Standardisation of DER Monitoring and Control Requirements

Open Networks | WS1B P6
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The voice of the networks

DOCUMENT CONTROL

Authorities

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Change history

Version	Description
1	Deliverable C and D DRAFT - Standardisation of DER operational monitoring and control requirements - Use Cases for the collection of DER operational Data Points
1.1	Addressed WS1B feedbacks
1.2	Addressed ESO's feedbacks
2	Added Deliverable E DRAFT - DER operational Data Points Technical Specification
2.1	Addressed product team and WS1B feedbacks
3	Added Deliverable F DEAFT - Gap Analysis, Impact and implementation plan

Distribution

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1. Introduction

About ENA

Energy Networks Association represents the companies which operate the electricity wires, gas pipes and energy system in the UK and Ireland.

We help our members meet the challenge of delivering electricity and gas to communities across the UK and Ireland safely, sustainably, and reliably.

Our members include every major electricity and gas network operator in the UK and Ireland, independent operators, National Grid ESO which operates the electricity system in Great Britain and National Grid which operates the gas system in Great Britain. Our affiliate membership also includes companies with an interest in energy, including Heathrow Airport and Network Rail.

We help our members to:

- Create smart grids, ensuring our networks are prepared for more renewable generation than ever before, decentralised sources of energy, more electric vehicles, and heat pumps. Learn more about our Open Networks programme.
- Create the world's first zero-carbon gas grid, by speeding up the switch from natural gas to hydrogen. Learn more about our Gas Goes Green programme.
- Innovate. We're supporting over £450m of innovation investment to support customers, connections and more.
- Be safe. We bring our industry together to improve safety and reduce workforce and public injury.
- Manage our networks. We support our members manage, create, and maintain a vast array of electricity codes, standards and regulations which supports the day-to-day operation of our energy networks.

Together, the energy networks are keeping your energy flowing, supporting our economy through jobs and investment and preparing for a net zero future.

About Open Networks

Britain's energy landscape is changing, and new smart technologies are changing the way we interact with the energy system. Our Open Networks programme is transforming the way our energy networks operate. New smart technologies are challenging the traditional way we generate, consume, and manage electricity, and the energy networks are making sure that these changes benefit everyone.

ENA's Open Networks programme is key to enabling the delivery of Net Zero by:

- opening local flexibility markets to demand response, renewable energy and new low-carbon technology and removing barriers to participation
- providing opportunities for these flexible resources to connect to our networks faster
- opening data to allow these flexible resources to identify the best locations to invest
- delivering efficiencies between the network companies to plan and operate secure efficient networks

We're helping transition to a smart, flexible system that connects large-scale energy generation right down to the solar panels and electric vehicles installed in homes, businesses, and communities right across the country. This is often referred to as the smart grid.

The Open Networks programme has brought together the nine electricity grid operators in the UK and Ireland to work together to standardise customer experiences and align processes to make connecting to the networks as easy as possible and bring record amounts of renewable distributed energy resources, like wind and solar panels, to the local electricity grid.

The pace of change Open Networks is delivering is unprecedented in the industry, and to make sure the transformation of the networks becomes a reality, we have created six workstreams under Open Networks to progress the delivery of the smart grid.

2022 Open Networks programme Workstreams

- WS1A: Flexibility Services
- WS1B: Whole Electricity System Planning and T/D Data Exchange
- WS2: Customer Information Provision and Connections
- WS3: DSO Transition
- WS4: Whole Energy Systems
- WS5: Communications and Stakeholder Engagement

Our members and associates

Membership of Energy Networks Association is open to all owners and operators of energy networks in the UK.

- Companies which operate smaller networks or are licence holders in the islands around the UK and Ireland can be associates of ENA too. This gives them access to the expertise and knowledge available through ENA.
- Companies and organisations with an interest in the UK transmission and distribution market are now able to directly benefit from the work of ENA through associate status.

ENA members

ENA associates

- Chubu
- EEA
- Guernsey Electricity Ltd
- Heathrow Airport
- Jersey Electricity
- Manx Electricity Authority
- Network Rail
- TEPCO

Executive Summary

Currently, developers connecting DERs across different regions of GB, are required to exchange different monitoring and control data sets at the connection interface depending on the DNO area the site falls into. WS1B P6 has been tasked with harmonising the DER monitoring and control requirements at the connection interface for DER connections across different DNOs.

The product team collected monitoring and control requirements from different sources, including DNOs specific requirements, DCode, the Grid Code and CUSC and looked at additional data points not currently collected that are considered to be beneficial going forward. A gap analysis has then been carried out, providing a view of what is currently being exchanged and the differences between DNOs.

The product team has then investigated use cases (Deliverable D) for each of the data points assessing the level of benefits that could be unlocked by collecting and making use of the data points.

This informed the recommendation on a set of data points DER customers should be able to exchange with the DNO if requested going forward (deliverable C), together with their technical specification (Deliverable F). To minimise the data request impact on customers, the product team has decided to focus on current use cases rather than future ones. The DER-DNO data exchange requirement should be revised on a regular basis to account for new network requirements, products and services.

This list intends to give a view to developers of all possible data points that could be requested across different DNO areas in GB and does not intend to mandate a list of data points to be requested going forward by each DNO. Full DER-DNO data points exchange harmonisation is not considered achievable at this stage due to the different ways DNOs have been developing their Active Network Management and due to the lack of commonly adopted standard for DER communication interfaces between the DNO and DER customers.

The product team has then looked at the potential impact that these additional data points would have on the DNOs and on customers both from cost and processes/systems perspective. The product team has then recommended an implementation plan and next steps to get the data points harmonised (Deliverable F),

1. Scope and Approach

1.1. Scope

The scope of ON22 WS1B P6 (DER Operational metering and monitoring) is to harmonise the monitoring and control interface data exchange requirements specified by DNOs to DER customers connecting to the distribution network, which are dependent on DNO specific requirements and requirements mandated by industry codes, including the Grid and Distribution Codes.

Currently, developers connecting DER across different regions of GB, are required to exchange different monitoring and control data sets at the connection interface depending on the DNO area the site falls into, or whether the customer is connecting to an IDNO. The data exchange requirements may be differentiated based on capacity, technology type and service provided etc.

WS1B P6 has been tasked with harmonising the DER monitoring and control requirements at the connection interface for DER connections across different DNOs.

The primary outcome is a set of data exchange points that DER customers should be able to exchange with the DNO, if requested, going forward. A distribution and/or grid code modification may follow including the production of an engineering recommendation with detailed requirements.

For clarity, this refers to operational metering data from the customer's equipment at the DER substation and exposed to the DNOs, rather than data collected by the DNOs through their own equipment. The data in scope of ON22 WS1B P6 are both monitoring points (from DER to DNO) and control points (from DNO to DER).

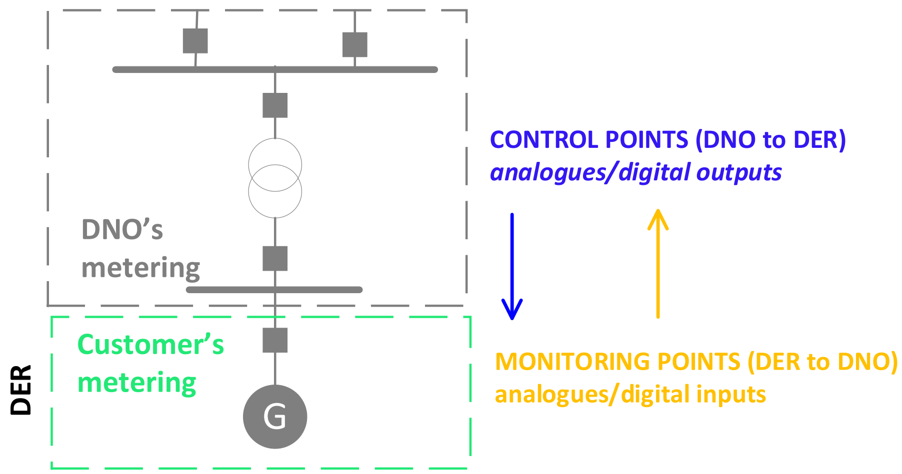


Figure 1: Scope of ON22 WS1 P6 – monitoring and control interface data exchange.

The product team has defined the following boundary conditions for recommending DER control and monitoring requirements going forward:

- **DER POC Voltage Level**: DERs that have a PoC voltage between 132kV kV bar at Grid Supply Points (GSP) and HV side of secondary substation.
- **DER capacity**: anything connected from HV to EHV, the minimum capacity is driven by DNO specific practices (200 kW-500kW depending on the DNO)
- **DER Type**: Generation and Flexible Demand.
- **DER Connection Date:** Applicable to DER connecting to the distribution network going forward.

  The deliverable description covered in this report are summarised below and capture in Table 1.

Table 1: ON 22 WS1B P6 – description of Deliverable C and D.

Table properties		
Ref	**Deliverable**	**Description**
Deliverable C	Standardisation of DER operational monitoring and control requirements	Produce a list of minimum operational data points to be provided by DER customers if requested going forward, which may be differentiated based on capacity (type A-D), service provided, technology type, etc
Deliverable D	Use Cases for the collection of DER operational Data Points	Justify the business needs for each of the DER operational data points through the definition of use cases. This will provide clarity on how each of the collected data point will be used by DNOs and/or ESO.
Deliverable E	DER operational Data Points Technical Specification	Produce a technical specification of the collected data points including data availability, tolerance, frequency of data capture etc.
Deliverable F	Gap Analysis, Impact and implementation plan	Carry out an assessment on the potential cost impact that these additional data points will have on DNOs and/or customers. An implementation plan is going to be recommended

1.2. Our Approach

This section describes the approach taken by the product team for deliverable C and D, which is also summarised in Figure 2.

1. **Defining Sources and Collecting data requirement**

The product team collected monitoring and control requirement from different sources, including DNOs specific requirements, requirements mandated by industry codes including the Distribution Code (DCode), the Grid Code (GCode) and the Connection and Use of System Code (CUSC). The product team also identified additional data points not currently collected, that are considered to be beneficial for DNOs and ESO use cases.

2. **DNOs Monitoring and Control Gap Analysis**

The product team mapped each of the monitoring and control data points in the aggregated list, against current data exchange requirement in place in each DNO area, and has specified whether this is applicable for a specific technology, capacity, service etc. This was used to produce a gap analysis highlighting the difference in data point exchange between different areas.

3. **Use Cases and & Benefits unlocked**

For each of the data points, the product team looked at possible DNOs and ESO use cases and qualitatively assessed the level of benefits that is going to be unlocked by collecting and making use of the data points under consideration.

4. **Should the data be collected going forward?**

The use cases and associated unlocked benefits, informed the decision on whether or not the data point shall be made available to DNOs going forward as well as applicability of the requirement (i.e. capacity, technology etc). The outcome is a recommendation of a harmonised list of the real-time data exchange requirements between DERs and DNO going forward.

The product team has followed a similar approach used in EREC G99: mandating the ability for the generator to make a data point available to the DNO, if requested, rather than mandating the DNO to collect the data point.

As a DCode modification may follow the recommendation captured in this report and may include an enhancement of what is currently mandated by EREC G99.

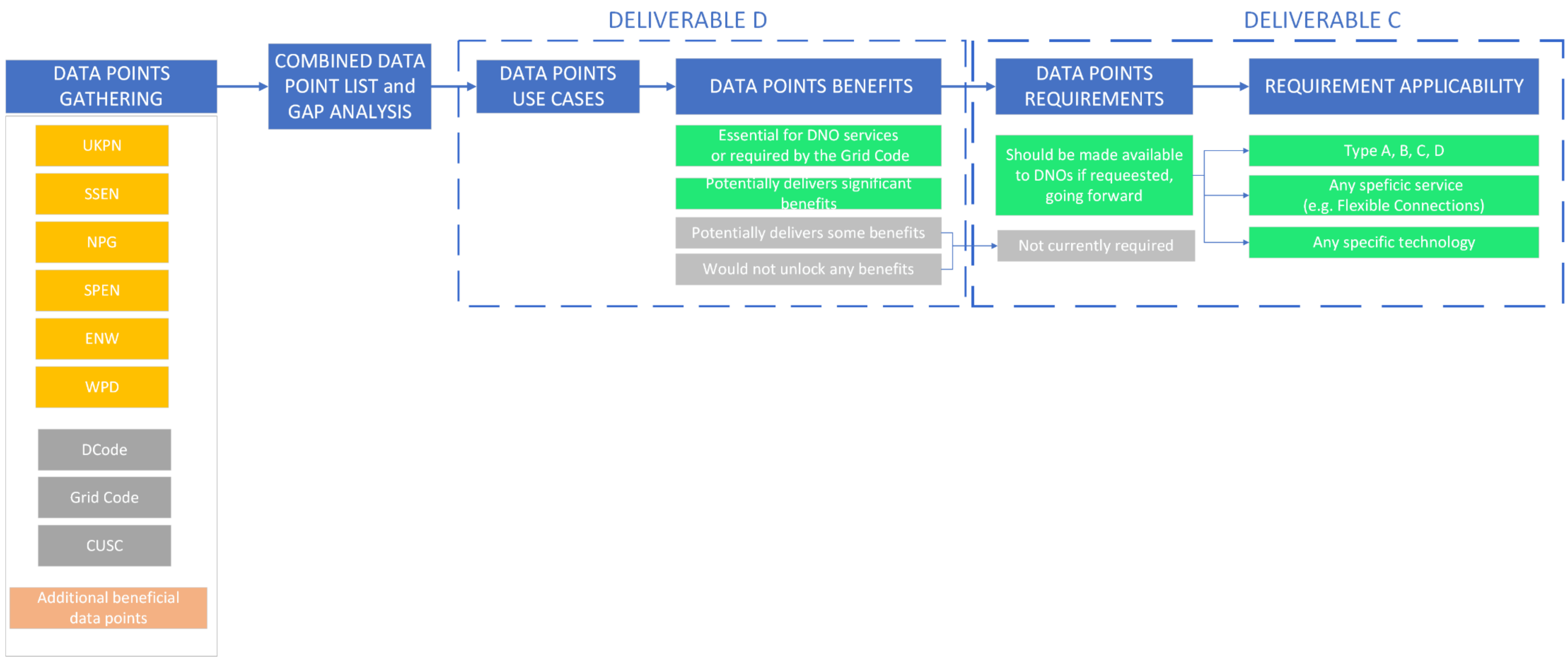


Figure 2: Approach taken for WS1B P6 Deliverable C and D.

2. Data Collection Protocols

2.1. Protocol vs Hardwire interface

DNOs currently are developing their Active Network Management approaches and there is no commonly adopted standard for DER communication interfaces between the DNO and DER customers.

Some DNOs specify more simplistic "hardwired" interface options such as volt-free contacts or inter-trip signalling, or simple 4-20mA current loop signalling. This is mainly to mitigate for cyber security risks but also to reduce the complexity of the installation for end customers. Volt-free contact or inter-trip signalling would essentially achieve binary signalling, whilst simple current loops are able to provide signalling of analogue values. E.g. 4 mA to 20 mA DC signal may correspond to a value of say 0 pu to 1.0 pu of Generation Registered Capacity Active Power. An equivalent binary signal might represent inhibit/block active power output for the on or high state and resume Active Power output for the off or low state.

Simple interfaces generally require a multicore/multi-pair cable to be run between the customer site and the DNO substation. A cable pair is required for each signal and any future signals rely on the existence of spare cable cores.

Other DNOs used slightly more complex protocols including serial, DNP3 or IEC 61850 protocols. These protocol interfaces generally require a physical communications cable such as fibre optic, or suitable alternative communications link (usually by exception). Protocol interfaces are mainly implemented for the advantages of customisability and futureproofing of the installation where the addition or amendment of signals is a control configuration issue, not a physical change. This may be more complex in the initial installation for end customers but can provide significant future benefits.

In any case, each DNO will generally discuss and agree with the DER customer for each connection the interface type and protocol to be used, including how any risks of maloperation etc are to be managed.

The future of flexibility service dispatch may use other industry protocols such as Web API, Open ADR, IEEE 2030.5 as alternatives to the approaches outlined above.

2.2. Implication on data exchange requirement

Protocol interfaces tend to come with more customisability and are relatively futureproofed for the additional of other signals or modifications to the existing signals.

Protocol interfaces may necessitate the need for additional signals including watchdog signals, analogue readbacks, and other optional status information where simple hardwired interfaces would not be due to the limitations of the physical medium required to collect this. E.g., cores in a cable, interface cards/modules to send/receive signals.

3. Data Collection Gathering

3.1. Distribution Code Requirements

3.1.1. DCode – EREC G99 – Operational Monitoring

The scope of Engineering Recommendation (EREC) G99 covers the requirements for the connection of generation equipment in parallel with public distribution networks and is a legal requirement for certain generators connecting on or after 27 April 2019. The specified Operational Monitoring requirements and Power Generating Module Performance and Control requirements included in the document detail the data exchange requirements between the DER customer and the DNO, which differs according to the generation type (-i.e., whether it is a Type A/B/C or D Power Generating Module (PGM)).

Monitoring requirements
System monitoring facilities mandated by EREC G99 are for the Power Generating facility (PGF) as opposed to Power Generating Module which differs to the Active Power control requirements which apply to the PGM.

For Type A generation, there is no requirement in ENA EREC G99 for the DG to expose any operational monitoring data back to the DNO.

For Type B generation, there is no requirement in ENA EREC G99 for the DG to expose any operational monitoring data back to the DNO unless requested by the DNO.

For Type C and D generation EREC G99 mandates Power Generating Facilities shall be capable of exchanging information with the DNO in real time or periodically with time stamping and the DNO, in coordination with the NGESO, shall specify the content of information exchanges including a precise list of data to be provided by the Power Generating Facility. Though the exact information exchanges are not explicitly outlined in G99, EREC G99 mandates Power Generation Facilities be equipped with system monitoring facilities capable of recording system data including voltage, Active Power, Reactive Power, and frequency. DNOs may also require generators to include provision for power quality monitoring and the monitoring of frequency sensitive mode data. It would be expected that if the DNO required this information, the generator is capable of providing it.

Control requirements

EREC G99 mandates that Power generation Modules are required to have a communication and control logic interface capable of controlling the Active Power output of their DER which differs depending on type. G99 requires that Power Generating Modules are capable of providing the following response upon receipt of a signal from the DNO:

- Type A: Cease active power output within 5 seconds
- Type B: Reduce active power output (may be zero or non-zero)
- Type C / D: Adjust active power output to a setpoint specified by the DNO within 2 minutes of the setpoint being adjusted (may be zero or non-zero)

DNOs will not directly control the Distributed Energy Resource (DER) device but send analogue limits to the customers DER Controller for the DER to operate below and/or send a control signal to set the export to agreed limits.

The DER shall have the capability to ‘ramp-down’ at an agreed rate upon receipt of the control signal.

Table 2 summarises monitoring and control requirements which may be mandated by G99.

Table 2: EREC G99 operational monitoring requirements.

Monitoring	Applies to
Measured Customer Active Power	Type C/D
Measured Customer Reactive Power	Type C/D
Measured Customer Voltage	Type C/D
Measured Customer Current	Type C/D
Measured Customer Frequency	Type C/D
Power Quality	Type C/D
Frequency Sensitive Mode data	Type C/D
Control	
Export Blocking Signal	Type A, B
Generation CB Trip	N/A
Active Power Limit	Type B, C, D

3.1.2. Distribution Planning and Connection Code (DPC) 9 Demand Side Services

Under DPC 9, provision for Demand Side Services is included which provides an overview of the interface requirements for a DSP but leaves out the finer detail of the data exchanges required for the implementation. A Demand Unit or Demand Units must be capable controlling its Demand or Reactive Power production or consumption over the range specified in any contract with the DNO.

DNOs will agree the protocol and data exchanges as part of the applicable service contract agreement, which is not applied to general demand connections.

DPC9.3.3.2 **Demand Units** must be equipped to receive modulation instructions either directly, or indirectly via a **Demand Services Provider**, from the **DNO**.

a) **DNOs** currently are developing active network management approaches and there is no common standard for communication protocols.

b) The **DNO** will provide details of the method to be employed between the **DNO** and the **Demand Services Provider**. Protocols currently in use between **DNOs** and **Demand Services Providers** include simple current loop; DNP3; IEC 61850.

c) The **DNO** will agree with the **Demand Services Provider** the protocol to be used.

d) By default if nothing it specified by the **DNO** then the interface will take the form of a simple binary output that can be operated by a simple switch or contactor. When the switch is closed the **Demand Unit** or **Demand Facility** can operate normally. When the switch is opened the **Demand Unit** will modulate its **Demand** (**Active Power** consumption or **Reactive Power** production or consumption) as required by the contract. The signal from the **Demand Unit** that is being switched can be either AC (maximum value 240 V) or DC (maximum value 110 V).

3.2. Grid Code Requirements

3.2.1. Connection Code (CC) Connection conditions

The Grid Code Connection Conditions and European Connection Conditions, specifically sections CC6.5.6/ECC.6.5.6 and CC6/ECC6 (with the exclusion of Embedded Small Power Stations as defined in the Grid Code), specifies the minimum technical, design and operational criteria which must be complied by Generators seeking connection to the national electricity system.

Under this section an operational metering is mandated, with the requirements differing by Power Station size (i.e., Medium or Large), and particular differences for technology types e.g., CCGT, synchronous/asynchronous etc. Under CC/ECC.6.5.6, the Grid Code enables provision between the individual generation unit where agreed in the Bilateral Connection Agreement (BCA). In addition, under ECC.6.6 there is also a requirement for monitoring with further details being specified in the Bilateral Agreement.

Table 3: Grid Code – Connection Condition, operational metering specifications

Operational Metering	Applies to
Circuit Breaker and Disconnector Status Indications	Type B, C (CCGT individual units and PPM)
Individual Alternator MW and MVAr	CCGT, Wind, Tidal Type B.C
Individual Unit and/or Transformer MW and MVAr	Large Power Station PPMs, CCGT
Individual Generator Transformer Tap Position Indication	Type B, C (only if identified in BCA)
Wind Speed	PPMs
Wind Direction	PPMs
Potential Power Available	PPMs

For monitoring – including dynamic System Monitoring, the signals are also specified in the Bilateral Agreement.

3.2.2. Operational Code Requirements

The implementation of Operational Codes such as OC6B (Embedded Generation Control) may require the DNO to collect measurements and implement emergency controls on embedded generation. In general, the data required for operational codes will be met by the Connection Conditions and European Connection Conditions of the Grid Code.

Where specific data is required, this will be recorded in the BCA.

3.3. CUSC

The CUSC generally refers back to the Bilateral Connection Agreement and Grid Code technical provisions. Technical requirements are generally not specified in the CUSC.

3.4. DNO specific requirements

Beside the data points mandated by industry codes, DNOs may agree the submission of additional interface data requirements with DER customers as part of their connection agreement to meet the relevant commercial and technical obligations required by the connection. To that extent, all DNOs may mandate additional data points to be exchanged with customers.

Additionally, differences in data exchange may be due to the differences in ANM implementation and the detailed implementation of the use case between different DNOs. E.g., different ANM system architectures, constraints being managed, failsafe methodologies, data collection protocols will mean the data points requested are not aligned.

Elaborating with an example from the above, DNO specific requirements may be related to the implementation of the respective interface type or be requested as a bi-product of the use of a specific protocol. E.g., for protocol interfaces, some DNOs may require the exchange of a communications "heartbeat" signal to ensure appropriate monitoring of healthy communications, whereas DNOs who specify a simple current loop may exclude these signals. Additionally, a bi-product of using protocol interfaces is that additional signals are much easier to implement so signals like read backs may be requested where they may not for hard-wired links.

Data points collected by DNO are captured and described in the next sections.

3.5. Additional beneficial data points

The product team has identified additional data points that are currently not collected by any of the DNOs and nor required by the Grid Coe or the DCode, that are considered to be beneficial for a number of use cases described later on in this document. The additional beneficial data points are captured in Table 4.

Table 4: Additional data points – not currently collected.

	Inputs (DER- DNO) - Operational Metering points
1	Electricity Storage State of Charge
2	Service contracted and Volume
3	Service being armed and Volume
4	Service being delivered and Volume
	Outputs (DNO- DER)
1	Flexibility service request

4. Combined data point list

Table 5 captures the aggregated data point list which combines existing DNOs monitoring and control requirement, DCode, Grid Code and CUSC requirements, as well as the additional data point identified by the product team.

Table 5: Combined Monitoring and Control data point list

Data Category	ID	Data Point	Description
OPERATIONAL METERING POINTS			
Customer metering – Net metering at the POC	M1	Measured Customer Active Power	Total Active Power at Connection Point interface measured from DER.
	M2	Measured Customer Reactive Power	Total Reactive Power at Connection Point interface measured from DER.
	M3	Measured Customer Voltage	Voltage at Connection Point interface measured from DER.
	M4	Measured Customer Current	Total Current at Connection Point interface measured from DER.
	M5	Measured Customer Frequency	Frequency at Connection Point interface measured from DER.
	M6	Power Quality	Power Quality (Flickers, harmonics etc) at Connection Point interface collected from DER.
Customer metering (Metering from individual units)	M7	Power Park modules metering (MW, MVAr, Amps, Volts)	Separate measurements for each power park module withing a Power Generating Facility (this applies to sites where multiple Power Park Modules are connected).
	M8	Generation and demand metering (MW, MVAr, Amps, Volts)	Separate generation and demand measurements (this applies to sites where the Generator supplies Customer demand other than that demand consumed when producing the generated power).
	M9	Alternator MW and MVAr	Measurement from each alternator within a Power Generating Facility.
	M10	Unit/Station Transformer MW and MVAr	Measurement from each unit and/or station transformer within a Power Generating Facility.
	M11	Generator Transformer Tap Position	Tap Position of each Generation Transformer within a Power Generating Facility.
customer's CB	M12	Customer's generation/G99 CB	This is the generator's or flex demand's beaker status which reflects open when all Generator Circuit Breakers (GCBs) are open and closed/not open when one or more of the GCBs are closed.

	M13	Customer's CB status for flexible demand/generation	CB status of each flexible unit (demand/generation) within a power park module.
	M14	Customer Islanded Open & Close	Visibility on the customer island mode operation.
	M15	Network Status Data	Any other CB status on the customer network (e.g., busbar split status/NOPs).
DER Availability	M16	DER in service (0/1)	This signal to inform the DNO that the DER is under maintenance and unable to receive instructions.
	M17	Installed Capacity in Service	Indication of the MW capacity in service in real time (as percentage or absolute value)
	M18	Number of Connected generators	Number of generators in service
	M19	Potential Power Available/ Real Available Capacity	Instantaneous sum of the potential Active Power available from each individual Power Park Unit within the Power Park Module calculated using any applicable combination of electrical or mechanical or meteorological data (including wind speed).
	M20	Reactive Available Capacity	indication of the available MVAr available
	M21	State of Charge	Electricity Storage state of charge in % or kwh
Weat her Data	M22	Wind Speed	Wind speed measured through weather devices at the DER premises
	M23	Wind Direction	Wind direction assessed through weather devices at the DER premises
	M24	Irradiance	Solare irradiance measured through weather devices at the DER premises
Readbacks	M25	Active Power Upper Limit readback	Readback of the Active Power Upper limit provided by the customer control system confirming acknowledgement of the control signal.
	M26	Active Power Lower Limit readback	Readback of the Active Power Lower limit provided by the customer control system confirming acknowledgement of the control signal.
	M27	Reactive Power Upper Limit Readback	Readback of the Reactive Power Upper limit provided by the customer control system confirming acknowledgement of the control signal.
	M28	Reactive Power Lower Limit Readback	Readback of the Reactive Power Lower limit provided by the customer control system confirming acknowledgement of the control signal.
	M29	Target Voltage readback	Readback of the Target Voltage provided by the customer control system confirming acknowledgement of the control signal.
	M30	Flexible / Curtailment Service acknowledged	Readback of the curtailment request by the customer control system confirming acknowledgement of the control signal.
	M31	contractual setpoint/Export Blocking Signal	Acknowledgement of the Export Blocking Signal has been received by the customer control system

	M32	Open breaker control readback	Acknowledgement that the CB Open/close instruction has been received by the customer control system
	M33	Watchdog signal received	This signal is used by DER to monitor communications health to DNO. If this signal is lost, the DER must apply a fail-safe set point which means reduce the output to a pre-defined level.
Mode of operation	M34	DER mode of operation/ Frequency sensitive enabled	This is the DER current service/mode of operation which DER sends DNO to indicate what service they are providing (P, Q, V)
Service Provision	M35	Service(s) contracted and volume	ESO and/or DNO service(s) that DER has been contracted to provide and volume.
	M36	Service(s) being armed and volume	ESO and/or DNO service(s) that DER has been armed for and volume.
	MP37	Service(s) actively delivered and volume	ESO and/or DNO service(s) that DER has been instructed to provide/is actively delivering e.g., Var= 0, DC=1, FFR=2, BM=3
CONTROL POINTS			
Analogues Control Points	C1	Active Power Upper limit	Maximum kW limit; Limiting maximum active power export of the DER
	C2	Active Power Lower Limit	Minimum kW limit; Limiting maximum active power import of the DER
	C3	Reactive Power Upper Limit	Maximum kVAr limit; Limiting maximum reactive power export of the DER
	C4	Reactive Power Lower Limit	Maximum kVAr limit; Limiting maximum reactive power import of the DER
	C5	Voltage Target	Voltage setpoint; To control DER target voltage.
Digital Control Points	C6	Default safe value setpoint/Export Blocking Signal	Request to the generator to ramp output to zero within 5 seconds.
	C7	DER Breakers Trip	Request to open the sites G59/G99 circuit breaker
	C8	Power Generating Module CB Trip	Request to open CB of a Power Park module within the Power generating facility
	C9	Flexibility Service Request/request	To activate set point control or a static flexible service/ for e.g., availability payment
	C10	P, Q, V Service Enable	instruction to DER to provide active power, reactive power, voltage services
	C14	Watchdog signal received from the DER	This signal is used to monitor the communications health to the DER.
	C15	Limit Breach	Notification signal for DER informing them that one or more limits has been breached.

5. Gap Analysis

Table 6 shows a combined view on data points each DNO exchanging with new DER customers, as well as data requirement specified in the DCode.

Table 6: Gap Analysis monitoring and control data points

	ID	Data Point	Currently Collected						
			UKPN	SSEN	WPD	NPG	ENW	SPEN	G99
OPERATIONAL METERING POINTS									
Customer metering (net metering at the DER PoC)	M1	Measured Customer Active Power	Yes	Only Type C and D	No	Only Flex Connections	No	Type B, C, D	TYPE C/D
	M2	Measured Customer Reactive Power	Yes	Only Type C and D	No	Only Flex Connections	No	Type B, C, D	
	M3	Measured Customer Voltage	Yes	Only Type C and D	No	Only Flex Connections	No	No	
	M4	Measured Customer Current	Yes	No	No	No	No	No	
	M5	Measured Customer Frequency	No	Only Type C and D	No	No	No		
	M6	Power Quality	No	No	No	No	No	No	
Customer metering (metering from individual units)	M7	Power Park modules metering (MW, MVAr, Amps, Volts)	No	No	Yes[1]	No	No	Yes	No
	M8	Generation and demand metering (MW, MVAr, Amps, Volts)	No	No	No	No	No	No	No
	M9	Alternator MW and MVAr	No	Only Type B. CCGT technology	No		No	No	No
	M10	Unit/Station Transformer MW and MVAr	No	Only Type B. CCGT technology	No	No	No	No	No
	M11	Generator Transformer Tap Position Indication	No	Only Type B. CCGT technology	No	No	No	No	No
customer's CB status	M12	Customer generation/G99 CB	Yes	Only Type C and D	No	Yes	Yes	Yes	No
	M13	Customer CB status for flexible demand/generation	No	No	No	No	Yes	Yes	No
	M14	Customer Islanded Open & Close	No	No	No	No	Yes	No	No
	M15	Network Status Data	No	No	No	Yes	No	No	No
DER availability	M16	DER in service (0/1)	Yes	No	No	No	No	No	No
	M17	Installed Capacity in Service	Yes	No	No	No	No	No	No
	M18	Number of Connected generators	No	Only Wind/Tidal type C/D	No	No	No	No	No

[1] this data point would apply only to Loads subject to DNO control as part of a Flexible Connection. It would only be requested in a very limited number of circumstances.

	M19	Potential Power Available/ Real Available Capacity	No	Anything nonsynchronous (Large PS) type C/D	No	No	Yes	No	No
	M20	Reactive Available Capacity	No	No	No	No	Yes	No	No
	M21	State of Charge	No	No	No	No	No	No	No
Weather Data	M22	Wind Speed	No	Only Wind/Tidal type B/C/D	No	No	No	No	No
	M23	Wind Direction	No	Only Wind/Tidal type B/C/D	No	No	No	No	No
	M24	Irradiance	No	No	No	No	No	No	No
Control readbacks	M25	Active Power Upper Limit readback	Yes	Yes	No	No	Yes	No	No
	M26	Active Power Lower Limit readback	Yes	?	No	No	?	No	No
	M27	Reactive Power Upper Limit Readback	Yes	No	No	No	No	No	No
	M28	Reactive Power Lower Limit Readback	Yes	No	No	No	No	No	No
	M29	Target Voltage readback	Yes	No	No	No	No	No	No
	M30	Flexibility service request acknowledged	No	No	No	No	Yes	No	No
	M31	contractual setpoint/Export Blocking Signal readback	Yes	Only Type B, C, D	Yes	No?	Yes	No?	No
	M32	Open breaker control readback	Yes	No	Yes	No	No	No	No
	M33	Watchdog signal received	Yes	No	No	No	No	No	No
Mode of operation	M34	DER mode of operation/ frequency sensitive mode	Yes	Only Wind/Tidal Type D	No	No	No	No	Type C/D
Service Provision	M35	Service(s) contracted and volume	No	No	No	No	No	No	No
	M36	Service(s) being armed and volume	No	No	No	No	No	No	No
	M37	Service(s) actively delivered and volume							
CONTROL POINTS									
Analogues Control Points	C1	Active Power Upper limit	Yes	Yes	Yes	Yes	Yes	Yes	Type C/D
	C2	Active Power Lower Limit	Yes	No	Yes	Yes	Yes	No	Type C/D
	C3	Reactive Power Upper Limit	Yes	No	Yes	Yes	Yes	No	No
	C4	Reactive Power Lower Limit	Yes	No	Yes	Yes	?	No	No
	C5	Voltage Target	Yes	No	No	No	No	No	No
Digital Control Points	C6	Default safe value setpoint/Export Blocking Signal	Yes	Yes	Yes	Yes	Yes	?	No
	C7	DER Breakers Trip	Yes	No	Yes	Yes	Yes	Yes	No
	C8	Flexible demand/generation CB Trip	No	No	No	No	No	No	No
	C9	Curtailment instruction request e.g., ANM Flex Connections	No	No	No	No	ANM Flex Connection only	No	No
	C10	Flexibility service request	No	No	No	No	No	No	No
	C11	P, Q, V Service Enable	Yes	No	No	No	No	No	No
	C12	Watchdog signal received from the DER	Yes	No	No	No	No	No	No
	C13	Limit Breach	Yes	No	No	No	No	No	No

6. Data Points Use cases (Deliverable D)

This section describes use cases for each of the metering and control points captured in Table 6. The identified use cases have informed the level of benefits that the data point would unlock, which has then been used by the product team to recommend whether the data point should be made available by the DER going forward, if requested by the DNO. Each of the data point has been categorised as below.

(grey)	Already mandated by EREC G99 – no additional requirements
(green)	Should be made available to DNOs if requested
(amber)	Currently not required

At this stage, the benefits have been assessed qualitatively rather than quantitatively. If the data exchange recommendation from this product team will take a more formal route (i.e. through a grid code mode) it for the cost and benefits to be actually quantified to inform a cost benefit analysis (CBA). Moreover, to minimise the data request impact on customers, the product team has decided to focus on current use cases rather than future ones. The DER-DNO data exchange requirement should be revised on a regular basis to account for new network requirements, products, services etc.

6.1. Customer metering - net metering at the DER PoC)

	DATA POINTS
M1	Measured Customer Active Power
M2	Measured Customer Reactive Power
M3	Measured Customer Current
M4	Measured Customer Voltage
	USE CASES
1	**Check metering** Metering from customer's substation can be compared against the metering from the DNO's substation for early detection of potential drift in measurements (either customer's or DNO's) allowing to carry out proactive maintenance.
2	**Flexible Connections – failure of DER metering from DNO substation** During failure of DNO's metering at a Flexible Connection DER site, currently the DER is given contractual values (usually 0kW export) to ensure network safety. Customer metering could temporarily be used instead as a backup when DNO metering fails, for the duration of the fault resolution time, avoiding customer to be failsafe. This is an additional I/o point from the customer to the DNO RTU, this would only be beneficial for failure of the DNO's measurement device/transducer and not for failure of RTU and communication infrastructure as the customer metering would still be going through the DNO RTU and comms.
3	**Ancillary and Balancing services** NGESO makes use of customer operational metering data for Dispatch and monitoring of Ancillary Service. Measurement don't currently go through DNO control system but are collected by an RTU and transferred directly to NGESO.
4	**Flexibility Services – compliance with service request and settlements**

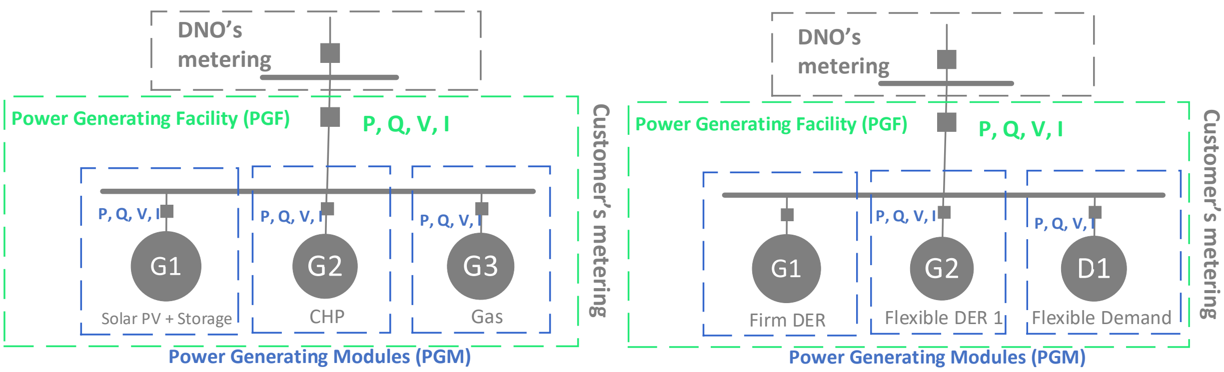
	Visibility of DGs participating into DSO Flexibility Services, will greatly benefit DNOs: primarily as it will allow DNO to check compliance with a service request, increasing the confidence around DG response following a dispatch instruction and allowing to take proactive actions when service is not being delivered. It will also help reducing over-dispatch in the expectation that not all capacity will be delivered reliably. DG visibility would also enable a more accurate benchmark for settlements, considering what was the customer doing just before and after a turn up/down instruction. This will become significantly more relevant with near real time procurement of services.
5	**Virtual Meters for Aggregators** Metering from customer substation will allow smaller units to provide capacity to aggregators to participate to ESO and DSO services. Where aggregators provide an aggregated service to the ESO, they currently have a “virtual meter” that provides the combined responses from the assets it has aggregated to provide the service, which will make available to the ESO/DSOs. Beside the “virtual meter” DSOs, might also need the disaggregated metering to validate any specific locational requirement.
	RELEVANCE OF THE DATA POINT
	Has the potential to deliver some benefits related to use cases above. However, DNOs would not always make use of DER metering for operational purposes (e.g., managing Flexible Connections customers in the live network) because of uncertainty around quality of measurements and lack of maintenance processes as well as additional cybersecurity risks.
	Data Point Requirement
	Already mandated by G99 for type C/D, no additional requirements.

	DATA POINTS
M5	Measured Frequency
	USE CASES
1	**System restoration** In an unlikely event of a blackout, system restoration through DER can be used to restore power to the transmission network through black start. This can be achieved in two ways – either an Embedded Generator comes under the remit of a Local Joint Restoration Plan and would be instructed by the ESO, or they fall under a Distribution Restoration Zone Plan where the DNO instruct Anchor Plant and Top Up Services to energise parts of the Distribution System. In some cases where there is sufficient fault level it may be possible to energise some sections of the Transmission System though in practice it is expected Local Joint Restoration Plans (a Top-Down approach) and Distribution Restoration Zone Plans (a bottom-up approach) would be used in parallel to get the system up and running as soon as possible. The wider issue of System Restoration and the recent requirement to implement an Electricity System Restoration Standard is currently being progressed through Grid Code modification GC0156
2	**Regional frequency measurements** Variation in regional frequency is possible as the system transitions towards net zero operation. Having visibility of DER frequency measurements could help give a more granular picture on the discrepancy in frequency throughout the GB network at different voltage levels.
	RELEVANCE OF THE DATA POINT
	Significant benefits, see use case above. Useful especially for DER providing System restoration events which are part of a Distribution Restoration Zone.
	Data Point Requirement

	Already mandated by G99 for type C/D, no additional requirements.

	DATA POINTS
M6	Power Quality
	USE CASES
1	**Grid Code compliance** DERs connecting to the distribution network are required to comply with relevant standards including operation within power factor limits, voltage step changes, flickers, and harmonics etc. Power quality information from the customer would allow verifying compliance with standards.
	RELEVANCE OF THE DATA POINT
	Would not unlock additional benefits – DNOs would already have equipment installed at DNO's substation (e.g., PQM) to verify compliance, getting the same data point from the customer is redundant. Unlike Operational metering (P, Q, V, I), power quality is not used operationally to inform control actions but rather to retrospectively verify compliance.
	Data Point Requirement
	Already mandated by G99 for type C/D, no additional requirements.

6.2. Customer's metering - metering from individual Flexible Units/Power Generating Modules



	DATA POINTS
M7	Metering from each Power Park module (P, Q, V, I)
M8	Separate metering for flexible generation and demand units (P, Q, V, I)
	USE CASES
1	**Flexible Connections – managing site with multiple generators at different LIFO positions** Metering from individual flexible units withing a Power Generating facilities allows ANM to manage multiple DER with different LIFO stack positions connected to the same site. Without metering from each of the units, this would not be possible: the customer would either need to apply for a different PoC or the whole site

	whole site would need to go down in LIFO position. Management of sites with multiple generators at different LIFO stack position will require capability enhancement of remote Terminal Unit (RTU).
2	**Power Park modules providing different services/ Service delivery** Metering from individual Power Park modules allows a customer to provide different services (e.g., Flex service, BM, frequency, MW dispatch) with different power park modules within a power generation facility. Monitoring of individual units is required for DNO/ESO to verify compliance with service request and allows to take proactive actions when the service is not being delivered. Note that this data exchange requirement with DNO would apply to power generating modules subject to any form of control from DNO (flex generation/demand) and not to units providing services to the ESO as this would feed commercial information.
3	**More accurate Operational Forecasting** Having visibility of real time output of each power park module within a power generating facility (or flexible generation/demand output within the power generating facility) will enhance accuracy of operational forecasting, especially in case the power generating facility is made up by different technology types. Forecasting the aggregated site output would not allow capture of the technology specific/weather dependant variations in output; integrating metering from individual units and technology type would instead allow capture of this and enhance forecasting accuracy. Moreover, having visibility of the real time output of a flexible unit within a power generating facility, would enable assessment of flexible generation/demand that needs to be curtailed based on network constraint forecast. Improvements in operational forecasting are also likely to provide benefits associated with the procurement of national reserve and frequency services. This, in turn, will help to reduce demand forecast errors, thus lowering the cost of system operation.
4	**Network Operation - visibility of pickup load/ swing after losing any unit** Having visibility of real time output of each unit (Power Park Module/ flexible demand and generation) within a Power Generating Facility, would allow assessment in real time of what the pickup load at the site was after losing any of the units, which is essential for safety and reliability of the network to avoid excessive risks. As an example, if a 50 MW generator is supplying 50 MW of local demand at a specific moment in time, metering at the POC will show a demand of 0MW. In case of a generator fault, the site load will increase rapidly from 0 to 50 MW.
	RELEVANCE OF THE DATA POINT
	Potentially delivers significant benefits – see use cases above.
	DATA POINT REQUIREMENT
	Should be made available to DNOs if requested.
	APPLICABILITY of the requirement
	This applies to any power generating module subject to any form of control.

	DATA POINTS
M9	Individual Alternator MW and MVAr
M10	Individual Unit and/or Transformer MW and MVAr
M11	Individual Station Transformer MW and MVAr
	USE CASES
	ESO's Network Modelling and Ancillary Services

	Used by NGESO for Network Modelling and Ancillary Services Monitoring for CCGT and wind. tidal technologies.
	RELEVANCE OF THE DATA POINT
	Required by the Grid Code for ESO specific use cases, this would be the case if a DER applied for Transmission Entry Capacity and/or had a direct agreement with the ESO. If required, DERs provide this information directly to NGESO without being collected by the DNO and exposed to NGESO, except for SSEN which is currently collecting these data points. The product team has not identified any DNO use case, meaning that having visibility of this data would not unlock additional any benefits for DNO/customers.
	Data Point Requirement
	Not currently required.

6.3. Customer's CB status

	DATA POINTS
M12	Customer's generation/G99 CB
M13	Customer 's CB status of flexible demand/generation units
	USE CASES
1	**Flexible Connections – Audit trail** Having visibility of CB status allows to retrospectively back up the action taken by ANM for audit trail purposes and to ensure good customer service. Through DNO, s equipment, DNO would have visibility of the incoming/metering breaker rathe that the DER breaker (power generating facility or module's breaker).
	Flexible Connections – managing sites with multiple generators at different LIFO stack positions. Use case apply to sites where ANM is managing multiple generators with different LIFO stack positions and ANM requests the customer to disconnect one of the units: having visibility the CB status of the individual unit that has been tripped, would give more certainty to DNO that the instruction has been actioned. If this is not available, DNO could see the response through the net power flow at the PoC, which could be counter balanced by any of the other units ramping up.
	Retrospective CB status operation during abnormal network events (e.g., 9th august). Having visibility of customer breaker status as well as status of individual Power Park Modules (where it applies) would help with post event investigation following abnormal network events including units that have tripped and the time of the event.
2	**Real Time Network Control – managing Fault level contribution** Having visibility of DER/units that are connected and DER that are not connected allow control engineers to operationally manage fault level in the network and by selecting DER that can be dropped off in operational timescales.
3	**Better accuracy of the state estimation/ load flow** Having visibility of customer CB status will allow a more accurate connectivity model in real time, which gives more accurate load flow and state estimation results.
	RELEVANCE OF THE USE CASE

	Would unlock some benefits – see use cases above
	DATA POINT REQUIREMENT
	Should be made available to DNO if requested
	APPLICABILITY OF THE REQUIREMENT
	CB status of individual units applies to flexible demand/generation units

	DATA POINTS
M14	Customer Islanded Open & Close
	USE CASES
1	**Better accuracy of the state estimation/load flow model** Having visibility of the customer islanded operation would allow automatic disconnection of the site during customer's islanded operation and have the correct site's equivalent impedance at any time, which would enable more accurate load flow/state results.
	RELEVANCE OF THE USE CASE
	Would unlock some benefits - see use case above?
	DATA POINT REQUIREMENT
	Should be made available to DNOs if requested.

	DATA POINTS
M15	Network Status Data (behind the meter customer network - where it applies) OR Available capacity feeding to each of the PoC
	USE CASES
	Flexible Connections - Better management of customer with two infeed. Currently customers with two infeed have a fixed maximum export per infeed/RTU (e.g., 20MVA of infeed 1 and 20 MVA on infeed 2). By changing the running arrangement behind the meter, the portion of capacity allocated for each of the infeed could be altered (e.g., 40MVA on infeed 1 and 0MVA on infeed 2). When this happens, curtailment setpoints given to each RTU would need to be adjusted in real time based on the portion of capacity which is feeding into each RTU. This would only be possible by having real time visibility of the behind the meter customer's network (by monitoring the key open points) and a connectivity model of the customer network, which would allow to asses the portion of capacity feeding to each infeed. The current solution for customers with two infeed is to failsafe the customer for any abnormal running arrangement in the customer network which alters the portion of capacity that feeds to each infeed. Having visibility of the behind the meter customer network would avoid failsafe in running arrangement different than intact (customer benefits). It must be considered that this could add significant burden on DNOs which become more significant with complex and more extensive customer networks. Some DNOs would prefer to have the information of the Available capacity feeding to each of the infeed directly from the customer instead or assessing it based on network status data.
	RELEVANCE OF THE USE CASE
	Could potentially delivers considerable benefits - see use case above.

	DATA POINT REQUIREMENT
	Should be made available to DNO if requested
	APPLICABILITY OF THE REQUIREMENT
	This applies to customers with multiple infeed, subject to any form of control. If Constraints are directly impacted by the running arrangement of the customer network (differently affected depending on what is feeding to each of the breakers).

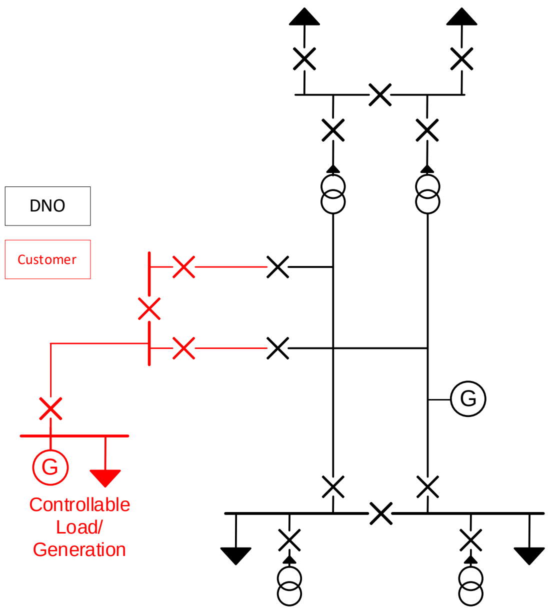


Figure 3: Example of customers with two infeed, where constraints are directly affected by the running arrangement.

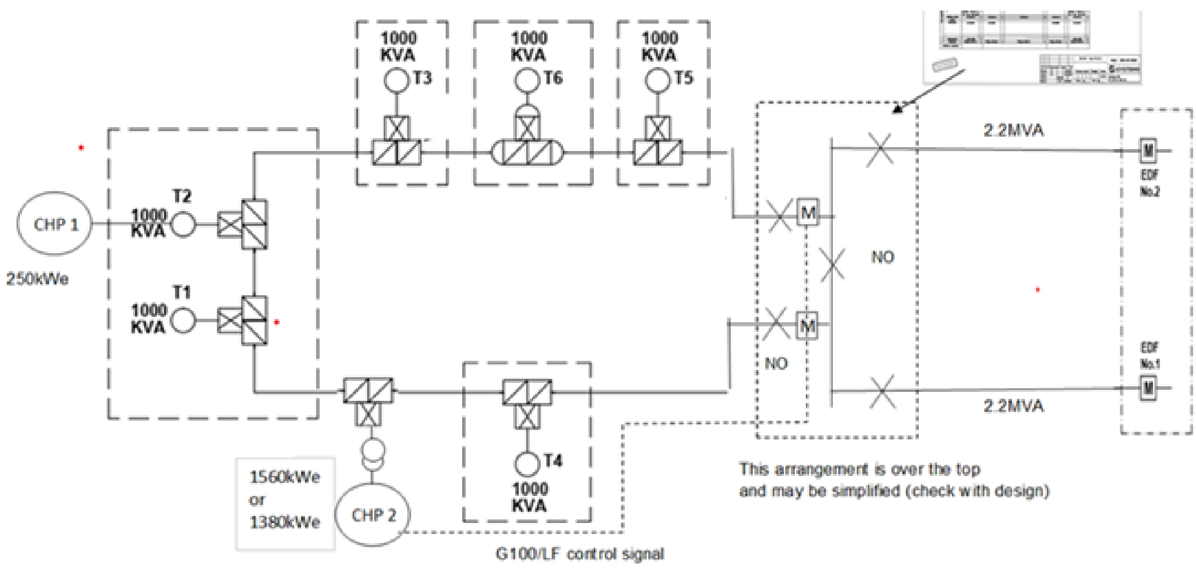


Figure 4: Example of a customer with two infeed - behind the meter network.

6.4. DER availability

	DATA POINTS
M16	DER in service (0/1)
M17	Installed Capacity in Service [MW]
M18	Number of Connected generators [units]
	USE CASES
1	**Flexible Connections - Optimise curtailment thresholds**, operating margins consider ramp rate of generators downstream a constraint, which is affected by the potential ramp rate of the capacity in service. Having visibility of the capacity in service may lead to less conservative thresholds and lower levels of curtailment. Visibility of capacity in service, may allow to release back capacity faster as curtailment is not released until excess capacity is available on the network to avoid hunting.
2	**Better modelling of the (real time) capacity that can be offered/controlled for different DNO/ ESO services.** This is especially relevant for closer to real time procurement e.g., for post fault services. Having visibility, the capacity in service (some of it may not be available for maintenance) will give visibility of the capacity that can be dispatched at any moment in time.
3	**Better accuracy of operational forecasting** Having visibility on whether the DER is in service and the level of capacity in service will enable more accurate forecasting results, as forecasts would be generated based on the capacity in service rather than on the full DER capacity.
	Avoiding service conflict Having visibility on whether the DER is in service and that a generator is operating at a reduced capacity would inform on the capacity that can be released without creating a conflict of services.
	RELEVANCE OF THE USE CASE
	Installed Capacity in Service [M17] could potentially deliver considerable benefits – see use cases above. The other two data points (DER in service [M16] and Number of connected generators[M18]) are considered redundant if the Installed capacity in service [M17] in known.
	DATA POINT REQUIREMENT
	M17 Should be made available to DNO if requested

	DATA POINTS
M19	**Potential Power Available**
	USE CASES

1	**Visibility of post-curtailment DER output** For sites being curtailed, this gives visibility of the potential output of the site when the constraint is no longer active, and the site is no longer curtailed. As an example, if a 30MW wind farm before curtailment was doing 15MW and the wind speed increased during the duration of the curtailment event, the potential power available would give visibility that if the constraint is no longer active the wind farm could ramp up to e.g., 25MW. This is useful information for the use cases below:
2	**Real time network operation:** potential sudden MW volume increase seen on the network.
3	**Flexible connections -** optimise curtailment thresholds. ANM thresholds are determined to account for the absolute worst ramp-up rate from generators downstream a certain constraint, to ensure constraints are not breached by the time ANM initiates a curtailment event. Visibility of the potential volume increase from generators downstream a constraint could help optimise thresholds.
4	**ESO ancillary and balancing service**: provide a view of the sudden potential MW volume increase when constraints holding up flexible generators are no longer active (for frequency/balancing of the system).
5	**Operational forecasting:** better forecast of what the output could be after a constraint is no longer active. This will enhance the accuracy of both ESO and DNO operational forecasting system and unlock number of benefits (DNO/ESO specific) by making use of its output.
	RELEVANCE OF THE USE CASE
	Could potentially deliver considerable benefits – see use cases above.
	DATA POINT REQUIREMENT
	Should be made available to DNO if requested
	APPLICABILITY REQUIREMENT
	This applies to variable weather dependent technology i.e., wind and solar.

	DATA POINTS
M20	**Reactive Power Available**
	USE CASES
1	**Reactive Power services** If a customer contracted to provide reactive power/voltage services. Reactive power availability enables a contribution to voltage control from the customer an any time, based on factors such as the allowed power factor range of operation, plant capability, nominal rating, active power output etc. This applies both to flexible connection contracted to provide reactive power service for e.g., voltage constraints and for reactive power markets (future use case). A use case for this is Voltage constraint management in the distribution network e.g., flexible connection triggering overvoltage's, whereby DNOs may want to give Q absorption instruction and having visibility of the Q availability would provide a better view on the portion of reactive power that can be controlled
	RELEVANCE OF THE USE CASE
	Has the potential to deliver some benefits – see use case above.
	DATA POINT REQUIREMENT
	Not currently a strong use case due to lack of reactive power markets.

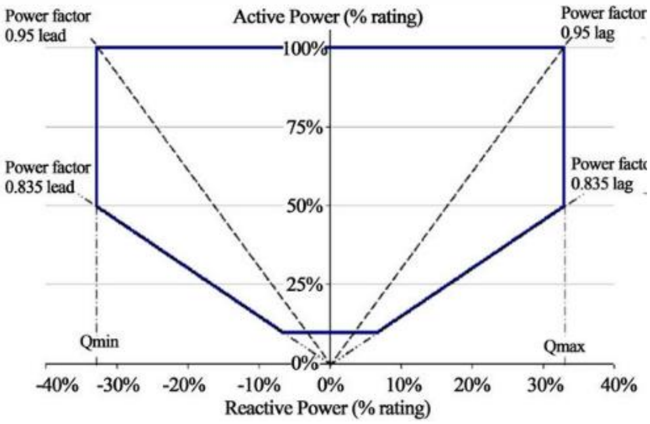


Figure 5: reactive power capability plant. – would be used by the customer to assess available Q capacity.

	DATA POINTS
M21	**State of Charge**
	USE CASES
1	**Operational Forecasting – storage operational behaviour** Having visibility of the state of charge of electricity storage modules will allow to better storage model behaviour in operational timescales. As an example, if the battery is empty (SoC 0%), the storage site is not going to be exporting even if the electricity prices are forecasted to be high, the forecast would either consider the site doing nothing or importing. Similarly, if the battery is full (SOC 100%), the storage site is not going to be importing. This will significantly enhance forecasting capabilities related to electricity storage sites.
2	**DNO/ESO services – duration service can be provided for** Having visibility of the state of charge from electricity storage sites providing services to ESO and/or DNOs will allow to have a view on the period the service can be offered for given a certain MW volume.
	RELEVANCE OF THE USE CASE
	Could potentially deliver considerable benefits – see use case above.
	DATA POINT REQUIREMENT
	Should be made available to DNO if requested.
	Applicability of the requirement
	The requirement applies only to Electricity Storage customers.

6.5. Weather Data

	DATA POINTS
M22	Wind speed
M23	Wind direction
M24	Irradiance/temperature
	USE CASES

1	**Wind and Solar Operational forecasting** Having weather data at individual unit level (e.g., Individual turbines) will allow better wind and solar operational forecasting compared to the weather data coming from meteorological weather stations.
2	**NGESO Ancillary and Balancing services** Wind direction is used by NGESO to give early indication of a potential change in output.
3	**Dynamic Line rating (DLR)** Wind speed and irradiance can be used to assess the dynamic line ratings of overhead lines based on an agreed methodology that produce a real time circuit ampacity value based on real time weather conditions. If the DLR is used to manage OHL constraints, the level of curtailment would be reduced compared to when fixed ratings are used.
	RELEVANCE OF THE USE CASE
	Limited benefit for DNOs - Weather data could be retrieved by meteorological weather station which would allow to have a more scalable solution and would ensure consistency of data (concerns on different vendors/ quality/whether the DLR devices are correctly calibrated etc). DNO would not rely on customer data to take operational decisions on DLR. Moreover, using weather data at hub height not useful for circuits height.
	DATA POINT REQUIREMENT
	Not currently required.

6.6. Control Readbacks

	DATA POINTS
M25	Active Power Upper Limit readback
M26	Active Power Lower Limit readback
M31	Contractual setpoint/Export Blocking Signal readback
M32	Open breaker control readback
	USE CASES
1	**Flexible Connections – ensure curtailment setpoint/ trip request has been received.** Readbacks give more confidence to DNOs that a signal has been received and take proactive remedial action in case it was not. Some DNO use a lack of readback signals to initiate failsafe actions (stage 1/ 2), other would not any different action if a readback signal is not received.
2	**Flexible Connections - traceability of action taken by ANM** Having traceability of the DNO sending a curtailment instruction to the customer and the customer has acknowledging the receipt, allows an audit trail of the actions taken by ANM. If a DER customer was tripped off, this data point could be used retrospectively to back up actions taken.
	RELEVANCE OF THE USE CASE
	Has the potential to deliver some benefits / essential for some DNO services – see use cases above.
	DATA POINT REQUIREMENT
	Should be made available to DNO if requested.

	DATA POINTS
M27	Reactive Power Upper Limit Readback
M28	Reactive Power Lower Limit Readback
M29	Target Voltage readback
	USE CASES
	Flexible Connections Q and V services– ensure instruction has been received. If a DER is instructed to provide a certain level of reactive power (lead/lag), the readback gives visibility to the DNO that the instruction has been received by the customer and allows to take proactive action it cases it was not. Some DNO use readback to initiate failsafe action if signal is not acted upon.
	RELEVANCE OF THE USE CASE
	Has the potential to deliver some benefits / essential for some DNO services – see use case above.
	DATA POINT REQUIREMENT
	Should be made available to DNO if requested.
	DATA POINT REQUIREMENT
	DER providing Voltages or Reactive Power services.

	DATA POINTS
M30	Curtailment instruction acknowledged
	USE CASES
	Flexile Connection – ensure curtailment instruction has been received Some DNO use a ‘curtailment instruction’ digital control signal, together with an ‘Active Power limit’ analogue control signal, to curtail flexible connection customers. The readback gives visibility to the DNO that the instruction has been received by the customer and allows to take proactive failsafe action in case it was not.
	RELEVANCE OF THE USE CASE
	Essential for DNO service – see use case above.
	DATA POINT REQUIREMENT
	Should be made available to DNOs if requested.
	APPLICABILITY REQUIREMENT
	DER subject to any form of control.

	DATA POINTS
M33	Watchdog signal received
	USE CASES
	Flexible Connection, detection of Loss of comms between DER- DNO

	Watchdog (or heartbeat signal) is used to monitor the healthy communication between the DNO and the DER customer. If the watchdog sent to and received by the customer are out sync, a loss of communication may have taken place, meaning that the customer is no longer able to receive curtailment setpoints. When this happens, the customer would automatically transition into contractual mode to ensure network safety.
	RELEVANCE OF THE USE CASE
	Essential for DNO service – some DNO use the watchdog approach to detect a loss of communication between the DER and the DNO to guarantee network safety.
	DATA POINT REQUIREMENT
	Should be made available to DNO is requested

6.7. Mode of Operation

	DATA POINTS
M34	DER mode of operation (readback)
	USE CASES
	DER providing multiple services This is a readback signal of the "DER mode of operation" control instruction, used by DNO to instruct a DER customer on whether the DER should be providing P services, Q services or V services, (provided that the customer has signed up / has been contracted to provide more than one service) This readback signal would give confidence to the DNO that the control instruction to start providing a different service has been received.
	RELEVANCE OF THE USE CASE
	Limited benefits unlocked. Provided that the DER is contracted to provide multiple services, the DNO can send a direct P, Q, V control instruction rather than the mode of operation instruction.
	DATA POINT REQUIREMENT
	Currently not required

6.8. Service Provision

	DATA POINTS
M35	Service contracted and Volume
M36	Service being armed and Volume
M37	Service being delivered and Volume
	USE CASES
1	**Operational Forecasting – better modelling of generation output providing services to the ESO/DNO.** Having a visibility service being provided in real time as well as the capacity, will enhance operational forecasting capabilities. As an example, if at a given moment in time a 50MW battery is providing full capacity to DC service in the current EFA block, DNO could expect the storage site to be providing frequency service for the duration of the EFA block i.e., for the following 4 hours. ESO service the duration is service specific, for DSO flexibility service the duration depends on the site-specific requirement driven by hours of being out of firm.

2	**Conflict Service Avoidance** Having visibility of service contracted, armed, and being delivered could avoid a conflict of services, given an agreed set of primacy rules. As an example, if a Flexible Connection customer is being curtailed due to a distribution constraint, which subsequently has headroom due to a firm DER turning down to provide STOR services, ANM would avoid releasing capacity if it had visibility of the service the firm DER was delivering and its connectivity to the constraint. Having visibility of service contracted/ armed and being delivered could also facilitate a transparent market.
3	**Visibility of the volume that can be offered for post fault products (Dynamic/ Restore)** Having visibility of the service the DER has been contracted to provide including provide Flex Service and any other ESO service, as well as visibility on the capacity that the DER is reserving (armed) for any of these service in real time, would allow DNOs to have a greater visibility of the capacity available/ that can be dispatched quickly following e.g., a post fault event. Based on this information and on the amount of network risk that DNO are willing to take considering the potential CI/CML penalties, DNO could compare this with the cost of flexibility. Other options that DNO could consider are also network reconfiguration and temporary load shed. Greater level of information would allow to assess best option.
	RELEVANCE OF THE USE CASE
	Could potentially deliver considerable benefits. See use case above. In summary: more accurate load forecast would allow to make more use of network capacity and decrease curtailment, Service conflict avoidance (decreased cost to customer), support market liquidity and facilitate transparent markets.
	DATA POINT REQUIREMENT
	Should be made available to DNOs if requested**.**
	Applicability of the requirement
	Applies to all customers providing services to ESO and/or DNOs including aggregated assets.

6.9. Analogue Control point

	DATA POINTS
C1	Active Power Upper
C2	Active Power Lower Limit
	USE CASES
1	**Flexible Connection – management of export and import constraints** Being able to send curtailment instruction to manage export/generation constraints (Active Power Upper to limit the maximum export) as well as demand/import constraints (Active Power Lower to limit the maximum import)
2	**ESO services e.g. MW dispatch** Active Power Upper limit allow to instruct DER to reduce export based on transmission network needs for potential unplanned outage events.
3	**Emergency planning, 9th of August** Being able to send an active upper/lower instruction would allow to control engineers to manage customer during emergency planning events as the 9th of August event.
	RELEVANCE OF THE USE CASE

	Essential for DNO services. It is already mandated by G99 for type C and D customer
	DATA POINT REQUIREMENT
	All Flexible generators should be able to receive Active Power Upper/Lower instruction from DNO if requested.

	DATA POINTS
C3	Reactive Power Upper Limit
C4	Reactive Power Lower Limit
	USE CASES
1	**Flexible Connections (control) – voltage constrain management** Reactive power upper/lower limit control points allow instructions to flexible DER on the maximum level of reactive power import/export required to mitigate network constraints. As an example, voltage constraints triggered by a Flexible Connections customer exporting at the end of a long feeder, can be mitigated by instructing the customer to absorb reactive power, which could be achieved through a Reactive Power Lower Limit instruction.
2	**Reactive power/voltage ESO/DNOs services provision** Reactive Power Upper/Lower limit allow to dispatch a customer to provide reactive power service to DNO and/or ESO.
3	**Compliance with relevant agreement i.e., BCA** Reactive Power Upper/Lower limit allow to comply with requirements in the Bilateral contract agreement (BCA) which mandate the ability to control reactive power range of customers in abnormal network conditions;
	RELEVANCE OF THE USE CASE
	Essential data point for any DER providing **REACTIVE POWER/**voltage services
	DATA POINT REQUIREMENT
	DER should be able to receive Reactive Power Upper/Lower instruction from DNO if requested

	DATA POINTS
C5	Voltage Target
	USE CASES
1	**Reactive power/voltage services provision (DNO/ESO)** This allows a voltage setpoint to be sent to a customer operating in voltage control mode, allowing the customer to modulate reactive power to keep the PoC voltage at the target value. The target value may be defined based on different network needs including the Voltage requirement at the boundary between the Transmission Licensee and DNO, which was the case of Power Potential Innovation project.
	RELEVANCE OF THE USE CASE
	Essential data point for any DER providing **REACTIVE POWER/**voltage services
	DATA POINT REQUIREMENT
	DER Should be able to receive Voltage Target Setpoint from DNO if requested.

6.10. Digital Control Point

	DATA POINTS
C6	Default safe value setpoint/Export Blocking Signal
	USE CASES
	All DNOs and ESO services that require sending a turn town instruction to the DER (e.g., Flexible Connections), emergency disconnection, real time control etc.
	RELEVANCE OF THE USE CASE
	Required by the Grid Code
	DATA POINT REQUIREMENT
	Essential data point - Already mandated by G99 for type A/BC/D- no additional requirements

	DATA POINTS
C7	DER Breaker Trip
	USE CASES
1	All DNOs and ESO services that require opening customer breaker (e.g., Flexible Connections, N-3), emergency disconnection, real time control etc.
'	DATA POINT REQUIREMENT
	Already mandated by G99 for type C/D- no additional **REQUIREMENTS**

	DATA POINTS
C8	Power Generating Module CB Trip
	USE CASES
1	**Flexible Connections – tripping individual flex units.** Having the ability to control breakers of individual flexible units (demand/generation) would allow to avoid tripping the whole site when one of the units does not comply with a curtailment setpoint. Instead, only the breaker of the flexible unit that has not complied would be opened, allowing not to affect pure demand, firm generation, and other flexible generation at different LIFO stack position. When a flexible generation is supplying local demand/site load and the whole site is tripped for noncompliance of the flexible unit, the DNO would be liable for CI and CML if the interruption is longer than 3 minutes.
	RELEVANCE OF THE USE CASE
	Could potentially deliver considerable benefits.
	DATA POINT REQUIREMENT
	Should be able to receive this control point from DNO if requested.
	APPLICABILITY REQUIREMENT
	Sites with multiple flexible generation and or demand unit.

	Site with flexible generation supplying firm site load.

	DATA POINTS
C9	Curtailment instruction request e.g., Flex Connections
	USE CASES
1	**Flexible Connections – curtailment instruction** Some DNO use a curtailment instruction digital control signal, together with an Active Power Upper limit control signal to curtail flexible connection customers. The overall control instruction could not be achieved with only one of the two signals being exposed to the customer
	RELEVANCE OF THE USE CASE
	Essential for DNO service (e.g., Flexible Connections/ANM) – see use case above.
	DATA POINT REQUIREMENT
	Should be able to receive Curtailment instruction from DNO if requested.

	DATA POINTS
C10	Flexibility Service dispatch/ Service Request
	USE CASES
1	**Allow DNOs to dispatch flexibility service customer via SCADA.** This is dependent on the site being equipped with an RTU and being able to receive an instruction via SCADA from the DNO. There are currently other ways of dispatching flexibility customers, from phone call to emails, to API. SCADA dispatch will allow to have clear visibility on when a customer was dispatched making the utilisation payment among other things much more traceable and simpler.
	RELEVANCE OF THE USE CASE
	Has the potential to deliver some benefits – see use case above.
	DATA POINT REQUIREMENT
	Should be able to receive a flexibility service dispatch from DNO if requested.
	Applicability of the requirement
	DER providing Flexibility services.

	DATA POINTS
C11	P, Q, V Service Enable
	USE CASES
1	**Instruct DER to provide different services (P, Q, V)** Used by DNOs to instruct a DER customer on whether the DER should be providing P services, Q services or V services, (provided that the customer has signed up / has been contracted to provide more than one service).
	DATA POINT REQUIREMENT

	Limited benefits unlocked. Provided that the DER is contracted to provide multiple services, the DNO could send a direct P, Q, V control instruction rather than the mode of operation instruction.
	DATA POINT REQUIREMENT
	Not currently required.

	DATA POINTS
C12	Watchdog signal received from the DER
	USE CASES
1	**Flexible Connection, detection of Loss of comms between DER- DNO** Watchdog (or heartbeat signal) is used to monitor the healthy communication between the DNO and the DER customer. If the watchdog sent to and received by the customer are out sync, a loss of communication may have taken place, meaning that the customer is no longer able to receive curtailment setpoints. When this happens, the customer would automatically transition into contractual mode to ensure network safety.
	RELEVANCE OF THE USE CASE
	Essential for DNO service - some DNO use the watchdog approach to detect a loss of communication between the DER and the DNO to guarantee network safety.
	DATA POINT REQUIREMENT
	Should be able to receive it from DNO if requested.

	DATA POINTS
C13	Limit Breach
	USE CASES
1	**Flexible Connections – Audit Trail** Following a curtailment instruction, if the customer does not comply with the given setpoint, the DNO can set a “Limit breach” flag to the customer, giving them visibility they one or more limit is not being complied with. This is only for visibility; this is only sent to the customer for visibility to allow traceability of action taken by ANM.
	RELEVANCE OF THE USE CASE
	Does not unlock considerable benefits.
	DATA POINT REQUIREMENT
	Currently not required.

7. Recommendation on Data Points to be requested going forward (Deliverable C)

The data points use cases captured in the previous section, helped the product team assessing the level of benefits that could be unlocked by collecting and making use of the data points. The use cases and associated unlocked benefits, informed the product team's recommendation on whether the data point shall be made available to DNOs going forward. The outcome of the assessment is captured in Table 7 below.

This list does not intend to mandate a list of data points that each DNO will request going forward. Data points will actually be collected if DNO has use case to use it. Moreover, full DER-DNO data points exchange harmonisation is not considered possible at this stage due to the different ways DNOs have been developing their Active Network Management (ANM) system and due to the lack of commonly adopted standard for DER communication interfaces between the DNO and DER customers. Instead, this list intends to give a comprehensive view of all possible data points that could be requested to developers, across different DNO areas.

Table 7: Reccomendation on the Monitoring and Control interface data exchange requirements to be collected going forward from DER customers.

Category	ID	Data Point	New/existing requirement
Input/ Operational Metering points			
Customer metering (Net metering at the DER PoC	M1	Measured Customer Active Power	Existing requirement
	M2	Measured Customer Reactive Power	Existing requirement
	M3	Measured Customer Current	Existing requirement
	M4	Measured Customer Voltage	Existing requirement
	M5	Measured Customer Frequency	Existing requirement
	M6	Power Quality	Existing requirement
Customer metering (Metering from individual units)	M7	Metering from each Power Park module (P, Q, V, I)	New requirement
	M8	Separate metering for flexible generation and demand units (P, Q, V, I)	New requirement
Customer's CB status	M12	Customer generation/G99 CB	New requirement
	M13	Customer CB status for each power generating modules?	New requirement
	M14	Customer Islanded Open & Close	New requirement
	M15	Network Status Data	New requirement
DER availability	M17	Installed Capacity in Service	New requirement
	M19	Potential Power Available	New requirement
	M21	State of charge	New requirement
	M25	Active Power Upper Limit readback	New requirement
	M26	Active Power Lower Limit readback	New requirement

Readbacks	M27	Reactive Power Upper Limit Readback	New requirement
	M28	Reactive Power Lower Limit Readback	New requirement
	M29	Target Voltage readback	New requirement
	M30	Flexibility service request acknowledged	New requirement
	M31	Contractual setpoint/Export Blocking Signal readback	New requirement
	M32	Open breaker control readback	New requirement
	M33	Watchdog signal received	New requirement
Service Provision (real time)	M35	Service(s) contracted and volume	New requirement
	M36	Service(s) being armed and volume	New requirement
	M37	Service(s) actively delivered and volume	New requirement
Output/ Control Points			
Analogues Output Points	C1	Active Power Upper Limit	Existing requirement
	C2	Active Power Lower Limit	Existing requirement
	C3	Reactive Power Upper Limit	New requirement
	C4	Reactive Power Lower Limit	New requirement
	C5	Voltage target	New requirement
Digital Output Points	C6	Default safe value setpoint/Export Blocking Signal	Existing requirement
	C7	DER Breakers Trip	New requirement
	C8	Flexible demand/generation CB Trip	New requirement
	C9	Curtailment instruction request e.g., Flex Connections	New requirement
	C10	Flexibility service request	New requirement
	C12	Watchdog signal received from the DER	New requirement

8. Data Points technical Specification (Deliverable E)

This section covers the technical specifications for the DER data points that have been recommended to be collected going forward, captured in Deliverable C and D. Technical specification define the data points' minimum requirement to meet DNO's use case requirements.

The parameters that have been defined in the technical specification include Source and Destination of the data points, Unit Measure, measurement type (analogue/digital), the accuracy and resolution of the measurement as well as the maximum latency between the collection of the data point and the DNO receiving the data point.

Technical specs on the link between the DER and the DNO are not covered as the scope of this Open Networks products is to align on the data points to be exchanged rather than how these data are communicated (i.e. hardwire vs protocol interface).

The section below describes the rationale on how accuracy, resolution and latency requirement has been set.

Data Points Accuracy

Measurement accuracy determines how accurate a measurement needs to be to meet DNO use case requirements. Accuracy of operational metering data points it is influenced by several factors including the class of the CT and the VT, the accuracy of the transducer provided by the manufacturer, the amps range in the transducer etc.

As part of the work delivered last year[2], WS1B P6 looked at the level of measurement accuracy DNOs currently have over generation sites collected through the high spec equipment commissioned for new connections. The measurement accuracy benchmark was broadly in line across different DNOs despite the different type and classes of equipment installed.

The current level of accuracy through DNO equipment is considered to meet current DNOs use cases. **The accuracy requirement for the operational metering points (Active Power, reactive Power, Current, Voltage) to be provided by the DER customers, has therefore been aligned with the DNO metering accuracy**.

For other type of data points including state of charge, power potential available etc which are not measured from equipment on site but are rather calculated values, the allowed error has been set to be a percentage of the site capacity in service. As an example, if the error allowed is 1% of the capacity, a 100MVA DER will be allowed 1MW error whereas a 10MW DER will be allowed 0.1MW error. The error has not been set as a percentage of the meter reading (as in ESO as the lower a site generates, the higher the accuracy requirement would get.

Data Points Resolution

For data points collected from metering equipment, resolution of data capture, defines how often a new measurement is made available and exposed to the DNO interface. Resolution is usually defined as the minimum change in measurement value (e.g. new measurement should be polled if the measurement changes more than 5Amps) between two consecutive measurements.

The resolution is primarily affected by the number of bits in the analogue to Digital (A/D) converter, used to sample the analogue input value and digitise it (typically using, 8 bit, 12 bit, 16 bit etc). Higher A/D converter resolution (with higher number of bits) allow to digitalize the analogue signal more accurately compared to lower resolutions A/D. The product team has therefore specified the **measurement resolution requirements as minimum number of bits in the A/D converter** rather than the actual minimum measurement change requirement.

For data points not collected from metering equipment the resolution has been specified as number of bits in the data point.

[2] on21-ws1b-p6-operational-der-visibility-and-monitoring-requirements-(13-dec-2021).pdf (energynetworks.org)

Data Points Latency

This is the maximum time allowed to collect the data point from the DER equipment and transfer it to DNO control interface and it is specified in seconds.

For the analogues data points collected from metering equipment, such as CT, VT and transducers, the time delay will be affected by latencies and dead bands in each of these equipment plus the time of transferring the data through the DER-DNO fibre link. Latencies associated to digital data points transfer are generally lower as the change of digital status from the relays is not associated to dead banding.

Based on the assessment on the latency that can be achieved, the product team has set a maximum time delay that DNOs can accept based on DNO's use case requirements (analogue measurement up to 5seconds-old and digital signals up to 1 second-old).

Technical specification for the DER data points that have been recommended to be collected going forward are captured in Table 8 below.

Table 8: Data Points Technical Specification

	Data Point	Source	Destination	Unit Measure	Analogues/Digital	Accuracy	Resolution (granularity)	Latency from DER to DNO interface
Inputs/ Operational metering points								
M1	Measured Customer Active Power	DER	DNO's interface	kW	Analogue	95% or better	16 bits A/D or higher	5s or lower
M2	Measured Customer Reactive Power	DER	DNO's interface	KVars	Analogue	95% or better	16 bits A/D or higher	5s or lower
M3	Measured Customer Current	DER	DNO's interface	Amps	Analogue	95% or better	16 bits A/D or higher	5s or lower
M4	Measured Customer Voltage	DER	DNO's interface	Volts	Analogue	95% or better	16 bits A/D or higher	5s or lower
M5	Measured Customer Frequency	DER	DNO's interface	Hz	Analogue	95% or better	16 bits A/D or higher	5s or lower
M6	Power Quality	DER	DNO's interface		Analogue	refer to G55	refer to G55	refer to G55
M7	Metering from each Power Park module (P, Q, V, I)	DER	DNO's interface	kW, kVARs, Amps, Volts	Analogue	95% or better	16 bits A/D or higher	5s or lower
M8	Separate metering for flexible generation and demand units (P, Q, V, I)	DER	DNO's interface	kW, kVARs, Amps, Volts	Analogue	95% or better	16 bits A/D or higher	5s or lower
M12	Customers DER circuit breaker	DER	DNO's interface	0/1	Digital	n/a	n/a	1s lower
M13	Customer CB status for each power generating modules?	DER	DNO's interface	0/1	Digital	n/a	n/a	1s lower

	Data Point	Source	Destination	Unit Measure	Analogues/Digital	Accuracy	Resolution (granularity)	Latency from DER to DNO interface
M14	Customer Islanded Open & Close	DER	DNO's interface	0/1	Digital	n/a	n/a	1s lower
M15	Network Status Data	DER	DNO's interface	0/1	Digital	n/a	n/a	1s lower
M17	Installed Capacity in Service	DER	DNO's interface	kVA	Analogue	n/a	16 bits	5s or lower
M19	Potential Power Available	DER	DNO's interface	kW	Analogue	99% of installed capacity in service	16 bits	5s or lower
M21	State of charge	DER	DNO's interface	kWh or %	Analogue	99% of installed capacity in service	16 bits	5s or lower
M25	Active Power Upper Limit readback	DER	DNO's interface	kW	Analogue	n/a	16 bits	1s lower
M26	Active Power Lower Limit readback	DER	DNO's interface	kW	Analogue	n/a	16 bits	1s lower
M27	Reactive Power Upper Limit Readback	DER	DNO's interface	KVars	Analogue	n/a	16 bits	1s lower
M28	Reactive Power Lower Limit Readback	DER	DNO's interface	KVars	Analogue	n/a	16 bits	1s lower
M29	Target Voltage readback	DER	DNO's interface	Volts	Analogue	n/a	16 bits	1s lower
M30	Flexibility service request acknowledged	DER	DNO's interface	0/1	Digital	n/a	n/a	1s lower
M31	Contractual setpoint/Export Blocking Signal readback	DER	DNO's interface	0/1	Digital	n/a	n/a	1s lower
M32	Open breaker control readback	DER	DNO's interface	0/1	Digital	n/a	n/a	1s lower
M33	Watchdog signal received	DER	DNO's interface	counter/ 0/1	Digital or analogue (depending on implementation)	n/a	n/a	1s lower
M35	Service(s) contracted and volume	DER	DNO's interface		Analogues & Digital	n/a	16 bits	5s or lower
M36	Service(s) being armed and volume	DER	DNO's interface		Analogues & Digital	n/a	16 bits	5s or lower
M37	Service(s) actively being delivered and volume	DER	DNO's interface		Analogues & Digital	n/a	16 bits	5s or lower

outputs/control points								
	Data Point	**Source**	**Destination**	**Unit Measure**	**Analogues/Digital**	**Accuracy**	**Resolution (granularity)**	**Latency from DER to DNO interface**
C1	Reactive Power Upper Limit	DNO's interface	Customer Control System	kW	Analogue	n/a	n/a	n/a
C2	Reactive Power Lower Limit	DNO's interface	Customer Control System	kW	Analogue	n/a	n/a	n/a
C3	Voltage target	DNO's interface	Customer Control System	KVars	Analogue	n/a	n/a	n/a
C4	Default safe value setpoint/Export Blocking Signal	DNO's interface	Customer Control System	KVars	Analogue	n/a	n/a	n/a
C5	DER Breakers Trip	DNO's interface	Customer Control System	Volts	Analogue	n/a	n/a	n/a
C6	Flexible demand/generation CB Trip	DNO's interface	Customer Control System	0/1	Digital	n/a	n/a	n/a
C7	Curtailment instruction request e.g. Flex Connections	DNO's interface	Customer Control System	0/1	Digital	n/a	n/a	n/a
C8	Flexibility service request	DNO's interface	Customer Control System	0/1	Digital	n/a	n/a	n/a
C9	Watchdog signal received from the DER	DNO's interface	Customer Control System	0/1	Digital	n/a	n/a	n/a

9. Gap Analysis, Impact and Implementation Plan (Deliverable F)

This section looks at the potential impact that the additional DER data exchange requirements recommended in deliverable C, will have on DNOs and customers. Firstly, a Gap analysis of the data points has been carried out and the potential impact of these additional data points has then been assessed. The impact has been looked at from a cost perspective i.e. the cost for facilitating the collection and exchange of these data points, as well as from a processes and systems perspective i.e. looking at the systems that needs to be upgraded and processes that needs to be established within the DNOs to facilitate the collection and usage of these data points. An implementation plan has then been recommended.

9.1. Gap Analysis

The product team mapped each of the monitoring and control data points against current data exchange requirement in place in each DNO area, and has specified whether this is applicable for a specific technology, capacity, service etc. This was used to produce a gap analysis highlighting the difference in data point exchange between different areas. The Gap analysis has been delivered as part of deliverable D and is available in Table 6.

Table 9 below summarises the delta number of data points per DNO between the state of the art i.e. what's currently being collected and the additional data point recommended in deliverable C. As some of the data points are technology and service specific, DNOs are likely not going to collect all data points in the list, for this reason Table 9 below provides a conservative view.

Table 9: Volume of Data points delta per site per DNO area.

	Data points currently collected per site	Data points per site in the harmonised list	Delta per site
UKPN	33	38	5
SSEN	24	38	14
NPG	11	38	27
NGED	8	38	30
SPEN	6	38	32
ENW	14	38	24

9.2. Impact on Cost

Additional data point could potentially mean additional cost for customers to collect the data and make it available to the DNO, and additional cost for DNOs to facilitate the interface, store the data etc. The product team has assessed the potential cost impact on DNO and/or customer looking possible and capital and operational costs. In some cases, it could be as simple as an i/o point to be configured at potentially zero cost for the customer or in other cases may require sensors to be installed, multicore fibre cables between DNO and the DER to be commissioned etc.

In a similar way the benefits have been described qualitatively rather than quantitively, the cost items have been identified and described qualitatively and have not been quantified. If the data exchange recommendation from this product team will take a more formal route (i.e. through a grid code mode) it is recommended to associated numbers to cost and benefits derive a cost benefit analysis (CBA).

Table 10 and Table 11 identify additional potential costs on the DNOs and the customers to facilitate the data exchange recommended in Deliverable C.

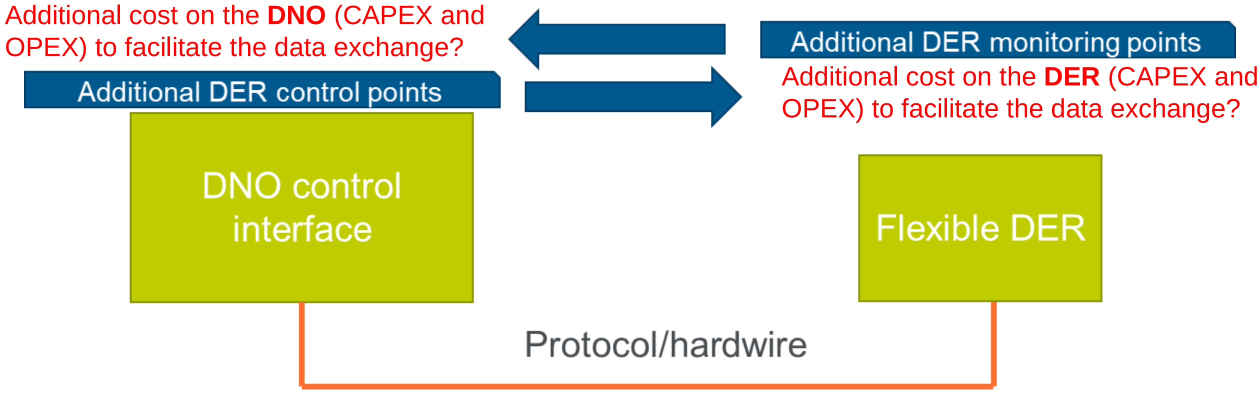


Table 10: Additional cost on the DNO to facilitate the data exchange

DNO cost - CAPEX	
1	**Development/ Upgrade of the system making use of the data** Data point exchange by itself has generally no benefits unless it is ingested and made use of by a system e.g. ANM, designed to meet certain use cases. There is a cost associated with enhancing the system with capabilities that allows it to make use of the data. As an example, Potential Power Available could be used by ANM to optimise curtailment threshold and minimise curtailment. DNO's ANM systems don't currently have the capability to do so meaning that the system needs to be enhanced as part of software releases driven by business requirements. The development/upgrade of systems is considered to be the biggest cost contributor; however the cost is primarily driven by business requirements (e.g. need to decrease curtailment) rather than to facilitate the actual data exchange.
2	**Upgrade the DNO interface to read the additional i/o from the customer** This applies to DNOs making use of protocol interface. Any new signal requires a a 4-20mA current loop to be configured. Beside the work required form customer side, the DNO also needs upgrade its system to be able to read the data point, upgrading the interface with termination boxes etc.
3	**Capacity on Communication infrastructure / FEPs (front End Processing) cost.** The more data points are collected and exposed to the central DMS system the higher the number of FEPs that will need to be installed. A new pair of FEPs can accommodate up to 25'000 new data points. Some DNOs make use of the data point locally (due to local ANM solution) rather than centrally, so they will not be impacted by this cost item.
4	**Storage of data / bigger servers** Higher number of data points collected (both from DNO and customer site) calls for bigger storage and servers' volume. Some DNOs wouldn't store all data point collected from the customer site hence are not affected by this cost item.
5	**Additional input Cards in the RTU** Each RTU is able to read a limited number of data points based on the card capability. The higher number of data points, the higher the number of RTU cards required. However, as this requirement applies to new sites going forward rather than retrospectively, the RTU should be sized to include all data point exchange requirement.
DNO cost - OPEX	
6	**PI operational cost to maintain the additional data points** Beside the additional storage capacity required to store the data points provided by the customer (cost included in the CAPEX,) there is usually a yearly operational cost to store data into the historian.

Table 11: Additional cost on the customer to facilitate the data exchange.

DER cost - CAPEX	
1	**DER- DNO Multicore fibre cables to be commissioned** This applied to DERs in DNOs area using a hardwire interface. The more data points to be exchanged with the customer, the more multicore fibre need to be commissioned in the interface between the DNO and the customer. This includes 2xcores for each of the current loops, plus termination, optical interface, interface box, Isolation. Material + labor. Alternatively, the DNO may decide to commission a separate DNP3 link for additional data points, which also come with an additional cost. DNO using protocol interface instead can facilitate the exchange of unlimited number of data points transfer with the same protocol link, and only requires the i/o point to be configured.
2	**Configuration in the control system** instead of collecting data points directly from field devices, some data points needs to be processed and calculated and hence require configuration into DER control system. The cost associated to it is related to time and configuration resources. As example of this is the Potential power available data point, which takes as an input weather conditions, capacity in service, power curve and others to produce an output.
3	**Data points Aggregator interface** Depending on the number of additional data points collected and exposed to the DNO, the customer may need to install an equipment to aggregate the data collected across the customer site to a single control interface. This is an extra box which normally hosts a more sophisticated control system.
4	**Additional sensors** Sensors to collect the data point specified in Deliverable C should already be installed at the customer site so this is not expect this to be a major cost contributor.
DER Cost - OPEX	
5	**Data Operation and maintenance** Operational cost to maintain additional data points, which includes fixing faulty analogues, boundary equipment to be maintained etc. The cost should however not be accounted if the data is already available, as exchanging the data with DNO does not increase OPEX cost.

The overall cost to enable data collection and exchange is impacted by a number of factors including the number of additional data points to be exchanged (which depends on each DNO starting level), the DER communication interfaces between the DNO and DER customers, the policy for storing data, the ANM system implementation etc. For this reason a DNO by DNO cost assessment shall be carried out.

The product team's view is that DNOs would not ask for data point if it was not beneficial either for the customer or for the DNO (ultimately a customer benefit), which is what the use case benefit assessment informed. The impact of collecting the data would be offset by the benefit of rolling out the use case.

9.3. Impact on DNO's Systems and Processes

This section captures the impact that the recommended additional data points have on DNO's internal processes and all the gaps to enable the data to be available, configured, tested and used in different DNOs systems.

The process starts with updating the specific DNOs Engineering Standards which capture the data exchange requirements that goes out to customers.

Once these data are made available by the customer, the additional data points need to be configured into the DNO's control interface e.g. Remote Terminal Unit (RTU); if the capability to ingest additional data point are not currently in place, the DNO will need to upgrade its control interface.

The data exchange between DNO and the customer will then need to be tested as part of the customer commissioning process to ensure the DNO is able to receive data from the customer and that the customer is able to receive instructions from the DNO. This also needs to esnure that the data have been correctly mapped.

Governance on the use of the data points will then need to be put in place by developing standards, policies and procedure on the use of customer's data, including data quality , accuracy testing, failsafe mechanism when data link is lost etc.

The DNO system will need to be enhanced to be able to ingest and make use of the data. An example of this is upgrading the DNO's ANM system to make use of potential power available data to optimise curtailment thresholds and decrease curtailment. This requires development of a dynamic threshold system which can ingest real time information and dynamically updates thresholds. In some cases the system making use of the data may need to be developed from scratch e.g. DNO forecasting system ingesting data to inform constraint loading patterns in different timescales.

Requirements	• DNO's engineering standards update
DNO control interface	• additional i/o points to be configured • updated list of tests
Testing/governance	• On going governance for getting DER data into DNO's system (quality..) • Policies to make use of the data e.g. dynamic line rating
System Enhancements and mapping	• Upgrade the system making use of the data • Data points to be mapped in the systems making use of the data

9.4. Implementation Plan

This section captures the recommended next steps to harmonise DNO-DER data exchange requirement across DNOs.

Having an appreciation of state-of-the-art DER control system by engaging with DER customers and manufacturer is considered key to have an understanding of the current capabilities and identify the gaps to enable data exchange. This will inform whether the capabilities are already available or if any upgrade needs to triggered will inform potential additional customer cost to enable the data exchange.

It is then recommended to carry out a DNO-specific CBA assessment for the data point rather than an industry wide CBA assessment. This is because the overall cost to enable data collection and exchange is impacted by DNO specific factors such as the number of additional data points to be exchanged (which depends on each DNO starting level), the DER communication interfaces between the DNO and DER customers, the policy for storing data, the ANM system implementation etc. Because cost and benefits could vary significantly across DNOs it's recommended to carry out DNO-specifics CBA assessment rather than an industry wide CBA assessment starting from individual use cases. If the CBA for a particular data point turns out to be positive, the data point would unlock considerable benefits for customers in a that DNO area and makes sense to collect it and not otherwise.

As an example, for the individual power generating modules operational metering data point, the CBA will need to look at the customers cost to collect and exchange the data point with the DNO, cost for enhancing ANM system capability, vs the DNO/customer's benefit which is is driven by allowing to manage sites with multiple generators at different LIFO stack positions without requiring the whole site to move at the bottom of the stack.

The next recommendation from the product team to harmonise DNO-DER data exchange requirement across DNOs is to standardise market data transfer between DER and DNOs. This applies to the market data recommended to be collected going forward, which includes visibility of the service a DER has been contracted to provide and well as the service a DER has been armed for and dispatched, together with respective volumes. Route for these data points could either be trough SCADA or through API feeding to market platforms. Currently there are a range of different approaches of how market data and dispatch instruction are managed and communicated by different System Operators but there is no industry standard. It is recommended to work closely with WS1A P3 (Dispatch Alignment recommendation) and other applicable industry working groups to drive a common industry data exchange route for market data.

Engagement with DER customer/ manufacturer

- Appreciation of state of the art DER control system, understand current capabilities
- Understand the impact of these additional data point on customer
- Use this to inform customer's indicative costs

DNO-specific CBA

- CBA should be use case driven
- Using DNO specif cost and benefits to derive whether or not data point is beneficial

Standardise market data exchange across industry

- working closely with WS1A P3 and other applicable industry working groups drive a common industry wide data exchange route for market data.

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