The Voice of the Networks

Energy Networks Association

Open Networks Project

Data Exchange in Planning Timescales; Data Scope - Final Report

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Executive Summary

This report covers Open Networks WS1B P4 sub-deliverable (a) – T-D Data Exchange Scope.

The P4 working group is proposing a number of enhancements to the scope and frequency of data exchange, between distribution and transmission companies, for the purpose of coordinated and efficient planning of their networks. These proposals are predicated against a transition to a SMART energy system and to distribution system operation activities. To support this transition it is proposed that the enhanced data exchange is commenced across the whole of a DNO's network when an Appendix G to the Bilateral Connection Agreement is established for a single Grid Supply Point; this applies to both distribution and transmission companies.

In respect of distribution to transmission data exchange, it is proposed to align elements of the data exchange requirements of the Grid Code with those of a Request for Statement of Works.

This will provide National Grid with:

- Full details of the sub-transmission network and any connections directly connected to the sub-transmission network
- Details of all distributed energy resource connections greater than 1MW to the distribution network and their impact on energy flows at cardinal demand points; peak demand, summer minimum demand and solar-peak/daytime-minimum demand.
- Details of all distributed energy resource greater than 1MW 'accepted' to be connected to the distribution network and their anticipated impact on energy flows at cardinal demand points; peak demand, summer minimum demand and solar-peak/daytime-minimum demand.
- Details of all distributed energy resource connections less than 1MW to the distribution network, aggregated by fuel type and disaggregated by substations connecting to the sub-transmission network.

This enhanced level of data transfer will, as a minimum, take place at calendar week 24 and when a Request for a Statement of Works is submitted.

In respect of transmission to distribution data exchange, it is proposed that this will, continue as present, be submitted at calendar week 42.

However, it is proposed that DNOs will, as standard, be provided with a switch level, single boundary format model of the transmission system. This model will cover the whole of the DNO area in detail, together with equivalent networks at agreed boundary points.

Furthermore, it is proposed that the transmission model shall be provided for the following demand points:

- Peak demand,
- Summer minimum demand,
- Solar-peak/daytime-minimum demand,
- National high power transfer dispatch scenario, and
- National low power transfer dispatch scenario.

It is also proposed to require IDNO to DNO and inter-DNO data exchange that facilitates accurate distribution to transmission data exchange.

1 Introduction

1.1 About ENA and our members

Energy Networks Association (ENA) represents the "wires and pipes" transmission and distribution network operators for gas and electricity in the UK and Ireland. Our members control and maintain the critical national infrastructure that delivers these vital services into customers' homes and businesses.

1.2 WS1B Product 4 – Data Exchange in Planning Timescales

This Product is a continuation of the work of the 2018 WS1 Product 12 (TSO/DSO & DER Data Requirements). It takes a wider approach to look at the scope and mechanisms of planning data exchange between network companies against a backdrop of an electricity system that is more decentralised, smarter and lower carbon.

The Product will propose an enhanced scope of data exchange between network companies that will better facilitate a coordinated and efficient approach to whole electricity system planning.

It is anticipated that both the scope and frequency of planning data will be significantly increased beyond that presently required by the network codes. The Product will review the current methods of planning data exchange, the existing capability to transfer the data electronically and, investigate and propose an industry standard for electronic data exchange.

The final element of the Product's work is to propose network code modifications enable the introduction of the proposed scope and mechanisms for planning data exchange.

This report addresses the scope, frequency and process of planning data exchange.

2 Data Exchange Requirements

The decarbonisation of the electricity system is precipitating an increased penetration of DER connections. This will have an impact on the operation of the transmission and distribution networks.

Initially, DER connections affect the distribution system; impacting network voltages, power flows, fault levels, protection settings and commercial arrangements amongst other things.

However, with increasing number of DER connections the operation of the transmission system is impacted. This has been observed in many areas of the distribution network, where the penetration of DER connections has required that the DNO and NGESO develop new data exchange arrangements to manage the technical and commercial interaction between transmission and distribution.

The situation is exacerbated when new generation and inter-connectors are connected to the transmission system. The interaction between the transmission and distribution systems becomes much more dynamic. In specific areas aligned within UKPN, WPD and Scottish Power distribution networks the penetration of DER combined with transmission connections has merited a much more collaborative approach and the establishment of Regional Development Programmes.

2.1 General Principles

In assessing the requirement for an enhanced data exchange between transmission and distribution network operators, the following principles have provided guidance:

- Future system – the developed data exchange requirements should recognise a future transmission/distribution system; a system that contains significantly increased levels of non-synchronous transmission connected generation and distribution connected energy resource from those present today.
- Necessity to exchange data – an enhanced level of data exchange should be adopted only when the system development requires it.
- Consistency – data shall have a consistent meaning across the range of transmission/distribution data exchanges.
- Demonstrable requirement – data shall only be collected and exchanged where there is a demonstrable need.

2.2 Existing Data Exchange Requirements

The Grid Code (Planning Code and Data Registration Code) requires DNOs to provide their network planning data to NGESO by weeks 24[1] and 50 of the calendar year.

The Grid Code also requires NGESO to provide to DNOs planning data relating to its transmission system by week 42 of the calendar year.

In addition, the Connection and Use of System Code (CUSC) requires DNOs to submit planning data in relation to the connection of a relevant Embedded Generator. This submission is known as a Request for Statement of Works.

[1] Note week 24 and week 50 data submission may be submitted as late as week 28 and week 02 respectively.

2.2.1 Grid Code Data – Week 24/50

DNOs are required to submit Standard Planning data to NGESO by calendar week 24 of the year.

To meet the requirements of EU regulation 2017/1485 (known as System Operation Guideline – SOGL) DNOs provide a second submission of Standard Planning data by calendar week 50 of the year. The week 50 data submission is effectively an update to the week 24 submission and details structural data that has changed between the submissions.

The week 24 submission covers the DNOs system data and its demand data. The data is submitted within standard schedules/tables that are defined in the Grid Code – Data Registration Code. The tables are submitted in the form of a number of Excel workbooks/spreadsheets.

Completed schedules/tables (workbooks/spreadsheets) are delivered to NGESO either by electronically uploading them to a data exchange portal that is hosted by NGESO, or by emailing them to NGESO.

Table 1 below details the schedules/tables that a DNO is required to complete as part of the week 24 data submission.

The Product (4) has focussed its attention on the 'Network Data' and 'Demand & Energy Data' elements of the week 24 submission. It is these data that change significantly throughout the year and influence the long term planning of the networks.

Some of the schedules within the 'Demand & Energy Data' are concerned with forecasting future demand scenarios; modification or enhancement of these schedules is under consideration by Product 2 (Whole Electricity System FES) of WS1B.

The 'Emergency Demand Disconnection Data' and the 'Equipment Data' remain unchanged; these data remain comparatively static throughout the year such that the existing Grid Code requirements are considered adequate.

	Proforma Table Name	Grid Code Reference	Data Registration Code (DRC) Reference	Description
Demand & Energy Data	10a	PC.A.4.2.1 (a)	Schedule 10 (Page 1 of 2)	Demand Profile for Day of User's Peak Demand based on Annual ACS conditions
	10b	PC.A.4.2.1 (b)	Schedule 10 (Page 1 of 2)	Demand Profile for Day of GB Peak Demand based on Annual ACS conditions
	10c	PC.A.4.2.1 (c)	Schedule 10 (Page 1 of 2)	Demand Profile for Day of GB Minimum Demand based on Annual ACS conditions
	17	PC.A.4.1.4.4 and noting PC.A.4.1.4.6	Schedule 17	Access Period definitions (submitted week 6)
	11	PC.A.4.3.1 4.3.2, 4.3.5, 4.5	Shedule 11 (Page 1 of 5)	Connection Point Demand at GB Peak, GB Minimum, Access Period Connection Point Peak, and other time specified.
	11	PC.A.3.1.4(a), 3.2.2(c)	Shedule 11 (Page 2 of 5)	Connection Point embedded generation. (see also notes in DRC and Table 11d)
	11c	PC.A.4.2.3	Schedule 10 (Page 2 of 2)	User's Active Energy Requirements by Customer Class (see also notes in DRC)
	11d	PC.A.3.1.4(a) (ii) & (iii)	Schedule 11 (Pages 3 of 5 and 5 of 5)	Embedded Small Power Station details
Emergency Demand Disconnection data	12a	OC 6.6.2	Schedule 12 (Page 2 of 2)	Automatic Low Frequency Demand Disconnection
	12c	OC 6.5.3(e)	Schedule 12 (Page 2 of 2)	Demand Reduction by voltage reduction or Demand Disconnection
	12c	OC 6.7.2	Schedule 12 (Page 2 of 2)	Percentage Emergency Manual Demand Disconnection
Equipment Data	14a	PC.A.2.2.6 (a)	Schedule 5 (Page 6 of 10)	LV Switchgear ratings at Connection Points
	14b	PC.A.2.2.6 (b)	Schedule 5 (Page 2 of 10)	LV Substation infrastructure ratings at Connection Points
	14c	PC.A.2.4.1	Schedule 5 (Page 2 of 10)	Reactive Compensation Plant
Network Data	Single Line Diagrams	PC.A.2.2.1, 2.2.2, 2.2.3	Schedule 5 (Page 1 of 10)	Single Line Diagrams of User's system layout
	Schedule 5 spreadsheet Node Data Tab	PC.A.2.3 PC.A.2.5.1, 2.5.4, 2.5.6 PC.A.4.3.4	Schedule 13	Lumped system susceptance Fault Infeeds Node Demands
	Schedule 5 spreadsheet Line Data Tab	PC.A.2.2	Schedule 5 (Page 4 of 10)	Line parameters
	Schedule 5 spreadsheet Transformer Data Tab	PC.A.2.2.5	Schedule 5 (Page 5 of 10)	Transformer parameters

Table 1

2.2.2 Statement of Works

When a DNO is requested to provide a network connection to an Embedded Power Station (Distributed Generation) that it believes is relevant to the operation of the transmission system it is required, under the Connection and Use of System Code (CUSC), to request from NGESO a Statement of Works. When requesting a Statement of

Works the DNO must submit to NGESO the technical data that relates to the Embedded Power Station and the transmission system connection point (Grid Supply Point – GSP).

The current requirements of the CUSC (section 6.5.5) relate to the connection of a single Embedded Power Station. However, the penetration of Embedded Power Stations and the high level of connection activity have rendered current requirements unworkable in most instances.

The 2017 work of the Open Networks project (Product 7 – Statement of Works) developed a process, and associated data tables, for the aggregated submission and assessment of multiple Embedded Power Station connections. This process and data submission requirements has generally been adopted by the DNOs.

The 2017 Open Networks Product 7 work has precipitated a CUSC modification proposal (Ref: CMP298 – Updating the Statement of Works process to facilitate aggregated assessment of relevant and collectively relevant embedded generation) that seeks to build on Products 7's work and update CUSC accordingly. The working group that is reviewing CMP298 has not, to date, concluded its work or proposed the changes that need to be made to CUSC.

The work of Open Networks (2019) WS1B Product 4 and this report has assumed that the process and data requirements developed by 2017 Open Networks Product 7 will be adopted.

In respect of the Statement of Works data submission Table 2 below details the GSP submission requirements:

	Tab Name	Description
Demand & Energy Data	Fault Infeed	Fault infeed to the transmission system before and after (and the delta) the addtion/removal of generation from the distribution system. Representing the most onerous fault conditions
	PQ Morning Period	Power flow infeed to the transmission system before and after (and the delta) the addtion/removal of generation from the distribution system. Between 04:00 and 06:00 on the day of minimum demand
	PQ Midday Period	Power flow infeed to the transmission system before and after (and the delta) the addtion/removal of generation from the distribution system. Between 10:00 and 16:00 on the day of minimum demand
	Generator Information	Listing of Generation sorted by category: Proposed, Accepted and connected. Including generation <1MW
	Medium PS data	Detailed data for synchronous and non-synchronous medium power stations connected to the sub-transmission level network, plus network data for each
Network Data	Sub-Tx Connections	Single Line Diagrams of User's system layout

Table 2

Currently, a Request for Statement of Works/Project Progression is made by the DNO when the aggregate connected capacity of Embedded Generation reaches a predefined

(by NGESO) level; a Planning Limit or Materiality Headroom. A request can be made at any time in the year. The data submitted when making a Request for Statement of Works provides NGESO with updated (from week 24 submissions or previous Request for Statement of Works) Demand & Energy data and Single Line Diagrams for the specific area of the distribution network; the data, in respect of fault level/demand/generation, is also of a greater scope than that submitted in the week 24 submissions. The Request for Statement of Works/Project Progression also provides a list of all connected DER together with basic information and detailed information for Medium Power Stations (in England and Wales).

Following a Request for Statement of Works/Project Progression NGESO will undertake system studies and formalise a contractual position in respect of the proposed Embedded Generation connections by making a GSP Bilateral Connection Agreement (BCA) - Agreement to Vary, CUSC offer to the DNO; specifically, an update to Appendix G of the BCA if the studies indicate there is impact on the NETS. Table 3 details the data that NGESO submit to the DNO within Appendix G of the BCA.

Part	Description
1	Existing Embedded Power Stations connected to the distribution system. No specific requirements.
2	Developer Capacity for relevant Embedded Power Stations, connected and to be connected (Accepted) to the distribution system. With specific requirements (Clause 11 of BCA).
3	Developer Capacity subject to interim restrictions on Availability (Clause 12 of BCA) and site specific requirements (Clause 11 of BCA)
4	Developer Capacity for Relevant Embedded Power Stations to be connected to the distribution system post completion of works (As CA) and subject to site specific requirements (Clause 11 of BCA)
5	Materiality & Wider System Limits

Table 3

2.2.3 Grid Code Data – Week 42

The Grid Code (PC.4.3.2) requires NGESO to submit detailed planning data to DNOs to allow DNOs to model the transmission system. The data is submitted in week 42 of each year.

Two methods exist for the submission of data from NGESO to DNOs in the Week 42 process; Multiple Boundary and Single Boundary format and these are described below. Either can be provided to the DNO depending on the DNO's preference. Both formats are based on one transmission system scenario, the Winter Peak, with standard winter peak running arrangements, winter peak despatch of MWs. For plant available but not generating the plant is connected at zero MWs to still provide fault infeed.

2.2.3.1 Multiple Boundary Format

This format comprises a single line diagram (SLD) for each equivalent e.g. if the equivalent is for a non-interconnected GSP, then the diagram would be just the Transmission HV Substation, the SGTs and the DNO substation as illustrated in Figure 1. If 2 GSPs are interconnected at DNO sub-transmission voltage level, then the SLD will be as illustrated in Figure 2. Hence the transmission system for a particular licence area is represented by multiple boundary of GSP(s) of groups of one, two or three nodes on the transmission system.

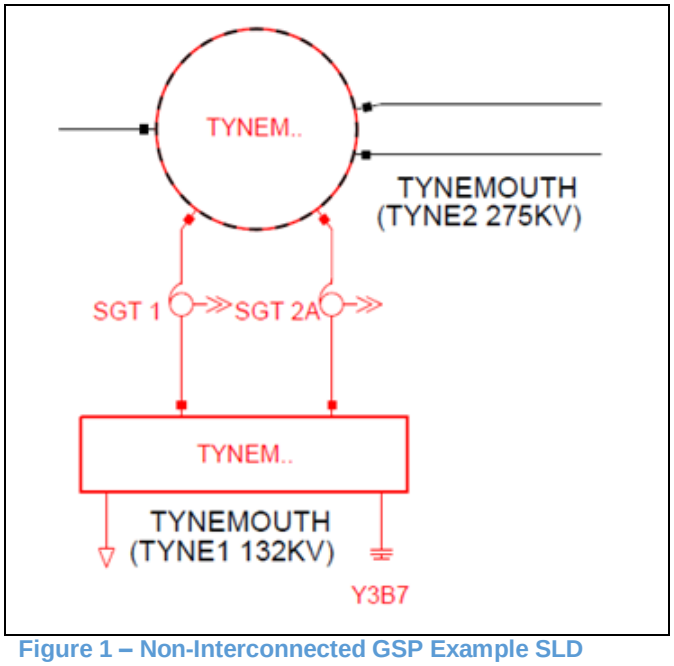

Figure 1 – Non-Interconnected GSP Example SLD

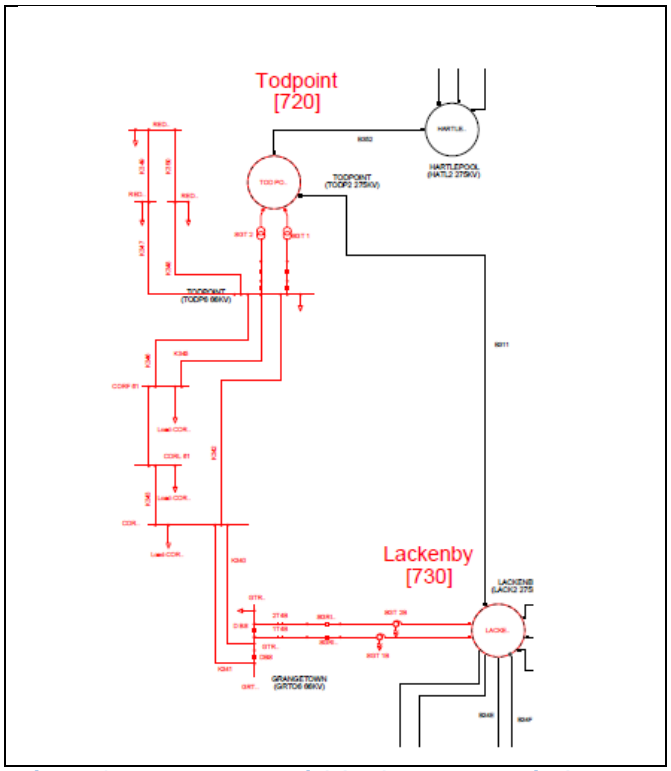

Figure 2 – Interconnected GSP Group Example SLD

For each node or group of nodes a table is filled out by NGESO with a fault level equivalent data:

- Symmetrical Three Phase Short Circuit current
- Positive sequence X/R ratio at instance of fault
- Initial positive sequence and Negative sequence source impedance of the nodal infeed as seen from the NG supergrid transformer HV node.
- Zero sequence source impedances as seen from the NG supergrid transformer HV node.

Where the GSP are interconnected group, in addition, the equivalent circuits between the transmission nodes will be presented in the following format:

Years Valid	Node 1	Node 2	Rated Voltage of Node 1 kV	Rated Voltage of Node 2 kV	Positive Phase Sequence % on 100MVA		Zero Phase Sequence % on 100MVA	
					R	X	R	X
	LACK21	TODP21	275	275	xxxx	xxxx	xxxx	xxxx

Table 4

Where there are more nodes on the equivalent transmission SLD then more equivalent circuits will be provided in the same format.

2.2.3.2 Single Boundary Format

In this format the transmission system is represented by an interconnected area of interest of the transmission system which is defined by the DNO and generally changes infrequently in scope. Figure 3 illustrates the single boundary format for ENW licence area. The rest of the transmission system and any other DNO network is represented by equivalent fault infeed, power injections and equivalent circuits. Further any power stations within the area of interest are represented by lumped P/Q injections and fault infeed equivalents.

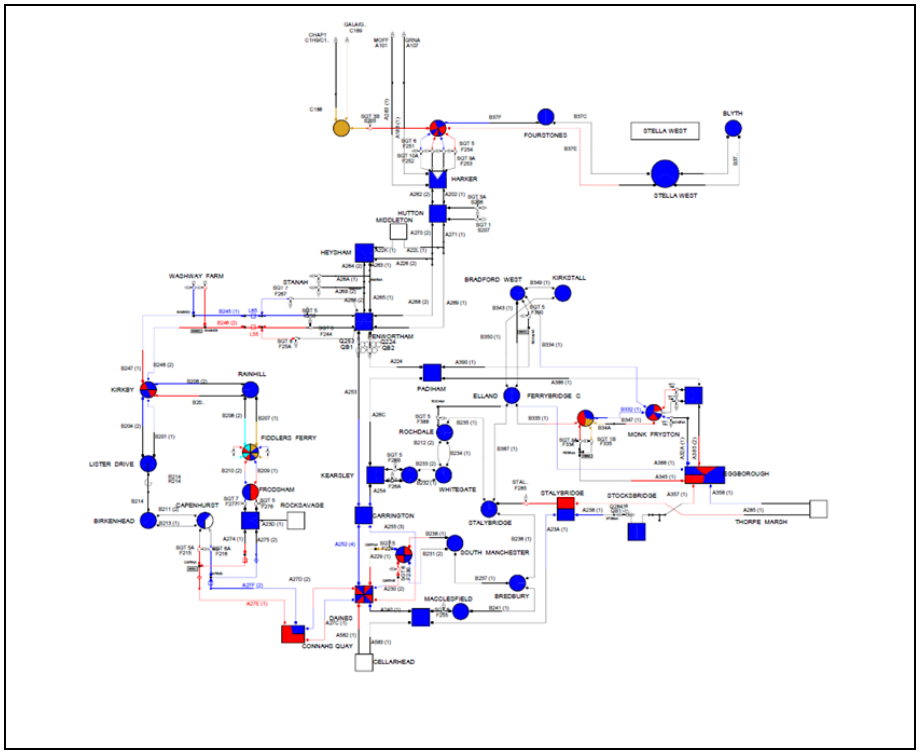

Figure 3 - SLD Single Boundary Data Format

The data provided comprises the following data which is described in further detail in the subsequent sections.

- Node Data
- Circuit Data
- Transformer Data

2.2.3.2.1 Node Data

Node data is best illustrated by some example nodes in the network:

Figure 4 is a through node example with no connected third party. As it is not a boundary node, there is no third-party network or power station connected this node data will have

- no fault infeed equivalent
- no P, Q injection /take

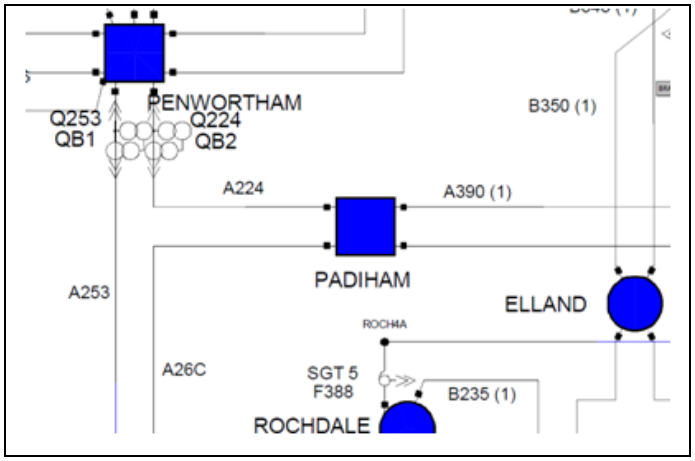

Figure 4 - Internal Node no Power station, no 3rd party

Figure 5 shows an example node of Heysham 400kV and 132kV sites (both transmission owned and operated) where there is power station equipment connected (Synchronous units at 400k and station transformer supplies at 132kV site) so the node data contains

- Fault infeed equivalent from the power station units at 400kV node and station transformers at 132kV node
- P, Q injection/take from the power station units at 400kV and station transformers at 132kV

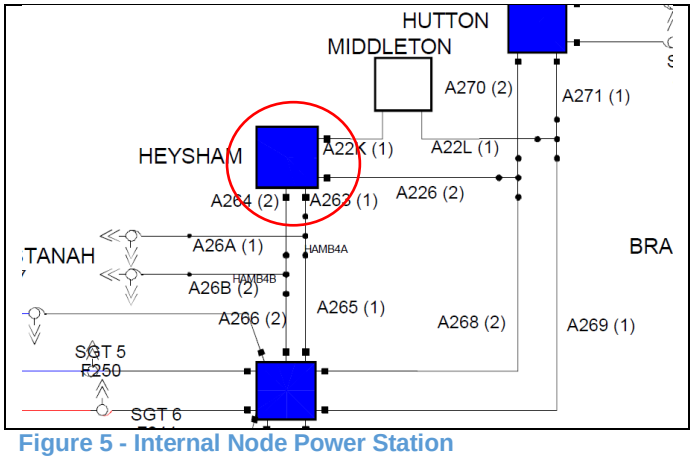

Figure 5 - Internal Node Power Station

Figure 6 and so will have.

- Fault infeed equivalent from the boundary equivalent network
- P, Q injection/take from boundary equivalent network

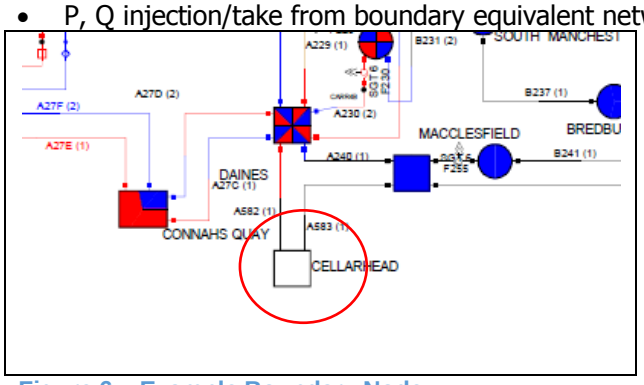

Figure 6 – Example Boundary Node

2.2.3.2.2 Circuit Data

The circuit data will contain two types of circuits

A. Actual Circuits that are internal to the area of interest and represented on the diagram and the following data will be provided;
   i. Ratings
   ii. Impedance data-positive, zero and mutual coupling data

B. Equivalent Circuits between boundary nodes. These are to represent how flows redistribute around the wider network if an outage is taken internal to the area of interest. To avoid an excessive number of equivalent circuits a threshold is agreed with the DNOs so not to have equivalent circuits with very high impedance (weak) represented for no real benefit. The data for equivalent circuits comprises:
   iii. Positive Sequence impedance Data

2.2.3.2.3 Transformer Data

This data is for Supergrid Transformers and is split into two data sets- one for 2 winding and for 3 winding transformer data. Detailed data on transformer ratings, taps and impedances are provided.

2.2.3.3 Comparison of Multiple Boundary and Single Boundary Format

Table 5 provides a high-level comparison of the two formats of transmission data submission.

Aspect	Multiple Boundary	Single Boundary
TSO Resource	2 weeks per annum per DNO	2 weeks per annum per DNO
DNO Resource	Update transmission fault levels. Infrequent updates to cover changes to SGTs or interconnection parameters.	Update transmission P,Q injections annually. Infrequent updates to cover changes on SGTs or interconnecting circuit parameters.
Representation of Transmission Interconnection	Only between interconnected GSPs but has no representation of transmission power flows.	Full representation of interconnection but only for one dispatch scenario (Winter Peak) and for one running arrangement (Winter Standard)
Fault Level Representation	Winter peak with infeed from all available plant. Transmission outages on overhead lines not represented as one contains equivalent circuits.	Winter peak with infeed from all available plant. Slightly enhanced compared to multiple boundary but marginal improvement.

Table 5 – Multiple/Single Boundary Comparison

2.3 Enhanced Distribution to Transmission Data Exchange

The following proposals for an enhanced level of distribution to transmission data exchange are based on the experience gained from the Regional Development Programmes (RDPs) that UKPN and WPD have collaborated with NGESO on and also the general experience of all DNOs and NGESO gained from the Statement of Works process.

2.3.1 Data Exchange – Process and Calendar

The existing week 24 data submission consists of 4 categories of data;

- Demand & Energy data;
- Emergency Demand Disconnection data;
- Equipment data, and;
- Network data

The data exchanged during a Request for Statement of Works relates to Demand & Energy data and Network data. It is these categories of data that are subject to a greater level of change within the year.

It is proposed to align the Demand & Energy data and Network data requirements of week 24 submission with those requirements for a Statement of Works submission. The Working Group has developed aligned schedules, these schedules can be found Appendix 1.

It is not proposed, at this time, to change the charging arrangements for Request for Statement of Works. It is anticipated that CUSC Modification Proposal CMP298 will address this issue.

NGESO would therefore receive updated Demand & Energy data and Network data submissions whenever a DNO submits a Statement of Works using the new templates. It is proposed that, National Grid will also receive accepted DER connections, in addition to the details of the existing connections in the Week 24 submission.

The week 24 data submission is to incorporate the aligned and enhanced Demand & Energy data and Network data. However, if a Statement of Works has been submitted between week 16 and week 24 then the DNO may simply re-submit the Statement of Works' Demand & Energy data and Network data as part of the week 24 submission, unless there are any network topology changes. If a Statement of Works submission has not been made between week 16 and week 24 then the week 24 submission will contain updated Demand & Energy data and Network data.

The week 50 submission does not require Demand & Energy data and Network data. This will remain the case under these proposals. It is assumed that if any material changes have occurred then these will have been communicated to NGESO via a Request for Statement of Works submission.

It is proposed to retain the existing provision that allows NGESO to request from a DNO Demand & Energy data and Network data for a GSP at any time during the year.

2.3.2 Triggers for Enhanced Data Exchange

The levels of DER penetration vary across the DNOs and vary within a DNO's distribution network.

There are parts of the distribution networks that have seen very little penetration of DER connections. In these areas there is very little justification to require DNOs to provide an enhanced level of data submission than is currently required in the Grid Code.

Where there is significant levels of DER connections then this will have inevitably required the submission of a Request for Statement of Works to NGESO. Should this Request for Statement of Works precipitate the establishment of an Appendix G to the Bilateral Connection Agreement, then it is at this point that it is proposed to move to submitting a proposed enhanced level of data in line with the process described above.

Figure 7 illustrates the change in D to T data exchange once the trigger level of an Appendix G has been reached for a part (a GSP) of the distribution network.

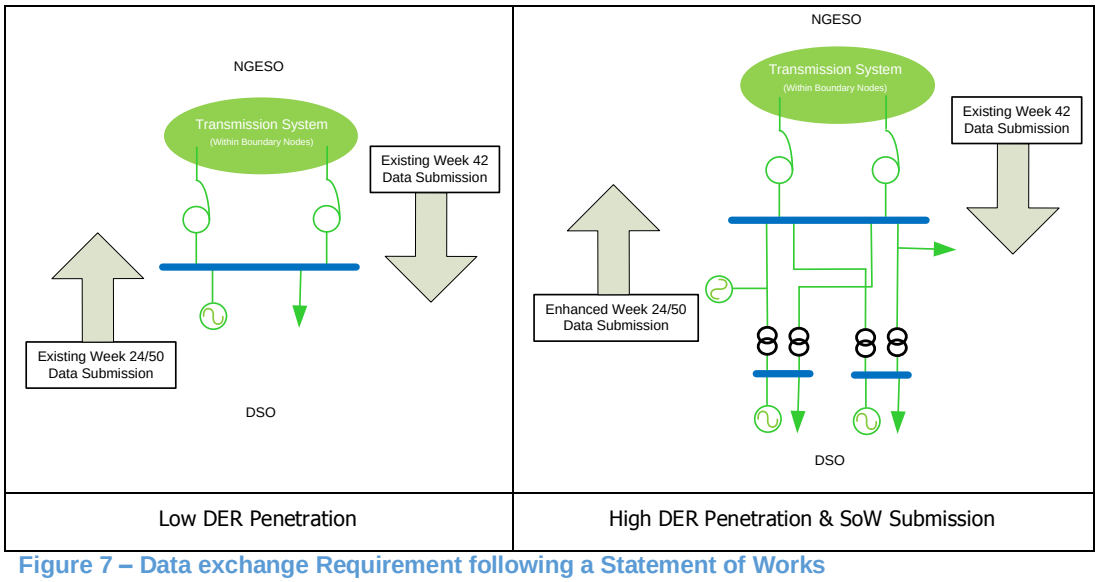

Figure 7 – Data exchange Requirement following a Statement of Works

It should be noted that one an Appendix G to the Bilateral Connection Agreement has been established for one GSP then enhanced data exchanged will be required for all GSPs within the DNO area.

2.3.3 Extent of Distribution Network Model and Data

It is proposed that the DNOs will provide node and line data that describes the sub-transmission network in more detail. The data will detail the DNO owned network and any direct customer connections to it at that voltage level, including any DER connections.

Figure 8 illustrates the level of the proposed SLD.

The same Impedance Data templates/schedules for the sub-transmission network will be provided in week 24 and Statement of Works submissions. The Impedance Data will be submitted in a new Schedule. The load and fault flow information will also be detailed in the new schedule (see Appendix 1; Schedule 5 – Enhance Node Data). Load/fault flow data will be described at the interface between the sub-transmission level and the lower voltage distribution network.

All DER with capacity greater than 1MW (and less than 100MW) will be referenced in another new schedule (see Appendix 1; Enhanced Schedule 11). Basic details are provided for all connected DER. Any DER (<100MW)[2] that is directly connected to the sub-transmission will have their detailed electrical characteristics recorded.

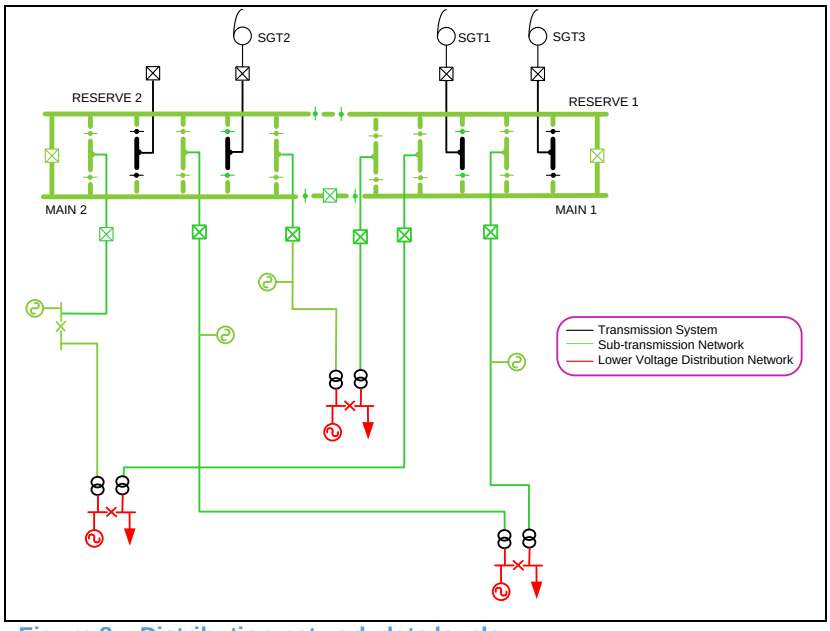

Figure 8 – Distribution network data levels

The new 'Enhanced Schedule 11' will also incorporate details of Small Power Stations (<1MW), aggregated by technology type, for each node (between the sub-transmission network and the lower voltage distribution network). Table 6 details the technology types (primary energy source) which aligns with the requirements of the EU Commission Regulation Requirements for Generation (RfG) and the ENA' EREC G99.

Primary Energy Source		Primary Energy Source
Solar PV		Wind
Hydro (run of river)		Hydro
Biomass		Other Renewable
Fossil gas		Waste
Fossil coal gas		Fossil oil
Fossil oil shale		Fossil peat
Geothermal		Fossil brown coal/lignite
Fossil hard coal		Hydro pumped storage
Marine		Nuclear
Offshore wind		Other
Other – battery storage		Other – storage – not battery

Table 6 – DER Categories

2.3.4 Demand Profile Cardinal Points

With increased penetration of DER connections to the distribution network there is an increased requirement to study the network at cardinal demand points other than just winter peak (maximum fault infeed).

It is proposed, as part of the new schedules, that load/fault flow data will be provided at the following demand cardinal points

[2] Note: Medium Power Stations not connected to the sub-transmission network will not have detailed data provided.

- Time of national peak demand
- Time of GSP peak demand
- Time of GSP minimum demand (~05:00hrs)
- Time of solar peak GSP minimum demand (~13:00hrs)

2.3.5 Enhanced Data Schedules

It is proposed to align week 24 schedule 5 and schedule 11 (Embedded Small power Station) with the Statement of Works schedules. These schedules will then be submitted with each week 24 (50) and Statement of Works submission.

All other week 24 (50) schedules remain unchanged from the existing Grid Code requirements as a result of this Product's work. Similar the frequency of all other week 24 (50) schedules is as currently specified in the Grid Code.

2.3.5.1 Schedule 5

Currently, schedule 5 requires provision of data for the Nodes, Lines, 2 Winding transformers and 3 Winding transformers that appear on the Single Line Diagram (SLD).

This basic requirement remains unchanged; however the extent to which the SLD is detailed is proposed to increase as described in section 2.3.3 of this report and illustrated in Figure 8.

Furthermore, to align with the submission requirements of the Statement of Works the Nodes data in schedule 5 is expanded as detailed in Table 7 below.

Data requirement	Existing Requirement	Proposed Requirement
P, Q, S & pf @ time GB Peak Demand, with existing connections	✓	✓
P, Q, S & pf @ time GB Min Demand (@~05:00), with existing connections		✓
P, Q, S & pf @ time GB Solar Peak/Min Demand (@~13:00), with existing connections		✓
I" & I' (or S" & S'), with existing connections	✓	✓
P, Q, S & pf @ time GB Peak Demand, with existing and accepted connections		✓
P, Q, S & pf @ time GB Min Demand (@~05:00), with existing and accepted connections		✓
P, Q, S & pf @ time GB Solar Peak/Min Demand (@~13:00), with existing and accepted connections		✓
I" & I' (or S" & S') & X/R, with existing and accepted connections		✓
Variance of P, Q, S and pf@ time GB Peak Demand with/without accepted connections		✓
Variance of I" & I' (or S" & S') @ time GB Peak Demand with/without accepted connections		✓
Variance of P, Q, S and pf@ time GB Min Demand (@~05:00) with/without accepted connections		✓
Variance of I" & I' (or S" & S') & X/R @ time GB Min Demand (@~05:00) with/without accepted connections		✓
Variance of P, Q, S and pf@ time GB Solar Peak/Min Demand (@~13:00) with/without accepted connections		✓
Variance of I" & I' (or S" & S') and X/R @ time GB Solar Peak/Min Demand (@~13:00) with/without accepted connections		✓

Table 7 – Existing & Proposed Schedule 5 Data Requirements

Note; there are a number of other data requirements that are common to both the existing and proposed schedule 5, ie Substation name, node code, node voltage etc.

2.3.5.2 Schedule 11 (Small Embedded Power Station)

Currently, schedule 11 (Small Embedded Power Station) requires a listing each of small embedded generators with a registered capacity of 1MW or greater connected to the distribution network.

Also, from 2019 schedule 11 (Small Embedded Power Station) requires an aggregated registered capacity of small embedded generators with registered capacity less than 1MW connected to the distribution network, broken down by fuel type.

It is proposed to align schedule 11 (Small Embedded Power Station) with the Statement of Works data requirements by expand the listing of small embedded generators with a registered capacity of 1MW or greater to include all small, medium and large power stations that are connected, or accepted to be connected, to the distribution network.

It is further proposed to provide the detailed synchronous and non-synchronous Power Station data (not large Power Stations), currently required for a Statement of Works submission, for each Power Station directly connected to the sub-transmission network.

It is proposed to refine the requirement to provide aggregated registered capacity of small embedded generators less than 1MW by fuel type; to require the data to be broken down by each node between the sub-transmission network and the lower voltage network.

2.3.6 IDNO to DNO Data Exchange

2.3.6.1 IDNO Connected to the Sub-Transmission Network

Where an IDNO's network is connected to the sub-transmission network the IDNO shall submit to the DNO by calendar week 20 completed new schedules/templates; 'Enhanced Schedule 11' and 'Schedule 5 – Enhanced Node Data' (see appendix 1) and including any detailed data of synchronous/non-synchronous generators connected to the sub-transmission network.

Furthermore, IDNOs are required under the Distribution Code to notify the DNO of any material changes. Any such notification shall be accompanied by completed new schedules; 'Enhanced Schedule 11' and 'Schedule 5 – Enhanced Node Data' (see appendix 1).

2.3.6.2 IDNOs Connected to Networks below the Sub-Transmission Network

Where an IDNO's network is connected to a DNO network below the sub-transmission level the IDNO shall submit to the DNO by calendar week 20 the new schedule/template 'Enhanced Schedule 11' completing sections 'Small Power Station Data<1MW' and 'Power Station Data>1MW' only.

2.3.7 DNO to DNO Data Exchange

2.3.7.1 DNO Connected to the Sub-Transmission Network of an Adjacent DNO

Where a DNO's network is connected to the sub-transmission network of an adjacent DNO the first DNO shall submit to the second DNO by calendar week 20 completed new schedules/templates; 'Enhanced Schedule 11' and 'Schedule 5 – Enhanced Node Data' (see appendix 1) and including any detailed data of synchronous/non-synchronous generators connected to the sub-transmission network.

Furthermore, the first DNO is required under the Distribution Code to notify the second DNO of any material changes. Any such notification shall be accompanied by completed new schedules; 'Enhanced Schedule 11' and 'Schedule 5 – Enhanced Node Data' (see appendix 1).

2.3.7.2 DNOs Connected to Networks below the Sub-Transmission Network of an Adjacent DNO

Where a DNO's network is connected to a second DNO's network below the sub-transmission level the first DNO shall submit to the second DNO by calendar week 20 the

new schedule/template 'Enhanced Schedule 11' completing sections 'Small Power Station Data<1MW' and 'Power Station Data>1MW' only.

2.4 Enhanced Transmission to Distribution Data Exchange

The following proposals for an enhanced level of data exchange from transmission to distribution network companies is based principally on the learning of the network companies involved in the Regional Development Programmes (RDP) in southern England, Open Networks WS1 P1 (2018), WS1B P1 (2019) and augmented through discussion at the Product 4 meetings.

2.4.1 Data Exchange – Process and Calendar

The data that relates to the transmission system is not subject to change significantly during a year; it is therefore proposed that the existing transmission to distribution data exchange frequency will remain as an annual "week 42" data exchange.

2.4.2 Triggers for Enhanced Data Exchange

It is proposed that an enhanced level of data exchange from transmission to distribution companies be required when an Appendix G to the Bilateral Connection has been set up for any GSP.

2.4.3 Extent of Transmission System Model and Data

It is proposed that all distribution companies receive transmission system data in the single boundary format.

This will provide distribution companies with a better representation of transmission flows that may impact interconnected GSP. Furthermore, a single boundary format will facilitate the understanding of the impact of different dispatch scenarios on the distribution network (see para. 2.4.4).

It is also proposed that Power Stations within the boundary nodes of single boundary format are not anonymised but represented as individual generating units. However, it is not thought necessary to represent these units fully, with governors, AVRs, control systems.

It is also proposed that a switch level model is provided (current transmission system models represented as nodes). This would have two advantages:

- Outages and changes of running arrangements can be more easily represent by simply changing switch positions.
- Also a switch level model would lend itself to a Common Information Model data transfer.

Whilst data is still exchanged as schedules/templates it is envisaged that defined boundary nodes will align with DNO franchise areas and include equivalents that represent adjacent parts of the transmission system. However, it is envisaged that with appropriate methods of electronic data exchange and interoperability standards, NGESO could provide a complete transmission system model, with the only equivalent networks being those that represent other DNOs.

2.4.4 Despatch Scenarios

It is proposed that data describing transmission system despatch scenarios that mirror those provided by distribution companies (week 24 submission) are provided:

- Time of national peak demand (Winter peak)
- Time of summer minimum demand (~05:00hrs)
- Time of solar peak GSP minimum demand (~13:00hrs)

The winter peak scenario will provide the DNOs with the worst-case fault level allowing them to assess the adequacy of circuit breaker ratings, as well as determining compliance with security standard EREC P2.

The winter peak scenario provides fault infeed from all available plant whether generating or not (by switching them on at zero MW output thus providing nearly all of their fault contribution). Providing summer minimum and solar peak scenarios (and fault levels), where generators are desynchronised at zero MW output, allows DNOs to assess the impact of low fault levels on protection settings and on the operation of connected converter technologies (that require a minimum fault level).

Providing this suite of scenarios also allows DNOs to ensure security of their network under a reasonable range of credible demand/generation scenarios.

In addition to the three scenarios detailed above it is also proposed that data describing the following transmission system despatch scenarios is provided:

- National High Power Transfer – a time when there is a high MW power transfer usually north to south across the UK.
- National Low Power Transfer – a time when there is a low MW power transfer usually north to south across the UK.

National high power transfers do not necessarily occur at the time of winter peak demand; they are often driven by high wind, transmission outages, quadrature booster operation or interconnector flows. For example, the UKPN area (specifically the South East Coast) flows are heavily influenced by interconnectors and wind generation. Interconnectors in this area going from maximum import to maximum export represents an 8GW swing on transmission flows alone; in addition, transmission connected wind generation can vary from 0 to 1000MW meaning a 9GW net swing in transmission flows is possible between scenarios in this area.

This variability in transmission flows will have significant impact on distribution flows in parts of the network with interconnected GSP. For radial GSPs the amount of generation that can be exporting at any one time will be significantly impacted. Therefore, in areas of the networks where an Appendix G to the Bilateral Connection Agreement has been established these high/low power transfer scenarios are consider essential to efficient planning of the networks.

Appendix 1

The following Excel Workbooks contain enhanced schedules/templates that have been developed by WS1B P4 and are to be considered in conjunction with this report;

Enhanced Schedule 11

Schedule 5 – Enhanced Node Data