilities and the DER resources that we will aggregate. This will allow us to provide balancing services within an acceptable timeframe for the SO. This will also need to be balanced against the capabilities of the DERs connected to our networks.

Our transition to a DSO will be both modular and proportionate.

- In terms of a modular approach, we will identify those network areas that most urgently require real time monitoring and control to address current issues.
- In terms of proportionality not all network and geographic areas will require the full range of integration and DSO services, this may be due to a lack of foreseeable network constraints. We will install sufficient network monitoring capabilities to monitor the requirements of these areas.

We believe that the correct way to transition towards a DSO is to develop the monitoring and control capabilities across our existing networks, focusing on our current network challenges. This is also the first stage in rolling out active network management in those network areas. These are no regrets actions, required to facilitate a smart grid network and a major stepping stone towards the technical requirements for DSO enabled network areas. This modular approach will also allow us to test the operation of a DSO model in a controlled manner, allowing learning to be applied to future DSO enabling works

We will work with Government, Ofgem, UK Network companies, DER providers and key stakeholders to develop and implement a fair and cost effective remuneration mechanism for all DSO services and DER providers.

The DSO role will require policy makers, industry and key stakeholders to develop remuneration mechanism(s) for DSO services. Research, modelling and trials will need to be carried out in order to ensure that the remuneration methodology is indeed in the best interests of UK customers. Any remuneration mechanism must also factor in the long term low carbon goals of UK Government.

TRANSITIONING TO A DSO

In order to realise our vision of transitioning to a DSO a number of industry developments will be required. These changes will also need to be developed and agreed with a wide range of stakeholders to ensure that the DSO model is compatible with all UK networks and provides a consistent approach for demand and generation customers. They can be broadly categorised as:-

- Key enabling technologies
- Key commercial changes

Key Enabling Technologies

Technology will be a vital component in facilitating the development of the DSO model to enable the interoperability and visibility of actions between DSO, generation units, demand side response providers and the SO. The DSO smart grid model of the future will look very different from the network of today. Power will be generated from multiple sources, flow in multiple directions and will offer consumers greater flexibility and choice. However with greater integration of intermittent renewable generation and demand this will create voltage and power quality issues and will impact the ability to adequately protect against system events.

DER, Demand Response (DR) and Energy Storage (ES) mechanisms will introduce new variables and complexities into the traditional passive distribution network. These variables will require a more dynamic and flexible solution, not only with respect to its operation but also investment decisions over an extended period of time. The DSO will have to manage an increasingly congested playing field with market drivers leading to potential conflicts with network availability or capabilities. The DSO will have to ensure reliability during times of peak load, whilst balancing local production and demand and accommodating new intermittent DER. As the flows of power become more complicated the ability to become more flexible will be essential.

Although enabling architecture may be complex in nature to address these issues, they will ultimately be born from the need to solve simple problems which will have to be addressed in any case to facilitate the Smart Grid. These include:-

- Enhanced Monitoring
- Improved modelling and Prediction tools
- Control and Automation of Assets
- Communication and Distribution Management System(s) (DMS)
- Cyber Security and Data Protection

Enhanced Monitoring

An increasingly complex distribution network will require higher levels of monitoring beyond the current substation boundaries. Data will need to be collected at key network locations and at a higher frequency and granularity, both in relations to real time system operations and longer term network planning. Current practices of real time monitoring must expand beyond the substation to strategic locations, service providers and DER installations. The ability to control the network, take actions and react to wider system events through the use of enhanced monitoring solutions will aid our ability to detect issues directly impacting network performance, system stability and ensure we maintain a safe and reliable network. New sensors, communication equipment and information technologies promise to improve efficiency, reliability and power quality of the distribution system, improve the quality of service and enabling increased DER penetration and improved customer choice.

Enhanced modelling capabilities will include:-

- Wide area monitoring at all voltage levels
- Increased penetration and scope of Intelligent Electronic Devices (IED)
- Real time state estimation
- Load flow analysis
- Power quality monitoring

Improved modelling and Prediction tools

Enhanced monitoring will lead to improved understanding and data capture from an increasingly dynamic and complex distribution network. As network understanding increases so will the need for more sophisticated network planning tools. These tools will offer SPEN the ability to forecast with improved accuracy, leading to improved network planning and development decisions. With tools and real time data detecting transient issues and market changes, development decisions and local solutions can be adopted to increase grid resilience. Moreover software tools will enable services and solutions to be managed autonomously without human intervention, predicting solutions and actions based on network information in near real time. Sophisticated analysis tools will support flexibility by enabling adaptability to changing business and system requirements.

Key enabling predictive solutions will facilitate,

- Improved Network modelling leading to real time network solutions
- DER forecasting and control
- Network capabilities for dynamic running arrangements
- Improved network flexibility

Control and Automation of Assets

Although improved monitoring and modelling tools will enable the network to be controlled and optimised with confidence, the ability to take actions will still be dependent on controllable assets. Network Controllable Points (NCPs) will be standard practise and will be essential for day to day network running. These controllable points will expand beyond the current operation of circuit breakers and voltage tap-changers, to power electronics and the control of active network management solutions in near real time based either on market drivers or network optimisation.

The DSO smart grid will require advancements in automation to enable legacy assets to be controlled and operating within their operating limitations. This will lead to the requirement for advancements in protection and fault detection solutions and increased monitoring and understand for assets coming towards end of life.

Highly reconfigurable protection will be essential to ensure appropriate protective settings based on circuit configuration and fault level contributions.

Advanced networks automation and control capabilities will include:-

- Voltage / power flow optimisation
- Active System Management
- Automatic control in real time to optimise network performance
- Control of load / demand
- Fault control / Fault level management
- Highly configurable or Dynamic Protection

Communication and Distribution Management System (DMS)

Ultimately the monitoring, modelling and control of assets will not be possible without an integrated IT solution and faster more reliable communication. Significant expansion of automation and monitoring will drive the need for additional bandwidth with expanded coverage. Wireless solutions with near real time monitoring and control will be required to operate and control service solutions based on market drivers. The DSO smart grid network will connect network assets, DER, customers and third parties service providers. It will require a common infrastructure to enable device to device communication across the network.

Communication capabilities will include;

- Interaction of wired and wireless communication platforms
- Prioritisation of service solution or coverage
- Automation distribution control
- Increase cyber security solution
- Increased reach of communication solution for rural and underground assets
- Centralised or Decentralised network intelligence

With greater visibility and control of the distribution system the requirement for a sophisticated distribution management system (DMS) that can handle and fully integrate a wide variety of system tasks will become essential. The integration of new sensors, communication and advanced information technology will accelerate the role the DSO can perform and its capabilities. Traditionally computing infrastructure has been centrally controlled and very much limited to the control room activities however as field devices become more intelligent many will have the ability to provide autonomous network solutions.

Computing infrastructure technology requirements and capabilities will include:-

- High availability
- Monitoring and health checks
- Increase functionality between service and third party providers
- Increase data processing
- 'Big Data'

Additional management capabilities will include,

- Black start and islanding running arrangement
- Information exchange between DSO, SO and third party service providers
- Firm and un-firm connection agreements
- Real time voltage and power quality control

Cyber Security and Data Protection

The transition to a full DSO model will result in a significant increase in communication links between the UK SO, network operators and 3rd parties it is essential that cyber security is fully risk assessed and mitigating actions put in place to ensure overall system security. In addition the types of data being transferred between parties need to be understood to understand the Data Privacy implications. These challenges have been at the forefront of the Smart Meter rollout in in the UK and it seems pragmatic to follow a similar process to minimise the risk to UK customers.

Key Commercial Arrangements

DNO/DSO Remuneration

The concept of DNOs being recompensed for ancillary services has been effectively trialled in Electricity North West(ENW) under the Customer Load Active System Services (CLASS) project. Through control of existing assets ENW have explored the provision of the following services to the UK SO:-

- DSBR (Demand Side Balancing Reserve)
- FR (Frequency Response)
- FFR (Firm Frequency Response)
- FCDM (Frequency Control by Demand Management)
- STOR (Short Term Operating Reserve), and
- Reactive Power Services.

Ofgem have provided confirmation on the regulatory treatment. The associated costs and revenues can be reported in the Valued Added Services' category of Directly Remunerated Services. This approach could be extended to additional services, however this could only be achieved through working with Ofgem and NG in its capacity as the UK SO.

Whilst this may be a suitable interim solution for the current distribution price control (RIIO ED1 2015-2023) period a more comprehensive charging mechanism for ancillary services will be required for RIIO ED2 (2023-2031) and as DNOs transition towards becoming DSOs.

Neutral facilitators of an ancillary services market

In our DSO vision we see ourselves as neutral facilitators of an ancillary services market. To achieve this goal we need a transparent and fair mechanism to remunerate DER providers, when they are called upon to provide ancillary services. Clear contractual arrangements will need to be provided to DER providers on how they will be dispatched and how they are prioritised. This will be crucial to ensure DER providers have all available information when they seek to secure financeability for their projects.

Given the increased volume of DERs we expect to be available to DSOs, we believe that the dispatch and remuneration process will need to be heavily automated through optimisation software and automated payment services. To date ANM schemes have focused heavily on automating networks based on electrical system requirements, this technology will need to adapt to balance both system and commercial demands.

Influencing the behaviour of uncontrolled DER assets

In addition to those DERs that will have direct contractual arrangements for the provision ancillary services, there will be generation and demand resources that have no such arrangements in place that may still assist in overall network balancing e.g. domestic storage, domestic EV charging. The extent to which a DSO has control over these resources, either through pricing signals or other non-direct means must be determined. This must be decided in conjunction with key stakeholders, reviewing the implications on:-

- Customer behaviour
- Energy pricing
- Decarbonisation of heat and transport
- Regulatory implications of DSO/DNO powers

DSO TRIAL AREAS

It is our intentions to trail two geographic areas as DSO enabled network areas within the RIIO ED1 price review. These areas have been selected as real time energy balancing could address existing network challenges.

SP Distribution Licence area - Dumfries and Galloway

The Dumfries and Galloway network area is rich in natural resources but has relatively low demand requirements, with the large volumes of DG now connected to the network Dumfries and Galloway is now a net exporter of energy. There is currently 190MW of demand with 340MW DG connected and a further 660MW contracted to connect to the network

SP Manweb Licence area - North and Mid Wales

The North and Mid Wales network area includes a wide range of urban and rural environments with a significant penetration of distributed generation. There is currently 800MW of demand with 800MW DG connected and a further 700MW contracted to connect to the network. In order to facilitate the future deployment if generation in the area we will seek to utilise innovative solutions including active network management, enhanced thermal ratings, battery storage and Direct Current (DC) cable solutions. The network also operates meshed (heavily interconnected) and will allow us to demonstrate novel ANM solutions on this type of network architecture.

ACKNOWLEDGMENTS

We would like to thank the SP Energy Networks DSO Steering Group members for their contributions in developing Our DSO Vision, we would also like to thank those organisations and individuals that responded to our consultation.

NEXT STEPS

In 2017 we plan to develop our vision document into a more comprehensive route map document. This will take into consideration our stakeholder feedback and outline detailed steps that we will take towards realising a DSO model in the UK. This will require engagement with wider UK industry, to that end the Energy Networks Association (ENA) has created a steering group focused on the DNO to DSO transition.

We will also be developing detailed transition plans for our two identified DSO trial areas in 2017.