The Voice of the Networks

Open Networks
Workstream 1: Product 2

Gaps & Issues Report

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Contents

1. Introduction

This report is part of the ENA Open Networks Workstream 1 – Product 2: Gap and Issues Analysis – Investment and Operational Processes.

To perform the Gaps and Issues Analysis, the working group developed the following objectives:

- Considering existing transmission and distribution investment[1] and operational planning processes, identify the key focus areas for analysis
- Identify gaps, issues and barriers, and provide analysis with respect to the DSO transition roadmap (this includes gaps in DNO, TSO and customer data)
- Review the key gaps and issues identified and propose actions to address them
- Identify what can be achieved in the short term and develop a work plan to address key gaps

The second revision of this report incorporates the analysis carried out for operational planning. For the avoidance of doubt, operational planning refers to planning timescales over and including a day ahead. Many gaps and issues as well as respective actions reflect both operational and investment planning processes.

1.1 Scope

1.1.1 Inclusions

To perform the Gaps and Issues Analysis, the following scope of work was developed:

- Reference Product 1 report to identify existing processes and methodologies
- Identify the key areas for analysis
- Derive the future state by considering the DSO transition roadmap
- Identify gaps in existing systems, policies, processes, data and technology that will need to be addressed
- Identify any barriers to implementation that may exist for each
- Consider existing network innovation projects and programmes of work that may be used to address these challenges
- Recommend a set of actions across the short, medium and long term
- Provide a detailed action plan to address what can be achieved in the short term

1.1.2 Considerations

The scope of the work will consider the impacts of the European Union (EU) network codes where possible and where information is available. Where necessary the outputs of this project will look to inform on the code drafting ahead of implementation.

[1] The latest editions of the report includes Gap and Issues Analysis with respect to Operational Planning

1.2 Background Information

1.2.1 Normative References

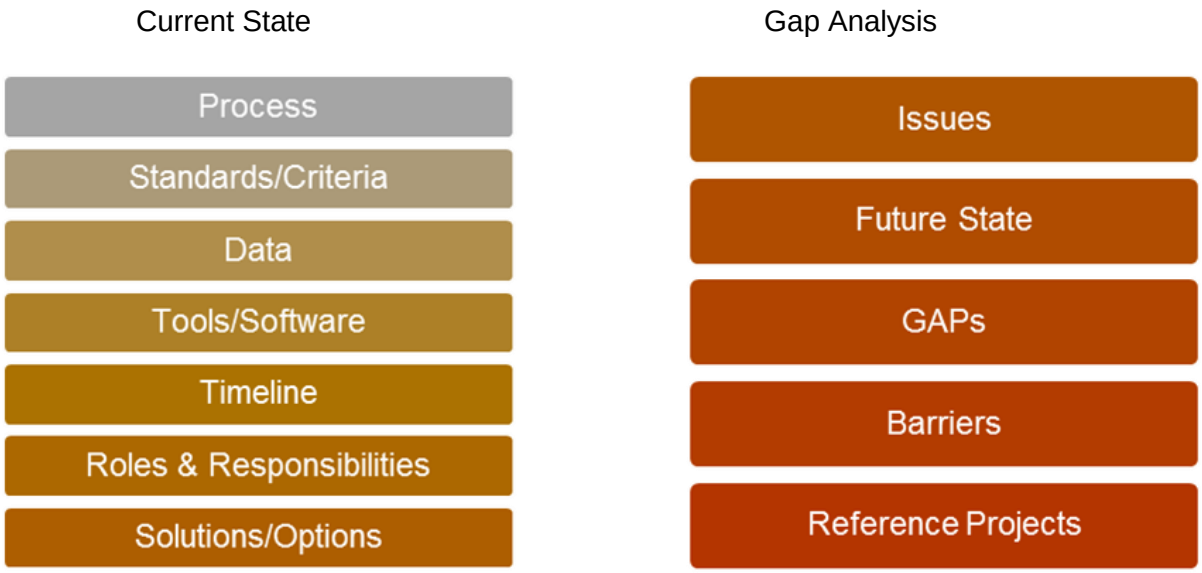
The referenced documents (in whole or part) required for this report's application include the following [2]:

- Statutory Requirements:
  - Electricity Safety, Quality and Continuity Regulations (ESQCR)
  - Electricity Act 1989 (as amended)
  - EU Network Codes
- Licence Requirements
  - Grid Code
  - Distribution Code
  - Security and Quality of Supply Standards (SQSS)
  - Connection Use of System Code (CuSC)
- Standards publications:
  - Engineering Recommendation P2 /6 'Security of Supply'
  - Engineering Recommendation P28 ' Planning Limits for Voltage Fluctuations Caused By Industrial, Commercial and Domestic Equipment in the UK
  - Engineering Recommendation G59/3 'Recommendations for the connection of generation plant to the distribution systems of licensed distribution network operators'
  - Engineering Recommendation P29 ' Planning Limits for Voltage Unbalance in the United Kingdom'
  - Engineering Recommendation G74 'Procedure to Meet the Requirements on IEC909 for the Calculation of Short-Circuit Currents in Three-Phase AC Power System'
  - Engineering Recommendation G5/4 'Planning Levels for Harmonic Voltage Distortion & the Connection of Non-Linear Equipment to Transmission Systems & Distribution Networks in the United Kingdom'

[2] For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2. Gap Analysis

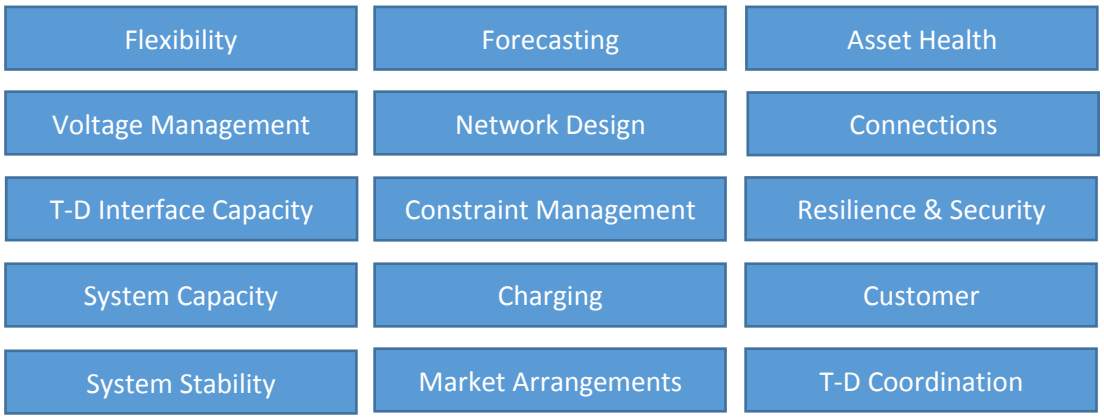
The analysis was formed using the information provided under Product 1 of the ENA Open Networks Project [Workstream 1] and through assessment against the proposed roadmap to DSO. The analysis was carried out by populating the following metrics:



The following drivers for change were identified:

- Level playing field across Transmission and Distribution
- Consistency in Transmission and Distribution approaches to planning
- Neutral facilitators
- Customer experience
- Whole System view

In considering the aforementioned drivers and the future state as defined through the proposed transition to DSO, fifteen focus areas were considered across Transmission and Distribution (T&D). These areas are categorised as follows:



Detailed information on the full gap analysis can be found in Appendices A and B of this document.

2.1 Consolidated Analysis

Through conducting a full analysis across the given areas, synergies and a commonality in gaps was observed. This section summarises the following themes derived from the detailed analysis. Individually, improving anyone of these themes ultimately assists in improving the customer experience but some of the themes form the building blocks towards a future looking operating model between distribution network owners, transmission network owners and the system operator, see figure 1.

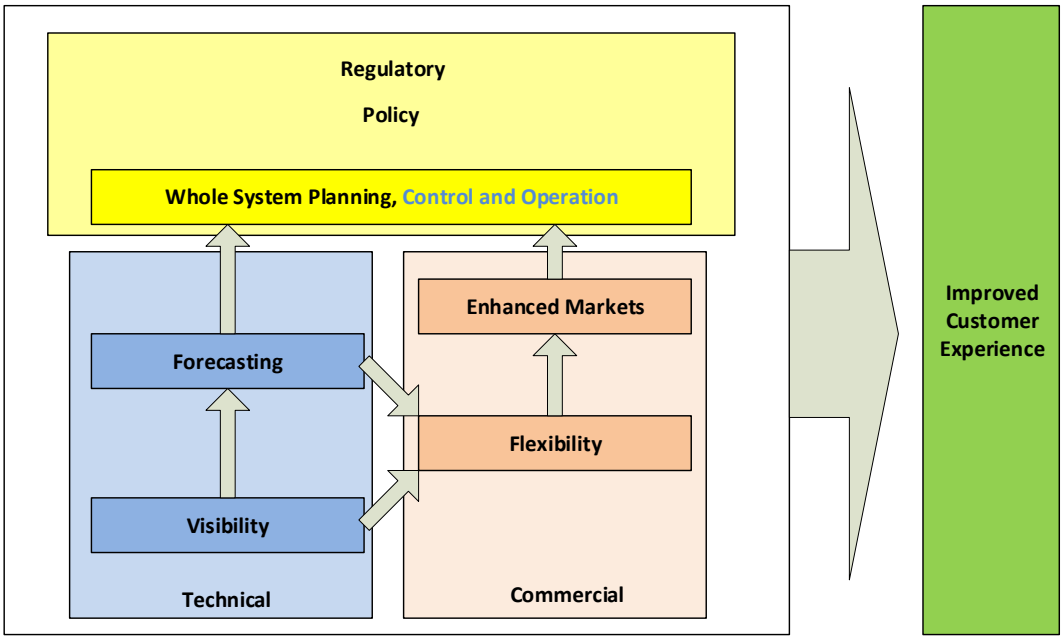


Figure 1 - Identified gap themes with change driver heading

These themes have also been allocated between the key change headings of Technical, Commercial, Regulatory and Policy. Whilst there is overlap between some of these headings, largely Visibility and Forecasting requires Technical change, Enhanced Markets and Flexibility requires Commercial change and the driver for Whole System Planning, Control and Operation comes from both Technical and Commercial changes governed by Regulatory and Policy change. A summary of the key gaps per theme are detailed below:

2.1.1 Visibility & Data

System monitoring

- Traditional operational monitoring at distribution level unlikely to be sufficient for system operation
- Insufficient visibility of transmission and distribution network configuration and capacity in operational timescales
- Limited availability of Whole System network models (Transmission – Distribution and Distribution - Distribution)
- Consistency in the application of short term asset ratings
- Inability to identify service conflicts

Visibility of DER/TER (demand & generation) and operating behaviour

- Insufficient visibility of demand (latent, gross and net) in operational and planning timescales
- Insufficient visibility of embedded generation in operational and planning timescales
- Insufficient visibility of contractual arrangements (incl. costs and third party arrangements)

- Lack of data on operating regimes of demand & generation
- Insufficient visibility across wider customer base

Information on DER resilience and dynamic performance

- Lack of understanding of DER behaviour can lead to system security issues and a cautious approach to new connections
- No coordinated approach to flexibility across transmission and distribution
- Insufficient understanding of the impacts of the increased provision of services from DER/TER
- No whole system view of available flexibility

Comparison of constraint and operational costs against further investment (building assets) costs

- Insufficient level of information to inform CBA
- No assessment process to balance the economic impact versus the security risk

2.1.2 Forecasting

Limited scenario planning at distribution level and whole system

- Not all DNOs are producing Future Energy Scenarios (FES) equivalents for Distribution networks
- No whole system approach to combine data from transmission and distribution scenario planning

Lack of coordination of Transmission and Distribution scenario, operational planning and other forecasting

- Local and Regional forecasting (services, demand, generation, weather, etc.)
- Understanding of Transmission and Distribution network topologies
- Service conflict forecasting

Insufficient Short, medium and long-term forecasting at transmission and distribution levels

- Forecasting of DERs, LCTs, demand and other active participants
- Forecasting of all passive participants
- Forecasting of dynamic ratings
- Forecasting of available flexibility (technical & commercial)
- Constraints/outages – planned position and known assumptions
- Year round approach in forecasting and planning
- Move away from focus on winter peak
- Identify potential issues not associated with winter peak
- Understanding of impact across the year (profile)
- Accurate forecasting of MVAr, MW, fault level and costs year round and in operational timescales

2.1.3 Flexibility

Inadequate flexible solutions to maximise available capacity and operational response on transmission and distribution networks

- Transmission and Distribution interfaces (software etc.)

Limited visibility of flexible resources as cost effective alternatives to network investment and to manage network operation

- Technical enablers
- Markets that encourage participation

Lack of processes to compare asset and service based solutions for network capability and security

- Wide range of DER and asset based flexibility solutions

Inadequate standards and procedures to facilitate coordinated deployment and operation of ANM and flexible solutions

- Whole system approach to ANM operation
- Considerations to local and system wide security

Limited signals and signposting to flexibility and short term contract requirements (i.e. operational trading)

- National system requirements
- Locational transmission and distribution requirements

Inefficiencies in traditional network planning due to uncertainty

- Flexibility can de-risk investment on the network

2.1.4 Enhanced Markets

Current lack of market structures to support whole system operation

- Markets for whole system services to include DER
- Market structures for managing constraints
- Markets to facilitate flexibility

Existing products don't necessarily provide a level playing field

- smaller players find it hard to access existing markets

Insufficient coordination of Transmission and Distribution connected resources

- Locational signals to achieve efficient deployment
- Whole system approach to developing markets

Lack of comparison of constraint and operational costs against further investment (building assets) costs

- Creation of information to inform CBA
- Economic versus security risk assessments

2.1.5 Whole System Planning, Control & Operation

Inability to optimise investment and operation using Transmission and Distribution solutions

- Lack of framework and processes to enable full assessment of Transmission and Distribution investment and operational options
- Understanding of capacity at the Transmission/Distribution interface
- Understanding of any barriers relating to incentive mechanism and regulatory treatment of cost reconciliation
- Visibility of pricing signals
- Whole system principles of access
- Impact of T or D network capacity on service availability

Inability to fully understand whole system operability challenges

- Impact of DER on whole system stability and resilience
- System Operability Frameworks (SOF) for Distribution networks
- Coordinated SOFs for Transmission and Distribution
- Whole system review of High Impact Low Probability events

Conflicts and coordination of system development and operation

- Security of supply and DER
- Consistent and appropriate design and network security standards for Transmission & Distribution
- Conflicts and coordination of services
- Coordination of operational control schemes

- Process for T/D coordination of emergency procedures (e.g. use or effects of ANM during emergency demand/generation disconnection)
- Whole system review of High Impact Low Probability events

Management and control resources
- Impact on current D and T network management resource
- IT infrastructure and comms (inc. ICCPs, OMS)
- Technical, commercial and legal skills gaps
- Whole system operational standards and procedures

2.1.6 Customer Experience

Inconsistencies in treatment of DER/TER and approaches to connecting
- Network access rights and charges
- Constraint management
- Inconsistency between different companies policies, standards and procedures

Inefficient connections processes
- Simplified processes for connection of smaller customers
- One stop shop (e.g. CION)

Inconsistency in approach to charging and operational use of markets
- Locational and national pricing signals in operational timeframes (coordinated)
- Inconsistency in approaches to compensated and uncompensated curtailment
- Transparent network charges
- Alignment of connections costs and charges

Lack of sufficient information to enable efficient operation of customer resource and customer investment
- Transparency in constraints to customers and associated costs
- Information on T, D and customer network constraints/outages in short and medium timescales
- Increased level of information and flexibility in Connection Agreements (including operational requirements)
- Information on cost of constraints to customers

2.2 Proposed Actions

The following tables give an overview of suggested actions that are needed to address the identified gaps. The proposals are broken down into short term actions (1-2 years); medium term (3-5 years); long term (8+ years).

When considering the timescales attributed it should be noted that for both medium and long term actions, elements of the work will begin in the short term and be developed over time. It also anticipated that the selected short-term actions will be building blocks for the longer term objectives.

2.2.1 Visibility & Data

A System Monitoring
B Visibility of Transmission and Distribution Network Configuration and Capacity in operational timescales
C Visibility of DER/TER (demand and generation) and Operating Behaviour in operational timescales
D Information on DER Resilience and Dynamic Performance
E Coordinated Approach to Flexibility across Transmission and Distribution
F Comparison of constraint and operational costs against further investment (building assets) costs

		A	B	C	D	E	F
Short Term	Review learning from Regional Development Programmes and other Projects	■	■	■	■	■	■
	Updated Statement of Works process		■	■			
	Review and update existing Standards & Policies	■			■	■	■
	Establish improved data requirements and exchange mechanisms including DER contractual details		■	■	■		■
	Review and update Customer Connection Agreements			■	■		
	Develop regional/national requirements for System Monitoring	■		■			
	Provide a mechanism for sharing information on constraints and costs in operational timescales					■	■
	Shared planning and operational models (CIM)		■	■	■		
	Improved Control Room Interface / ICCP links including for managing service conflicts	■	■	■		■	
	Update Minimum Information Requirements from DER			■	■		
Medium Term	Identify and review funding mechanisms	■					■
	Review and update network codes		■	■	■	■	■
	Enhanced data exchange mechanisms/frameworks including DER contractual details		■	■	■	■	■
	Exchange and coordinate forecasting information (Demand and Generation) in short, medium and long term timescales		■			■	
	Whole system process to assess economic v security risk					■	■
	T&D joint procurement events and coordinated technical requirements					■	■
Long Term	Advanced modelling (dynamic, quasi-dynamic etc.)		■		■	■	■
	Service Agreements to replace / compliment Connection Agreements			■		■	
	National database for all DER		■	■	■		
	Common methodology for assessing Flexibility across T&D		■			■	■

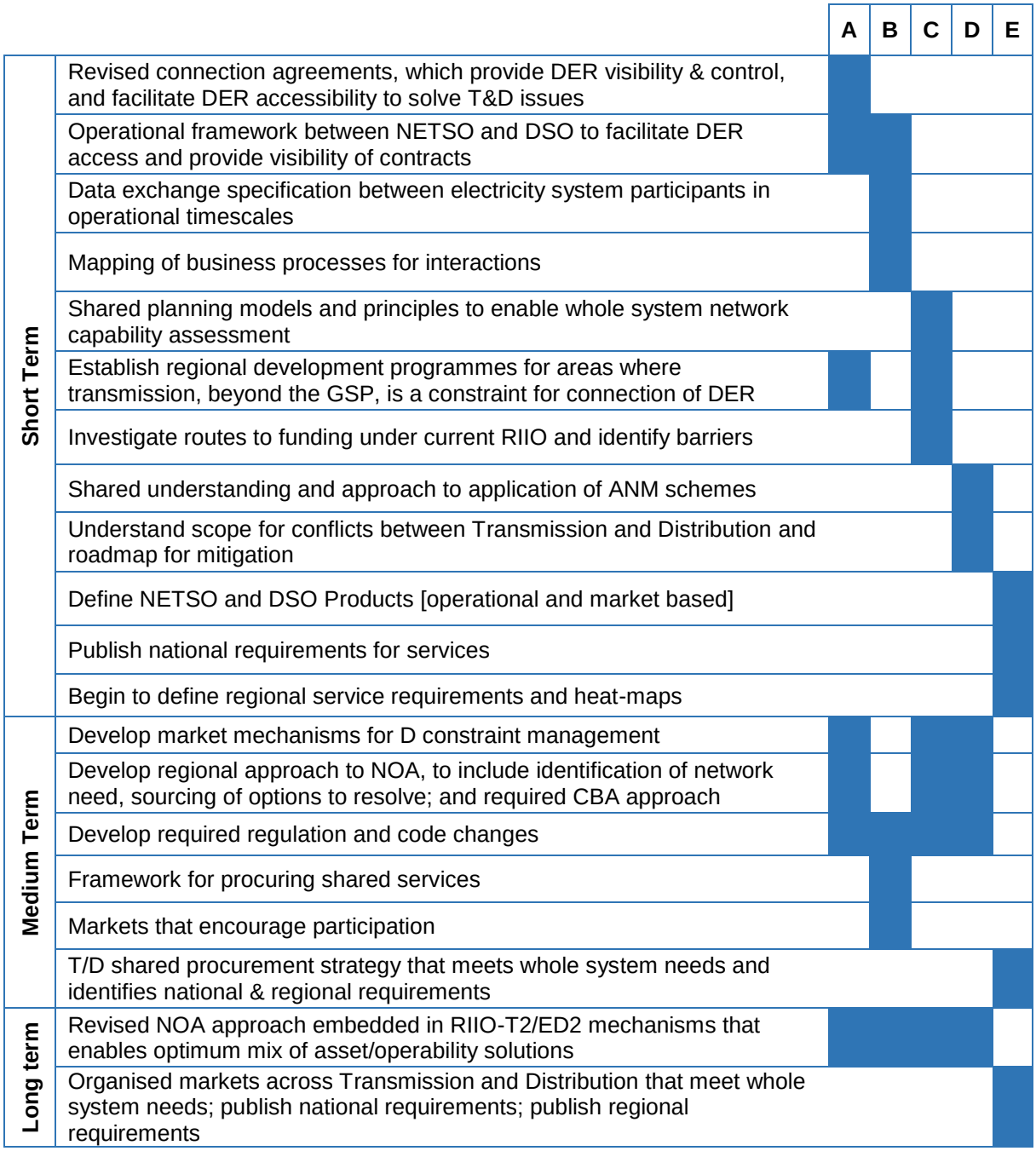
2.2.2 Forecasting

A Limited scenario planning at Distribution level
B Limited scenario and operational planning for Whole System
C Lack of short, medium and long term forecasting of network resources at Distribution and Transmission level
D Whole System forecasting fairly limited to system peak

		A	B	C	D
Short Term	Develop and agree common methodology to produce a distribution style FES on a priority basis - per GSP	■			
	Collaborate between T&D to identify system stress periods and ensure data is captured for these times in operational timescales		■		■
	Produce regional distribution style FES by region/licence area	■			
	Review current forecasting and look for best practice including input from academic research			■	
Medium Term	Produce whole system FES		■		
	Improve monitoring of DER and demand behaviour to enable forecasting for non-market participants			■	
	Develop forecasting tools to take in current data and refine demand forecast			■	
	Improve data gathering for input into forecasting tools and network modelling [incl. market participants]				■
Long term	Refine and adapt forecast methodology to keep pace with external changes.	■	■		
	Improved forecast models and data flows			■	
	Forecast adapts to take in new times of system stress				■

2.2.3 Flexibility

A Flexible solutions to provide capacity and operational response on transmission and distribution networks
B Visibility of flexible resources as cost effective alternatives to network investment and to manage network operation
C Processes to compare asset and service based solutions for network capability and security
D Standards and procedures to facilitate coordinated deployment and operation of ANM and flexible solutions (Whole system approach to design and implementation, considerations to system wide security)
E Signals and signposting to flexibility and short term contract requirements (i.e. operational trading)



2.2.4 Enhanced Markets

A Current lack of market structures to support whole system operation
B Existing products don't necessarily provide a level playing field
C Coordination of Transmission and Distribution connected resources
D Comparison of constraint and operational costs against further investment (building assets) costs

		A	B	C	D
Short Term	Enhance data exchange mechanisms between T&D		■	■	■
	Projects to trial the participation of DER in transmission markets	■	■		
	DNOs to develop flexibility markets as an alternative to reinforcement	■			
	Simplify and evolve existing ancillary services markets to facilitate DER participation	■	■		
	Framework for managing conflicts and optimise synergies of services provided to T and D networks in operational timescales	■	■	■	
	Shared approach to compensatory curtailment for distribution generation solving transmission constraints		■	■	
	Operational framework between SO and DSO to facilitate DER access and provide visibility of contracts, to support network security and efficient whole system planning		■	■	■
	Market approach for managing constraints on Distribution network	■		■	■
	Development of system-wide resource register (akin to TEC register)		■	■	
	Development of constraint assessment tools capable of assessing both Transmission and Distribution network limitations			■	■
	Develop standardised approach for assessing operational and service conflicts			■	■
	Facilitate the participation of DER in the Balancing Mechanism	■	■		
Medium Term	Identify and review funding mechanisms to consider flexibility and market alternatives				■
	Develop framework for T&D coordination in tendering, procurement, delivery and monitoring of DER services	■		■	■
	Targeted regulatory and policy changes	■	■	■	■
	Develop whole system framework for considering markets and flexibility as an alternative to traditional reinforcements and more efficient operation	■		■	
	Expand markets to facilitate flexibility from all existing and future available resources		■		
	Establish and standardise market arrangements for constraints management on T&D networks	■		■	
	Development of access rights for DER		■		
	Develop DSO commercial capabilities	■		■	■
	Advanced modelling (e.g. OPF) of T&D networks	■		■	
Long Term	Extension of the NOA methodology to cover market solutions for the whole system	■		■	
	Common methodology for assessing flexibility T&D	■		■	■
	Flexibility markets standardised and coordinated		■	■	
	Facilitate local balancing markets and peer-to-peer trading	■		■	

2.2.5 Whole System Planning, Control and Operation

A Inability to optimise investment and operation using Transmission and Distribution solutions
B Inability to fully understand whole system operability challenges
C Conflicts and coordination of system development and operation
D Additional - Increased level of uncertainty and inefficiency due to multiple layered assumptions

		A	B	C	D
Short Term	Shared planning and operational models (CIM)	■	■	■	■
	Shared approach to compensatory curtailment for distribution generation solving transmission constraints	■			
	Shared understanding and approach to application of ANM schemes [including principles of access]	■	■	■	
	Shared data on contributions from transmission and distribution connected equipment to stability		■		
	Common principles for security of supply applying to both generation and demand			■	
	Establish regional development programmes for areas where transmission, beyond the GSP, is a constraint for connection of DER	■			
	More granular and detailed raw data for National planning purposed collected at distribution level				■
Medium Term	Alignment of design and network security standards for T&D	■		■	
	Whole system stability studies		■		
	System Operability Frameworks (SOF) for Distribution networks		■		
	Whole system coordination of control schemes and emergency procedures		■	■	
	Product and service design co-ordination [including whole system principles of access]	■		■	
	Mitigation framework to resolve market conflicts			■	
	Regulatory treatment of cost reconciliation for flexible solutions	■		■	
	Provision of capacity planning limits for each demand group	■		■	
	Business change requirements (incl. resource, IT and comms)	■	■	■	■
	Shared methodologies for developing growth scenarios				■
	Whole system process to assess economic v security risk	■		■	■
Long term	Whole system network options assessment process	■			
	Regulatory framework that enables investment across transmission-distribution boundaries	■			
	Coordinated SOFs for T&D		■		
	Whole system review of High Impact Low Probability events			■	
	Whole System Code	■		■	
	Coordinated FES for Transmission and Distribution				■

2.2.6 Customer Experience

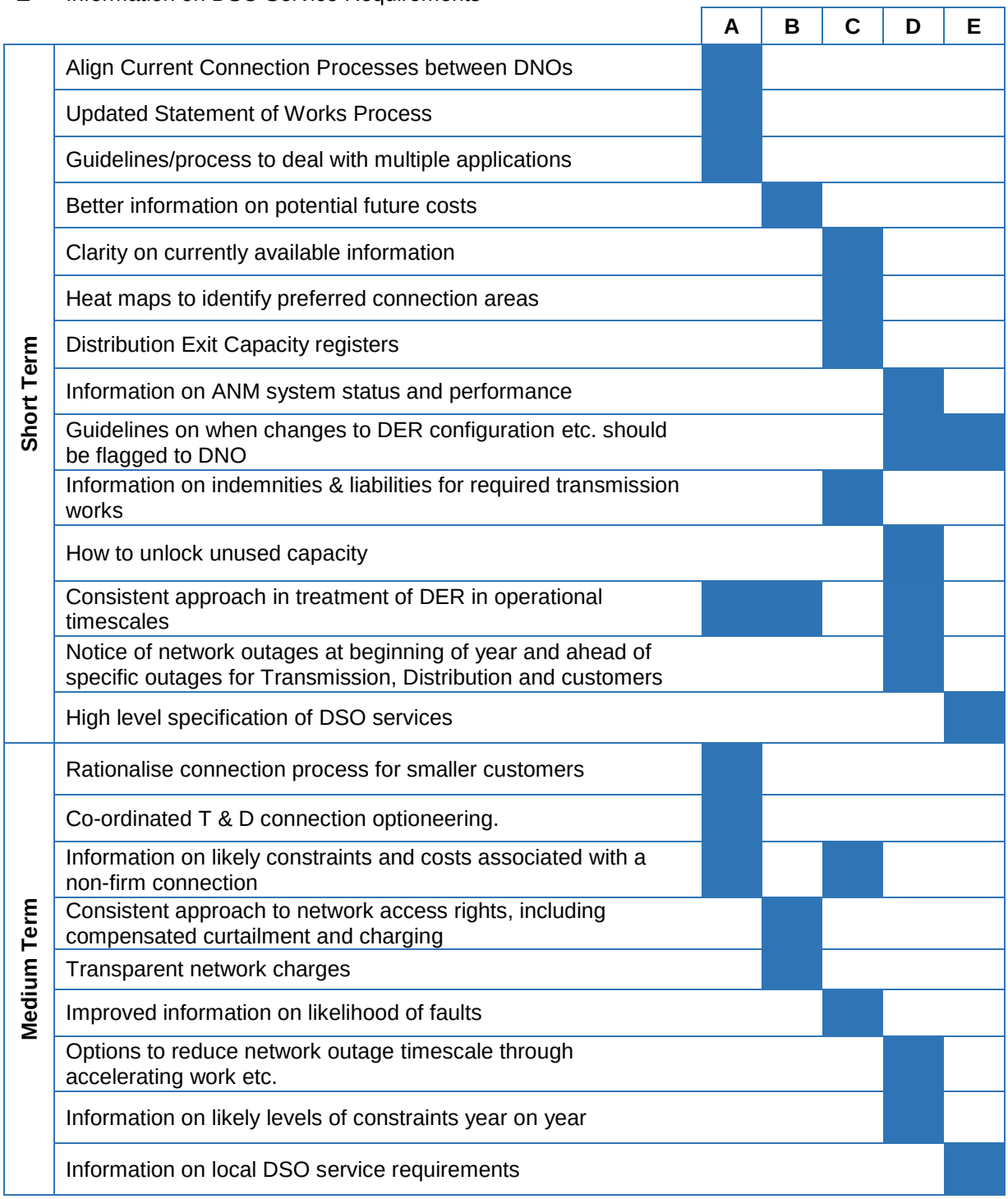
A Inconsistencies in treatment of DER/TER in managing constraints and approaches to connecting

B Consistency in Approach to Charging, Access and Operational use of markets

C Information to support Customer Connections, Investment & efficient operation of customer resource

D Ongoing Connection Arrangements

E Information on DSO Service Requirements



Long term	Processes that are robust to new technology types			
	Single place for customer to get clarity on optimum connection arrangements			
	Alignment of connections costs and charges			
	Locational pricing signals in investment and operational timescales			

3. Work plan

The short-term actions have been identified, scoped and grouped into discrete work packages (WPs) for delivery. They are a reflection of the combined and consolidated outputs of section 2.2. The scope of these actions has taken into consideration ongoing work within the ENA Open Networks Project (Workstreams (WS) and Products (P)); Regional Development Programmes; SO and DNO projects/working groups. Coordination, collaboration and learning from these existing workstreams and other key projects/industry groups will be fundamental to the successful delivery of the WPs. An assessment will need to be made based on resources, timescales and stakeholder priorities as to the extent to which these actions are progressed in Phase 2 of the Open Networks Project.

WP1 Whole System

Action	Timeline	Who
Establish roll-out plan for Regional Development Programmes (RDPs) • Identify high priority areas for next RDPs focusing on areas with limited capacity for DER • Develop future programme of works for next RDPs • Use RDPs to trial operational data exchange where needed	0-12 mths	WS1 New
Revise existing processes to enable a range of investment and operability options across T&D to be considered • Consider investment and operability options to be included in whole system CBAs • Revise existing investment planning processes to consider the above options (develop T&D Investment Planning framework/model)	0-12 mths	WS1 P3
Develop constraint assessment tools for assessing both T&D network limitations • Review existing models and tools • Review key learnings from RDPs • Identify required data and common models • Develop common methodology for assessing constraints across T&D	0-24 mths	WS1 New (P3) WS1 P5
Develop framework for providing contract visibility, conflict resolution and service optimisation across Transmission and Distribution networks for investment planning • Review key learnings from external activities and identify quick wins 0-12mths • Establish end-to-end process for roll-out of ancillary services in the distribution network • Establish a mechanism for sharing data on existing and future services on T&D networks • Establish a mechanism for shared procurement of services	0-24 mths	WS1 New WS1 P6

• Define SO and DSO Products		
Develop standardised approach for managing synergies and conflicts in operational timescales • Establish a process for assessing and resolving operational conflicts and services • Improve visibility of DER contractual positions • Develop a framework for whole system coordination of operational control schemes	0-24 mths	WS1 New P5
Harmonise principles for security of supply across T&D and give consideration to emergency procedures in investment and operational timescales • Ensure SQSS/P2 reviews meet the whole system planning requirements • Review existing planning approaches to maximise existing infrastructure through increased use of flexibility • Establish whole system coordination of control schemes and emergency procedures • Consider need for whole system loss of infeed security criteria	Started 2016	WS1 New
Facilitate the participation and remove barriers of DER in the Balancing Mechanism • DNO/WS1 representation on BSC working groups to understand consequences of proposals and establish future activities required under Open Networks WS1 • Identify and mitigate any additional impacts of DER flexibility	Start 2017	WS1 New

WP2 Forecasting

Action	Timeline	Who
Establish a whole system approach to FES • Review current forecasting and look for best practice including input from academic research • Develop and agree common methodology to produce a distribution style FES on a priority basis - per GSP and by region/licence area • Establish process for FES coordination across T&D	0-24 mths	WS1 New
Define regional service requirements and constraint heat maps • Develop T&D heat maps to inform whole system investment and operational planning; heat maps to include operational requirements • Develop SOF equivalents for distribution networks to help inform whole system capability needs - compliment to National Grid SOF, SNAPS	0-24 mths	TBC
Publish national and regional requirements for services • Determine and publish requirements for services across whole system	0-24 mths	TBC

WP3 Data

Action	Timeline	Who
Update Statement of Works process and consider revisions to Week 24 and 42 processes • Identify synergies and interactions between Statement of Works and Week 24/42 processes • Explore options to consolidate processes	0-12 mths	WS1 P7
Improve Control Rooms Interface / ICCP links • Review existing control rooms links between DNOs/SO/TOs • Assess what standard protocols / ICCP links should be established for GBSO / DNOs including managing service conflicts • Consider roll-out of a standard solution	0-24 mths	WS1 P5 New
Develop regional/national requirements for System Monitoring • Review of current approaches • Agree on minimum monitoring requirements • Identify further monitoring required to enable DSO and whole system activities	0-12 mths	WS1 New
Develop shared planning and operational models (CIM) and principles to enable whole system network capability assessment • Identify required visibility level of future planning models • Establish a common methodology for sharing models (CIM) • Agree on a common approach for applying short term asset ratings • Develop advanced modelling capabilities for Distribution Networks	0-24 mths	WS1 New
Provide a mechanism for sharing information on constraints, costs and conflicts (between Transmission and Distribution) in investment and operational timescales • Identify the data that needs to be shared to understand and resolve whole system capability issues • Identify the data and costs information that needs to be shared to inform investment CBAs and regional strategies • Identify the information required for managing operational and service conflicts including DER contractual details	0-12 mths	WS1 New P5
Establish processes to capture ANM system status and performance for investment planning purposes • Develop the capability to evaluate the cost of energy curtailment • Provide a methodology for valuing the reliability of ANM systems	0-12 mths	WS1 New
Undertake development of a system-wide resource register that includes all GB generation, storage and flexible demand (Transmission and Distribution) • Review of what is currently provided • Identify format and data requirement (incl. thresholds) for whole system register • Establish common approach for sharing contracted DER information, considering confidentiality issues • Consider publication of queues, behind GSPs, reinforcements etc. (inc., data protection requirements)	0-12 mths	WS1 WS2 New

Update minimum information/detailed data requirements to be provided from DER customers when they apply for and agree a connection from the DNO • Review learnings from key projects (e.g. RDPs) • Review and enforcement of existing requirements • Identify new information requirements; including data on stability and resilience and contractual details • Agree assumptions for unavailable data	0-12 mths	WS1 WS2 New

WP4 Customer

Action	Timeline	Who
Align approach and definitions across all DNOs in respect of firm/non-firm connections and connections triggered investment • Review approach to firm and non-firm connections considering access rights and charges • Consider triggers for investment inc. revisions to CCCM • Review approaches to investment planning triggered by connections • Identify DNO differences and best practice • Produce an agreed and aligned approach to new connections	0-24 mths	WS2 with input from WS1
Develop guidelines / process to deal with multiple applications • Consider a single application approach • Develop an optioneering framework for assessing POCs on transmission or distribution that are optimised for both the customer and the whole system; should include CBA against investment requirements	0-24 mths	WS2 with input from WS1
Develop guidelines on when changes to DER should be flagged to DNOs • Develop a set of guidelines to clearly and consistently establish DNO requirements in respect of DER operators to provide visibility of on-going operating behaviour • Identify criteria that DER shall use to check when changes to operating regimes or configurations are being considered. This should include agreements to provide system services to other parties.	0-24 mths	WS2
Establish mechanisms to unlock unused capacity • Review current circumstances and arrangements by which capacity set out in a Connection Agreement but unutilised is used by the DNO in the further efficient development of the network. • Consider potential changes to the approach and arrangements for releasing such unutilised capacity. • Set up industry group to agree proposals	0-24 mths	WS2
Development of consistent approach for providing enhanced information to customers • Define the information to be provided to customers in respect of connection costs and where applicable current or future curtailment • Define the standard for informing on operational requirements	0-12 mths	WS2

• Develop a consistent approach to the development of heat maps (Transmission and Distribution) to identify preferred connection areas and available capacity • Publication of information on ANM system status and performance • Process to provide information on network outages at the beginning of each year and ahead of specific outages		
Development of consistent approach in treating DER in operational timescales • Review current practices for ANM application and principles of access • Develop proposals for fair access to the network capacity in operational timescales • Setup industry group to review proposals	0-12 mths	WS1 with input from WS2

Other actions identified but already underway or completed elsewhere

Action	Timeline	Who
Review and revise customer connection agreements • provide DER visibility and control • facilitate DER accessibility to solve Transmission and Distribution issues	Ongoing	P5 P6
Shared understanding and approach to application of ANM schemes • Standard approach to design of ANM schemes • Establish mechanisms for data sharing across distribution and transmission networks • Application of ANM and impacts on long-term investment planning	Ongoing	P5
Common principles for security of supply applying to both generation and demand • Consideration to alignment of P2 and SQSS	Ongoing	ER P2/6 and SQSS review
Develop common curtailment assessment methodology	Ongoing	WS1 P5
Develop distribution flexibility markets as an alternative to reinforcement	Ongoing	WS3
Simplify and evolve existing ancillary services markets to facilitate DER participation	Ongoing	SO
Shared approach to compensatory curtailment for distribution generation solving transmission constraints • Develop framework between Transmission and Distribution to cover procurement/utilisation interactions • Seek consensus across GB on current approach	Ongoing	P4

4. Summary

The outputs provided by this report are a product of a series of review and challenge assessments. When considering the actions to be addressed continuous reference should be made to the context and content that sits behind them, and to other associated/dependant actions. Further work will be required to create a similar 'work plan' for medium to long term objectives, although it is anticipated that these will change as short term goals are realised. Within each action there is a standing requirement to establish in detail the business impact, and regulatory or commercial barriers.

It is anticipated that WP1 will be addressed in part through Product 3 of WS1 and through the creation of new products as required. WPs 2 & 3 will similarly require new products to facilitate delivery. WP4 has been identified as a group of activities that should be delivered through WS2. The assessments carried out also identified actions that are currently being addressed through either Open Networks workstreams/products or external groups, and as such require no further work other than coordination and review activities. The following review cycles should be carried out with respect to all actions where relevant:

Review	**When**
Review learning from RDPs and other relevant projects	Where identified as ongoing work in other activities
Review and update existing Standards/Policies/Codes	As required by individual activities
Investigate routes to funding under current RIIO and identify barriers	As required by individual activities
Assess and determine necessary resources (skills, management resource, IT etc.)	As required by individual activities

Appendices

A Breakdown of current processes by focus area

A.1 Flexibility

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Customer Connections	G59, P2, P28, P29	Historical data Customer capabilities and equipment details Asset ratings	PowerFactory, IPSA, PSSE, DINIS, Bespoke applications Connection Agreements	Ad-hoc	Asset Mananagement, Connections	Network reconfiguration Reinforcement/Retrofit Load Transfer ANM DSR Flexible/Alternative Connections
DNO	Operational/Outage Planning	D code, P2	Historical data Details about outage request (asset, times, work details etc.) OC2 weekly model of T network with D equivalents	PowerFactory, IPSA, PSSE, DINIS, EWAP (excel schedule)	Ad-hoc, dependent on requests Weekly update of Eight Weeks Ahead Program	Outage Management	Load tranfers Network reconfiguration Generation curtailment Stand-by generation
DNO	TDI Operational Planning	Grid Code OC2	D and T outage schedule Availability of large power stations, Sync/Desync schedule OC2 weekly model of T network with D equivalents (power factory only)	DigSILENT, IPSA, PSSE, DINIS, TOGA (online platform), EWAP (excel schedule)	Annual update/review of long-term (2-5 years ahead) and One Year ahead planning	Outage Planning, Asset Management, Operations	JTPM and other meetings TOGA and EWAP regular updates NETS outage plan
DNO	Week 24	Grid Code	Embedded generation per GSP Demand at defined timestamps per GSP Demand at GB peak day per BSP	PowerFactory, IPSA, PSSE, DINIS, Bespoke applications	Annual	Asset Management	Week 24 submission
SO/TO	Grid Supply Point reinforcement.	NETS SQSS, P2	Grid Code Week 24 data. Connection Application data.	DigSilent PowerFactory	As required, reinforcement is progressed when highlighted through annual compliance process.	System Design and Investment team	Largely network reinforcement solutions. Other operational solutions such as autoreclose schemes etc. Limited use of smart/flexible solutions at
SO/TO	Generation Connection Application Process	NETS SQSS	Connection Application data (type, MW, control system, freq & volt performance etc)	DigSilent PowerFactory	As per applications.	SO Connections Team, System Design	Network reinforcement, some element of customer choice available for incfreased/decreased standard of connection.
SO/TO	Network Options Assessment process for wider Transmission boundary capability.	NETS SQSS	FES scenarios, GB network models, TO reinforcement options	DigSilent PowerFactory, BID3 Economic Model CBA	Annual Process	SO Network Capability Electricty (Assessment), TO's (Options)	Recommendation to take forward transmission reinforcement options. Options are almost entirely based on asset reinforcement. Limited availability of non-asset based solution options at present.

A.2 Voltage Management

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Network Modelling	P28, P29, P18, G74, ESQCR	Network parameters Demand/generation assumptions Power factors Historical data Forecasts	DigSilent, IPSA, Dinnis, PSSE, Data Historian, Bespoke tools	Regulatory Period	Network Planners	Network reinforcements, Network reconfiguration Static Reactive Equipment AVC
DNO	Connections	P28, P29, ESQCR, G59, G83	demand/generation assumptions Network parameters Historical data Power factors	DigSilent, IPSA, Dinnis, PSSE, Data Historian, Bespoke tools	As needed	Operational Planners	Connection Agreements, Network reinforcements AVC
DNO	Ops feedback	P28, P29, ESQCR, G59, G83	Historical data	Data historian	As needed	Operations teams	
DNO	QS feedback	G5/4	Historical data	Data historian	As needed	Q of S Team	
SO/TO	Network Modelling	SQSS, ESQCR	network parameters, MVAr forecasting, Historical data, Load characteristics (response) Load profiles Large generation availability	DigSilent, ATP, PSSE, PSCAS, Data historian, EMT	As needed	System Design (inc. QofS)	Reactive Equipment (static and reactive) Network reinforcements Network reconfiguration Voltage Switching Commercial
SO/TO	SOF		Historical data, FES	Digsilent	annually	Operational Planners	
SO/TO	Connections (inc. closures)	SQSS, ESQCR	MVAr forecasting				Connection Agreements
SO/TO	Ops feedback	SQSS, ESQCR	Historical data				
SO/TO	Voltage studies (inc. Dynamic, ToV)	SQSS, ESQCR	network parameters, MVAr forecasting, Historical data, Load characteristics (response) Load profiles Large generation availability	DigSilent, ATP, PSSE, PSCAS, Data historian, EMT	As needed		

A.3 Transmission & Distribution Interface Capacity

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Statement of Works	Grid Code	Network parameters, Demand/generation assumptions Generation capacity register MVA not Watts, Switchgear/associated equipment ratings	DigSilent, IPSA, Dinnis, PSSE, Data Histiorian, Bespoke tools	As needed	Network Planners	Connection agreements, ANM, Conventional reinforcement Standard Intertrip
DNO	Appendix G	Grid Code	demand/generation assumptions		As needed		
DNO	DNO Network design	P28, P29, P18, G74, ESQCR, Dcode	Network parameters Demand/generation assumptions Power factors Historical data Forecasts	DigSilent, IPSA, Dinnis, PSSE, Data Historian, Bespoke tools	Regulatory period	Planners	
SO/TO	current SOW process	NETSQSS	Provision of revised network data & generator data	Digsilent Powerfactory	Ongoing, Dependant on updates from DNO's	System Design/Customer Contract manager/GB Connections team/Legal	Updating agreements to provide realistic planning limits. ANM schemes. Network reinforcements - additional SGT capacity, replacing overstressed switchgear Optimise T/D network reinforcements, i.e. cost benefit analysis of T/D reinforcements
SO/TO	Appendix G (trial)	NETSQSS	Embedded Gen scaling (required for each cardinal point) TEC / embedded qeue Transmission connected generator discpatch)	Digsilent Powerfactory Appropriate repository / schedule of contracted generation	Appendix G - out of date at point of issuing?	System Design/Customer Contract manager/GB Connections team/Legal Customer Contract Managers	embedded generation heat map. ANM schemes Increase materiality limit alone provide indicative planning limit with materiality limit Optimise T/D network reinforcements, i.e. cost benefit analysis of T/D reinforcements

A.4 System Capacity

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Demand head room / Firm capacity	P2	Load data (generation data where required e.g. F factor for security compliance), network data e.g. line impedance, ratings etc	PSSe, Digsilent, IPSA, DINIS	Regulatory period, Week 24, Adhoc and for LTDS	Planners	LTDS, Capacity maps
DNO	Generation headroom	none	Load data, generation data, network data e.g. line impedance, ratings etc	PSSe, Digsilent, IPSA, DINIS	Adhoc	Planners	Capacity maps
DNO	Fault level assessment		Switchgear/ associated equipment ratings - Make/Break withstand/peak/RMS	Bespoke	Week 24, Adhoc and for LTDS	Planners	
DNO	Planning levels for Harmonic distortion	G5	Bespoke site specific	Bespoke	adhoc	Planners	
DNO	demand modelling	P28	Network data	PSSe, Digsilent, IPSA, DINIS	Regulatory period	Planners	AVC control, Reactive compensation
SO/TO	STCP	Grid Code NETS SQSS	EYTS models/data FES TEC Register LTDS real time/historic data	DigSilent PI historian	Annual	Planners	Reinforcements Load Management Schemes/ANM FACTS
SO/TO	Generation connection applications / Feasibility request	NETSQSS	DRC SPD data. Existing network data. (Full range of studies would be done, Thermal, Voltage, fault level, stability, NPS)	Digsilent Powerfactory	Ongoing adhoc	System Design / Wider investement team	Network reinforcment/ Customer choice to avoid enabling works
SO/TO	Customer Connections Interface tool	NETSSQSS	Contracted generation, results of national fault level study / reports of recently studied generation in area	Digsilent Powerfactory / Desktop analysis	Annual	System design / GB Connections	Gives indicative (non binding) timescales for connection based on high level programme of likely works
SO/TO	ETYS / NOA	NETSQSS	Generation Scenarios. Bid3	Digsilent	Annual	SO Network Capability. To - System Design	Recommendations for reinforcements

A.5 System Stability

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Appendix G / SOW	Grid Code	Embedded generation details (size, point of connection, fault level contribution) Minimum demand at agreed timestamps Loss of mains protection (MW and settings)	Embedded generation register Data historian	Ad-hoc	Asset Management	Run ad-hoc studies to assess the impact of DER
DNO	Week 24	Grid Code	Embedded generation details (size, point of connection, fault level contribution) Maximum/Minimum demand for SQSS compliance D network data down to BSP	PowerFactory, IPSA, PSSE, DINIS, Bespoke applications	Annual	Asset Management	SO/TOs consider this data for SQSS only
SO/TO	Connection application	SQSS, Grid Code	Automatic voltage Regulator models and Parameters Machine data, Network data including assured fault clearance times HVDC link dynamic nodels and parameters	PowerFactory, PSS®E	As needed	Network Planners	Connection agreements Inertia products Dynamic and static reactive compensation Network reinforcement Intertripping of generation
SO/TO	Integration of FACTS device solutions	SQSS, Grid Code	Machine dynamic models and parameters Machine data, Network data including assured fault clearance times HVDC link dynamic nodels and parameters	PowerFactory, PSS®E	As needed	Operational Planners	Connection agreements Inertia products Dynamic and static reactive compensation Network reinforcement Intertripping of generation
SO/TO	National Stability assessments	SQSS	Automatic voltage Regulator models and Parameters. Machine data, Network data including assured fault clearance times	Powerfactory		System Design	Network reinforcement / running arrangements review

A.6 Connections (T/D optioneering)

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Connection Application Process	Agreed Charging methodology 200/kW rule P2 Dcode	ENA G59 Application Form Supplementary information (e.g. Energy Storage) DNO application forms	DigSilent, IPSA, Dinnis, PSSE, IPSA, Data historian, Bespoke tools, Connection costing tools	When requested by customer	Network Planners	Connection agreements, ANM, Conventional reinforcement Standard intertrip
SO/TO	STCP	Grid Code NETS SQSS	EYTS models/data FES TEC Register LTDS real time/historic data	DigSilent PI historian	Annual	Planners	Reinforcements Load Management Schemes/ANM FACTS
SO/TO	Connect and manage	Connection application Customer choice	Types of connection agreements TEC/Generation /Demand capacity	PSS®E PowerFactory	Continuous	Network planners Connections team	ANM schemes
SO/TO	current SOW process	NETSQSS	Provision of revised network data & generator data	Digsilent Powerfactory	Ongoing, Dependant on updates from DNO's	System Design/Customer Contract manager/GB Connections team/Legal	Updating agreements to provide realistic planning limits. ANM schemes. Network reinforcements - additional SGT capacity, replacing overstressed switchgear Optimise T/D network reinforcements, i.e. cost benefit analysis of T/D reinforcements

A.7 Resilience and Security

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Demand assessment	P2	Load data (generation data where required e.g. F factor for security compliance), network data e.g. line impedance, ratings etc	PSSe, Digsilent, IPSA, DINIS	Regulatory period, Week 24, Adhoc and for LTDS	Planners	LTDS, Capacity maps
TSO	Application of SQSS Criteria (N-1, N-D, N-2, Infeed Loss etc)	NETS SQSS	TO Network Data, User Data, Scenarios	DigSilent PowerFactory	Ongoing	System Designers, Future Operability Engineers	Network Investment, Derogation, Contracts etc
TSO	Application of other "low-likelihood, high impact" criteria.	NETS SQSS	TO Network Data, User Data, Scenarios	DigSilent PowerFactory	Ad Hoc	System Designers, Future Operability Engineers	Network Investment, Curtailment, Contracts
TSO	Consideration of demand security with DNOs.	P2	Grid Code Week 24, Week 42 Data	DigSilent PowerFactory, Spreadsheets	Annual Assessment	System Designers	Network Investment, Demand Transfer
TSO	New Connection Compliance Processes	Grid Code Connection Conditions	User Data, Compliance Checks	Various including Compliance Tests	During Connection (Interim Operational Notification etc)	Customer Connection team, Compliance Teams	User Design, Operational Restrictions etc
TSO	Ensure Demand Control is Effective in Operational Timescales	Grid Code OC6 Voltage/ Demand Control	System Trials, Demand Response Models	System Trials, Demand Response Models	AnnualReview, Ad Hoc Review	SO (Electricity Policy & Performance)	Update Settings & Wider Arrangements
TSO	Ongoing LFDD Review (ENA Group). Ensure LFDD is Effective in Operational Timescales	Grid Code OC6 Automatic Demand Disconnection	Demand Blocks by GSP, Frequency Settings, DER locations.	Various	Ongoing review.	SO (Electricity Policy & Performance)	Revise settings, Revise demand blocks
TSO	Revision of Requirements in GB Codes	European Network Codes - Reqt's For Generators	Various	Various	Ongoing	SO Various	Implementation of changes in G & D Codes
TSO	Protections Settings Review, Studies	T & D Protection Settings	Minimum Fault Levels, DER Infeed Data etc	DigSilent PowerFactory, Other	New Connections, Annual review		
TSO	Ongoing Grid Code Changes & Working Group	G59/G83 Req'ts for Loss of Mains	Inertia Levels, RoCoF etc	Various Models	Ongoing	SO (Electricity Policy & Performance)	
TSO	Overhead Line Requirements	ENA Standards eg ETR 132					
TSO	Substation Reviews & Implementation of Flood Defences	ENA Standards eg ETR 138					

A.8 Forecasting

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Planning Load Estimates		Historical demand data	Bespoke tools	Annual	Asset Management	
DNO	Long-term forecasting for RIIO framework		Historical data Macroeconomic data	Bespoke tools	Annual and used for preparing RIIO submission	Business Planning	
SO/TO	annual FES process		TEC/interconnector/ embedded generation register. Fuel Prices. Stakeholder / industry engagement. Interconnector flows Fuel Prices. Stakeholder / industry engagement. Interconnector flows	BID3 models	ongoing annual cycle	Energy Insights	
SO/TO	ranking orders - winter peak/summer min.		week 24 data	Ranking orders. Annual Load factors report		SOF team	
SO/TO	spatial modelling (locational)		stakeholder / industry engagement	Generation backgrounds		energy insights	
SO/TO	work feeds into ETYS/NOA/EMR/SOF		metered data			energy forecasting	
SO/TO	Winter / Summer outlook reports		fuel prices / Energy Prices. Generator Break down rates. Interconnector flows			Network Capability (ETYS, NOA team	
SO/TO	Demand data		week 24 data / metered data		Annual - Week24	Network capability, Data and modelling team	

A.9 Network Design

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Network design process	P2, P27, P15, P17, Bespoke network planning standards	Network parameters demand/generation assumptions Analogues Unmasked demand Generation capacity register MVA not Watts Switchgear/ associated equipment ratings	DigSilent, IPSA, PSSE, Dinnis, IPSA, Data historian, Bespoke	Continuous or as needed	Network Planners	Reinforcement Maybe reliance on generation within group Inter-DNO transfers Cross-DNO transfers
SO/TO	Internal processes (Design manuals)	NETS SQSS	ETYS models/data Generator output assumptions/Generation scenarios Transmission Plant availability Asset replacement priorities	DigSilent	Annual	System Design	Reinforcements (load)
SO/TO	Network Options Assessment (NOA) process for wider Transmission boundary capability.	NETS SQSS	FES scenarios, GB network models, TO reinforcement options	DigSilent PowerFactory, BID3 Economic Model	Annual Process	SO Network Capability Electricty (Assessment), TO's (Network Investment Options)	Recommendation to take forward transmission reinforcement options.
SO/TO	ETYS	NETSQSS	Generation Scenarios. Bid3	Digsilent	Annual	SO Network Capability. To - System Design	Recommendations for reinforcements
SO/TO	STCP	Grid Code NETS SQSS	EYTS models/data FES TEC Register LTDS real time/historic data	DigSilent PI historian	Annual	Planners	Reinforcements Load Management Schemes/ANM FACTS

A.10 Constraint Management

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Operational Planning	Conventional	Real time powerflow data, network data model	PSSe, Digsilent, IPSA, DINIS	Continuous	Operational Planner and Control Engineers	ANM schemes
DNO	ANM schemes		Real time powerflow data, network data model	Bespoke hardware/ software solutions	Continuous	Planning - Operational and Network	Further development
DNO	Flexible connections		Real time powerflow data, network data model	Bespoke hardware/ software solutions	Continuous	Planning - Operational and Network	Further development
SO/TO	Connection application	SQSS	Customer choice - firm/non-firm	PowerFactory	Commection assessment stage	Operational planners System Design	Connection agreements
SO/TO	Operational planning	Connect and manage	Types of connection agreements	PSS®E PowerFactory	Continuous	Network planners	ANM schemes
SO/TO	Intertrips	STCP 16.1, 18.1	Real time power flow data and network topology	PS ODMS	As needed		intertrip schemes
SO/TO	ETYS / FES - identifying boundary constraints	NETSQSS	Generation Scenarios. Network reinforcement	Bid3	Annual		Reccomendations on

A.11 Charging

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	ED1	Common Connection Charging Methodology			regulatory period	Regulation teams	
DNO	CCCM	Charging Methodology Statement			Ongoing	Finance	
DNO	DUoS		Historical data Data from suppliers	PowerFactory, IPSA, PSSE, DINIS, Bespoke applications Connection Agreements	Ongoing	Finance	
SO/TO	CUSC	As defined in the CUSC Statements of Transmission Use of System Charges			As defined in the CUSC	commercial/pricing	Application Fees Connection Charging Security/Liability TNUoS
SO/TO	TO Charging Statement	T Licence			annually	commercial/pricing	connection and other charges
SO/TO	STCP	STC				pricing	annual TO charge setting

A.12 Market Arrangements

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
SO/TO	Network Options Assessment (NOA) process for wider Transmission boundary capability.	NETS SQSS	FES scenarios, GB network models, TO reinforcement options	DigSilent PowerFactory, BID3 Economic Model	Annual Process	SO Network Capability Electricty (Assessment), TO's (Network Investment Options)	Recommendation to take forward transmission reinforcement options.
SO/TO	P2 compliance assessment and subesquent modificaton applications.	NETS SQSS, P2	Grid Code week 24 and 42 data.	DigSilent PowerFactory	Annual process based on week 24 (demand data) through to week 6 (compliance report).	TO and DNO System Design functions.	Recommendation to take forward supergrid transformer (SGT) reinforcement or new supply points. Also DNO network reinforcements to transfer load.
SO/TO	N/A	No TO/SO interaction with DNO network investment at	N/A	N/A	N/A	N/A	N/A
SO/TO	Review by TO's of network voltage management requirements against changing generation and demand backgrounds. Precipitated by new connections, closures, changing demand and/or changing generator operational regimes.	NETS SQSS	FES scenarios, other background sensitivities (eg generation closure)	DigSilent PowerFactory	As required	SO Network Capability Electricity, TO System Design functions	TO investments including static compensation (eg MSCs, shunt reactors) and dynamic compensation (eg SVC's, Statcoms). Occasionally, generation contracts to cover short-medium term requirements.

A.13 Asset Health

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Asset Health and Criticality	CBRM	Asset condition, location, duty, safety consequences, environmental consequences, financial	bespoke asset management system	Regulatory period	Operations, Planning and Regulatory reporting	
SO/TO	Asset Health Indices / Replacement priorities (Looks at criticality)	Overarching policy statement PS(T) EPS12.0 - "Equipment Replacement & Refurbishment (General)" also subset of policy statements specific to asset families	Ellipse - database official data source	Deterioration models	ongoing	Asset Health	Strategic Asset Management (some items have gone live DGA results) . Improved information flow
SO/TO	Criticality reviews	EPS10.0 - PS(T) Asset Health Indices	existing asset health review models	Deterioration models	Monthly updates	Asset strategy / Future	Improved access to condition data
SO/TO		Technical Guidance Notes (TGN) used to determine AHI	Driver Documents		annual updates	System Design (confirm ongoing requirement	Improved information flow
SO/TO			Asset health condition data		ongoing		
SO/TO			Fault and Defects Survey (FADS) data		quarterley		
SO/TO			Plant Status - database		ongoing		
SO/TO			Faults and failures log		quarterley		
SO/TO							
SO/TO	Risk based priorties (has more consequence related stuff for decision	Going forward - new NOMS methodology - ongoing discussions with Ofgem			Targeted by next year		

A.14 Transmission/ Distribution coordination/engagement

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	Operational Planning (Outage planning)	Distribution and Grid Code		BCA, JTPM			
DNO	connections	sow					
DNO	CUSC	As defined in the CUSC			As defined in the CUSC	Design Engineers/Network Planners	T/D Boundary Works
DNO	CUSC	As defined in the CUSC			As defined in the CUSC	Commercial Team	Management of Contractual Interface with NGET
SO/TO	STCPs	Transmission Licence			As specified in the STC	Design Engineers Network Planners Commerical Team Control Engineers	Investment Planning Connection offers Contractual offers Contractual Management Operational Planning & System Operation
SO/TO	JTPM	N/A	Network development proposals Asset replacement priorities Week 24 data Compliance report		Bi-annual / Quarterley	System Design planners Investement Delivery, Customer Contract managers System Design	

A.15 Customer Visibility/Experience

Owner	Process	Standards/ Criteria	Data	Tools	Timeline	Roles	Solutions
DNO	ENTIRE SYNC Demand Turn Up CLASS CLNR ANM/FPP/LLCH/Orkney Power Potential CMZ (ALL BESPOKE & PROJECT BASED)	N/A	Analogues Generation Capacity Register Network Assets Unmasked Data Forecasting	Curtailment analysis Timebased Curtailment		Network Strategy Netwokr Planners Connections Policy Team	Demand turn up/down Generation turn up/down Energy Storage Connection Agreements
DNO	Generation and demand heat maps		Generation and demand capacity LTDS Constraints due to T network Other technical constraints	Maps available online (interactive)	Regularly		
DNO	Customer forums		Overview of network capacity ANM areas Constraints		Regularly		
SO/TO	SQSS	ANM	Circuit status and loading		As needed	Network planners	Dicrete control (intertrips)
SO/TO	Connect and manage	Connection application Customer choice	Types of connection agreements TEC/Generation /Demand capacity	PSS®E PowerFactory	Continuous	Network planners Connections team	ANM schemes
SO/TO	annual FES process		TEC/interconnector/ embedded generation register. Fuel Prices. Stakeholder / industry engagement. Interconnector flows Fuel Prices. Stakeholder / industry engagement. Interconnector flows	BID3 models	ongoing annual cycle	Energy Insights	
SO/TO	SOF		Historical data, FES	Digsilent	annually	Operational Planners	

B Detailed Analysis

The following sub-sections detail the gap analysis for each of the focus areas.

B.1 Flexibility

Issues	○ Increased cost for balancing services - DSO and DER could be an additional provider of lower cost services ○ Under- or Over-Investment for network development - DSO and DER flexibility resources can be a cheaper alternative to capital intensive network development ○ There are limited incentives in place for different parties to develop solutions based on DER/Asset flexibility ○ Network Operators do not have processes that take on board flexible solutions provided by users and 3rd parties
Future State	○ Flexible solutions to provide transmission capacity, distribution capacity and transmission-distribution interface capacity are available and used as cost effective alternatives to asset based reinforcement ○ Wide range of DER / Asset based flexibility solutions available to network designers. ○ Ensuring where flexibility is the right solution the mechanisms are in place to utilise ○ Broader investment processes to bring forward flexible solutions from a range of stakeholders
Gaps	○ DSO flexibility (network and DER) resource not considered in T investment and operational planning ○ D network operational solutions are not available to the SO ○ D network capabilities not fully assessed (taps, reconfiguration etc.) ○ Enhanced markets for DER and DSR services to SO ○ OC2 weekly model is provided in PowerFactory only ○ Non-network based options are not being included at present
Barriers	○ D System monitoring ○ Short-term forecasting at D level ○ Not enough incentives for all relevant parties (SO, DSO, DER) ○ Insufficient skill-set to assess existing resources and plan and control on operational timescales ○ Communications between control rooms and DER not suitable for operational timescales ○ Lack of suitable commercial incentives and frameworks to support flexibility solutions ○ Network Operator skills and tools to identify and value flexible options ○ Insufficient DER visibility and controllability to provide flexible alternatives to network asset based solutions.
Reference Projects	○ Power Potential ○ Class

B.2 Voltage Management

Issues	○ Low Volts ○ High Volts ○ Margins ○ Step change ○ Voltage Imbalance ○ Reducing Reactive Power demand on D Networks ○ Reactive Power Spill to Networks from DER
Future State	○ DER services ○ T services ○ D or T operational solutions ○ Enhanced Customer Connection ○ Agreements/BCAs ○ Optimised siting of reactive equipment ○ Utilisation of DER reactive power capability ○ Control of DER connection arrangements.
Gaps	○ Modelling (inc. assumptions) ○ Less-deterministic planning approach ○ MVAr forecasting inc. T/D ○ Solutions available ○ Commercial markets both at T & D
Barriers	○ Resource/volume of connections/skill base/lack of common model/data exchange ○ resource/volume of data/tools/SQSS & P2 ○ monitoring/volumes of data/understanding of changing voltage profiles ○ lack of visibility on VAR reqs/market structure for employing D solutions ○ lack of visibility on VAR reqs/market structure ○ Suitable reactive power market arrangement. ○ Connection compliance arrangements.
Reference Projects	○ Class ○ Power Potential

B.3 Transmission & Distribution Interface Capacity

Issues	○ Delays in giving connectees certainty ○ Lack of visibility of capacity at the Transmissions/Distribution interface ○ Lack of efficient investment planning process to consider whole system
Future State	○ Planning limits across Demand Groups ○ Visibility of existing / contracted generation across Transmission and Distribution ○ Capacity management ○ Investments optimised across Transmission and Distribution
Gaps	○ Certainty with regards to available capacity that can be attributed to DER projects ○ Optimisation of available capacity via load modelling ○ Visibility / control of DER in control room timescales ○ Reliable means of producing optimised investment that considers whole system
Barriers	○ Apportioning planning limits across major system boundaries / DNO boundaries or across multi point access groups ○ Shared understanding of active network management (ANM) schemes ○ Management of interactivity when Distribution connections compete for capacity with Transmission connections ○ DER scaling (required for each cardinal point) ○ Forecasting DER generation output ○ Metering of Small DER projects
Reference Projects	○ WPD South West Embedded Generation Connections ○ Thames Estuary Embedded Generation Connections (planning limit trial) ○ Regional Development Programme

B.4 System Capacity

Issues	○ Fault Levels ○ Harmonics ○ Thermal ○ Stability ○ No way to utilise T capacity for D and vice-versa.
Future State	○ Optimising existing infrastructure using D or T solutions ○ Whole System process to enable full assessment of T & D options.
Gaps	○ View of T capacity - SOW data/ Real-time ○ T&D capacity for generation ○ Visibility (real-time and planning timescales) of T on D and vice-versa ○ Information and process to support Whole System assessment.
Barriers	○ Changing infeed and operation of both T & D networks. ○ Data exchange fairly limited ○ Quality of information within the organisation is poor ○ Agreement on Whole System process.
Reference Projects	○ Network Options Assessment (NOA)

B.5 System Stability

Issues	○ G59 protection (OV/UV, Loss of mains etc.) impact on system stability ○ Increased cost of balancing services due to non-dispatchable DER ○ Limited capacity for additional DER ○ Risk of Whole System instability through reduced system strength
Future State	○ Whole System Stability Study/Management ○ Robust DER (fault ride through) ○ Robust D-Network Protection with lower short circuit levels.
Gaps	○ DER impact on whole system stability not fully assessed ○ Lack of dynamic studies at D networks ○ Generation masked in demand - no clear view of true demand ○ Lack of information regarding inertia at Distribution level ○ Modelling ○ Commercial products ○ Information on DER resilience, dynamic performance.
Barriers	○ Visibility (SO to D network) ○ Visibility of small PS (e.g. G83) in terms of numbers and system impact ○ DNOs skills to carry out dynamic studies ○ D Customer data insufficient for dynamic studies ○ System monitoring at D lower voltage levels ○ Large size of the model, skills to model new technologies, suitability of current tools? ○ Definition of market products for providing integrated services including system stability, e.g inertia ○ Ability to inter-trip DER in appropriate timescales ○ Agreed requirements. ○ Skills, capability to assess low system strength scenarios.
Reference Projects	○ Regional Development Plans

B.6 Connections (Optioneering across Transmission & Distribution)

Issues	○ Hard to establish what is low cost for overall system ○ Principles of connection between T/D not very clear ○ No alignment of connection costs and charges ○ complicated industry arrangements
Future State	○ Least cost solutions T or D ○ Coordinated assessments ○ One Stop Shop (e.g. COIN) ○ Connection process more straightforward ○ Customers to find solutions without having to go through multiple interfaces ○ Alignment of connection costs and charges
Gaps	○ No easy T-D comparison process ○ No easy customer OPEX costs (use of system charges) ○ No framework for identifying solutions that are efficient for the whole system
Barriers	○ Principles of what customers want and are contracting for ○ charging arrangements ○ Share of information between T/D with regards to customers ○ Only customer initiated
Reference Projects	

B.7 Resilience & Security

Issues	○ Limited understanding of DER vulnerability ○ Vulnerability to whole system (T&D) generation loss ○ Decreased system resilience through reduced system strength ○ No Whole System (T&D) protection reviews taking place
Future State	○ Fuller understanding of DER vulnerability & introduction of Whole System (T&D) generation security assessments ○ Robust DER connections (frequency deviation, voltage dips, fault ride through etc) ○ Whole system review of some elements of security standards ○ Whole system process to review critical T & critical D Network designs ○ Effective voltage and demand reduction under emergency conditions ○ Effective Low Frequency Demand Disconnection (LFDD) ○ Robust Loss of Mains Protections for Distributed Generation ○ Robust T and D network protection with lower short circuit levels ○ Robust overhead lines in place ○ Substation flood defences in place
Gaps	○ P2 & SQSS consistency for demand and distributed generation security ○ Generation security covered in P2 standard? ○ D network design considering T impacts and vice versa ○ Whole system (T&D) review of low likelihood, high impact events. ○ More urgent and extensive reviews required given increased levels of DER, changing demand types ○ Information on DER resilience and dynamic performance
Barriers	○ Agreed requirements for DER resilience ○ Skills, capability to assess low system strength scenarios ○ Low pace in ongoing programmes
Reference Projects	○ Ongoing Grid Code/Distribution Code workgroup on Loss of Mains Protection ○ Ongoing Distribution Code workgroup on P2 ○ Ongoing Grid/Distribution Code workgroups addressing EU codes requirements (inc frequency & voltage resilience, fault ride through)

B.8 Forecasting

Issues	○ Increase of sub-optimal investment of network development and solutions due to uncertainties with regards to DER (storage, DG, Evs, etc.) and changing load profiles ○ Generation forecasting – very little visibility of DER – especially solar. Any data is historic ○ Feasible new technologies – route to market subsidies etc ○ Unknown fuel types, load factors / operating regimes ○ Accurate forecasting of future demand ○ Forecasting for multiple times points through the year to support investment processes
Future State	○ Coordinated scenario planning (FES built through regional FES) ○ Short to medium term forecasting of DER and available flexibility ○ More accurate demand forecasting ○ Full understanding of demand impacts of EV, heat pumps etc ○ Year round forecasts in place so that a complete picture of DER operation and impacts can be built up
Gaps	○ Long-term DER impact not fully understood and considered ○ Short-term forecasting at distribution level not available ○ FES has no input from DNO's ○ Current long-term DNO forecasting (used for RIIO submission) is insufficient to capture the dynamics of the changing energy landscape ○ Deterministic approach in forecasting ○ Utilisation of available data is limited ○ Unknown load factors/operating regimes ○ Generation output modelling – diversity of technologies – quantifying likely generation outputs
Barriers	○ Skills and resources, especially at DNO's ○ Visibility of LV connections (storage, EV's, rooftop PV etc) ○ Cooperation between forecasting teams (DNO, SO and TOs) ○ Exchange of information between TO/SO and DNOs ○ Wider range of future scenarios ○ Large volumes of data
Reference Projects	○ Forecasting modules from KASM

B.9 Network Design

Issues	○ Inefficiencies in network development due to the absence of whole system design ○ Different design standards at T and D
Future State	○ Diversity/Standards/Equipment Specs/ANM ○ Consistent design standards (with levels as appropriate for risk).
Gaps	○ Whole system design ○ Visibility of T and D network developments ○ Detailed assessment of T impact on D and vice versa (generation, quality of supply, voltage etc.) ○ FES equivalent for D network
Barriers	○ SQSS v P2/6
Reference Projects	

B.10 Constraint Management

Issues	○ Lack of market based structure for controlling DER to manage constraints ○ Conflicts of services (ANM, balancing services etc.) ○ Constraints to customers and associated costs are not transparent
Future State	○ More transparent CBA model ○ (See Voltage Management)" ○ Transparent costs for constraining generation ○ Comparison between investment and operational costs (constrain versus build assets)
Gaps	○ Standard approaches for ANM and flexible connections ○ Visibility of the impact of new products implemented at the D level on the T level ○ D network: Lack of cost comparison processes (e.g. at which point it is more cost efficient to expand network than paying for constraints) ○ Whole system CBA process - flexibility vs build
Barriers	○ No visibility of constraints costs and how it compares with further investment (building assets) ○ Info on cost of constraints to customers
Reference Projects	○ Regional Development Programme

B.11 Charging

Issues	○ Complex pricing structures ○ No incentives for connections that help the whole system ○ Inconsistent approach for connections charging across T and D
Future State	○ Locational signals ○ Equivalent charges T or D
Gaps	○ Coordination between T and D charges ○ No locational signals
Barriers	○ Existing charging mechanisms
Reference Projects	

B.12 Market Arrangements

Issues	○ Market derived alternatives to provide transmission network capacity are not being brought forward ○ Market derived alternatives to provide T-D interface capacity shortfalls (e.g. storage to reduce peak demand) are not being brought forward ○ No whole system consideration of distribution network shortfalls at present ○ Market derived alternatives to transmission network investment for voltage management are not being brought forward
Future State	○ Markets to facilitate DER/T solutions to manage the system ○ A broader range of solutions available to address long-term and short-term capacity shortfalls ○ A broader range of solutions available to address long-term and short-term T-D interface capacity shortfalls ○ A broader range of solutions available to address voltage management shortfalls
Gaps	○ Mechanisms to identify and support alternatives to network investment (for wider capacity, T-D interface capacity, voltage management etc.) are not in place. ○ No market arrangements at D network ○ No market co-ordination or interactions between T and D ○ Access to markets for small customers
Barriers	○ Charging/funding arrangements
Reference Projects	○ ENTIRE ○ SYNC ○ Demand Turn Up ○ CLASS ○ CLNR ○ ANM/FPP/LLCH/Orkney ○ Power Potential ○ CMZ

B.13 Asset Health

Issues	○ New assets under- or over-utilised ○ Effect of innovative solutions (e.g. ANM) on asset health ○ Ongoing asset health of new control arrangements (e.g. ANM) ○ Increased need to update / replace control system solutions going forward ○ Effect of reverse flows on SGT's and impact on asset health ○ Understanding of asset degradation as a result of increase system loadings (i.e. pushing assets harder to leverage capacity of existing system rather than investing – especially in areas of intermittent generation sources)
Future State	○ Improved asset health monitoring ○ Asset health monitoring and replacement policies in place. ○ Coordinated asset replacement programmes across Transmission and distribution based on shared asset health data
Gaps	○ Consistency of views on asset replacement for assets that were commissioned at the same time ○ Alignment of price controls ○ Consistency of methodologies ○ Flexibility as an alternative to asset replacement ○ Lack of whole system framework to assess alternative options to asset replacement ○ Suitable policies and monitoring processes need to be developed
Barriers	○ Resource planning ○ Data storage / information exchange ○ Retention of skills / detailed knowledge ○ Asset health monitoring ○ Flow on information between TOs and DNOs ○ Multiple control systems being used ○ High volumes of monitoring information would need to be managed
Reference Projects	○ NIA projects

B.14 Transmission & Distribution Coordination

Issues	○ Current industry structure only requires limited engagement ○ Non-aligned priorities
Future State	○ Whole system code (e.g. STC)
Gaps	○ Further engagement required to address future challenges, i.e. could high volts been anticipated years ahead? ○ Alignment of price controls (RIIO ET and ED) ○ Engagement to address future challenges
Barriers	
Reference Projects	○ Regional Development Programme ○ Statement of Works V2 - Planning Limits

B.15 Customer

Issues	○ Inconsistency between different companies policies ○ Internalise the complexity between D and T rather than sharing this with the customers ○ Smaller customer find connection processes complex (e.g. T and D code)
Future State	○ Information available to enable market to deliver services and optimise location of assets ○ Simplified processes for connection of smaller customers
Gaps	○ Customer visibility not available for all customers ○ Availability of customer data in defined compliant formats ○ Defined commercial products as well as requirements for customers for participation ○ FES and SOF equivalent for D networks
Barriers	○ Interoperability and connectivity of devices requires an extensive comms network. These come with their challenges - cyber security and resilience. ○ Lack of common standards for provision of customer data and how this would be used in the administration of services ○ Lack of commercial products and specified requirements to allow customers to tailor their equipment and services
Reference Projects	

Glossary

Term	Definition
Balancing / Ancillary Services	National Grid procures Balancing / Ancillary Services in order to balance demand and supply and to ensure the security and quality of electricity supply across the GB Transmission System.
Bilateral Connection Agreement (BCA)	Each party connected to the GB Transmission System shall enter into and comply with a Bilateral Connection Agreement in relation to such connection.
Connect and Manage	Connection scheme which allows Generation Customers to connect on the Transmission Network ahead of the completion of any wider transmission system reinforcements required under the security standards. Connecting generators ahead of the completion of wider works are subject to generation constraints.
Connection Agreements	An agreement between the DNO and the User or any Customer setting out the terms relating to a connection with the DNO's Distribution System (excluding any CUSC Bilateral Agreement).
Common Distribution Charging Methodology (CDCM)	The Common Distribution Charging Methodology (CDCM) is used to calculate charges to users who are connected to the LV and HV levels of the distribution network.
Connection Agreements	An agreement between the DNO and the User or any Customer setting out the terms relating to a connection with the DNO's Distribution System (excluding any CUSC Bilateral Agreement).
Connection and Use of System Code (CUSC)	The Connection and Use of System Code (CUSC) is the contractual framework for connection to, and use of, the National Electricity Transmission System (NETS).
Construction Agreement	Each party who wishes to construct or modify a direct connection to the GB Transmission System or commence or modify use by his Embedded Power Station or Distribution Interconnector, or any Distributor who wishes to connect a Relevant Embedded Medium Power Station or Relevant Embedded Small Power Station to his system shall enter into and comply with a Construction Agreement in respect of any construction works required as a result of that connection or Modification, together with a Bilateral Agreement as identified in Paragraph 1.3.1 or, as appropriate, an agreement to vary such Bilateral Agreement. In any case under the OTSDUW Arrangements, paragraph 1.5 applies to such Construction Agreement.
Customer	A person who is the owner or occupier of premises that are connected to the Distribution System.
DER	Distributed Energy Resources. This may include any technology connected at the distribution network and covers demand, generation and storage.
Distribution Code	A code required to be prepared by a DNO pursuant to condition 9 (Distribution Code) of a Distribution Licence and approved by the Authority as revised from time to time with the approval of, or by the direction of, the Authority.
Distribution License	A distribution licence granted under Section 6(1)(c) of the Electricity Act 1989 (as amended.including by the Utilities Act 2000 and the Energy Act 2004).
Distribution Network Operator (DNO)	The person or legal entity named in Part 1 of the Distribution Licence and any permitted legal assigns or successors in title of the named party.

Term	Definition
Distribution System	The System consisting (wholly or mainly) of electric lines owned or operated by the DNO and used for the distribution of electricity between the Grid Supply Points or Generation Sets or other Entry Points to the points of delivery to Customers or Authorised Electricity Operators, or any Transmission Licensee within Great Britain and Offshore in its capacity as operator of the licensee's Transmission System or the National Electricity Transmission System and includes any Remote Transmission Assets (owned by a Transmission Licensee within Great Britain), operated by the DNO and any electrical plant and meters and metering equipment owned or operated by the DNO in connection with the distribution of electricity, but shall not include any part of the National Electricity Transmission System.
Embedded/Distributed Generator	A Generator including a Customer with own generation whose generation sets are directly connected to the DNO's Distribution System or to an other authorised distributor connected to the DNO's Distribution System. The definition of Embedded Generator also includes the OTSO in relation to any embedded Transmission System.
Generator	A person who generates electricity under licence or exemption under the Electricity Act 1989 (as amended.including by the Utilities Act 2000 and the Energy Act 2004).
Grid Code	The code which National Grid Electricity Transmission plc. is required to prepare under its Transmission Licence and have approved by the Authority as from time to time revised with the approval of, or by the direction of, the Authority.
ICCP	Inter-Control Center Communications Protocol
Innovation	The execution of new functional operations within an organisation.
LCT	Low Carbon Technologies
Long Term	An implementation period of more than eight years
Loss of Mains protection	Protection to achieve disconnection of the distribution generator from the Distribution System in the event of loss of one or more phases of their supply.
Market	The non-geographical area or arena in which commercial dealings are conducted.
Medium Term	An implementation period of longer than three but less than five years.
National Electricity Transmission System Operator (NETSO)	National Grid Electricity Transmission (NGET) in its capacity as operator of the National Transmission System.
OMS	Operational Management System
OPF	Optimal Power Flow
Regulatory	In the context of this report, refers to economic regulation, by Ofgem
Short Term	An implementation period of less than a 2 years.
Statement of Works (SoW)	Statement of Works is submitted to National Grid for the purposed of assessing the impact of embedded generation upon the National Electricity Transmission System.
System	An electrical network running at various voltages.
System Stability	The ability of the System, for a given initial operating condition, to regain a state of operating equilibrium, after being subjected to a given system disturbance, with most System variables within acceptable limits so that practically the whole System remains intact.
System Operator (SO)	The System Operator is responsible for ensuring the stable and secure operation of the whole transmission system.

Term	Definition
TER	Transmission Energy Resources. This may include any technology connected at the transmission network and covers demand, generation and storage.
The System Security and Quality of Supply Standard (SQSS)	Transmission licensees – both onshore and offshore – are required by their licences to comply with the National Electricity Transmission System Security and Quality of Supply Standards (NETS SQSS), which sets out criteria and methodologies for planning and operating the GB Transmission System.
Transmission and Distribution Interface	The point at which transmission and distribution systems are coupled together. This will normally be at the lower voltage side of the transformation point between the transmission system and the distribution system
Transmission License	The licence granted under Section 6(1)(b) of the Electricity Act 1989 (as amended.including by the Utilities Act 2000 and the Energy Act 2004).
Transmission System	A system of High Voltage lines and plant owned by the holder of a Transmission Licence and operated by the NETSO, which interconnects Power Stations and substations.
Transmission Owner (TO)	Transmission Operators (TOs) are licensed to develop, operate and maintain the high voltage system within their own distinct onshore transmission areas.
User	A term used in various sections of the Distribution Code to refer to the persons using the DNO's Distribution System.
Whole System	The integrated system of connected generating plant, Transmission System, Distribution Systems and associated electrical demand.