Visibility of distributed generation connected to the GB distribution networks

Northern Powergrid's response to Ofgem's call for evidence

KEY POINTS

- **There are two main drivers to accessing real time distributed generation information: managing system resilience and facilitating a more flexible electricity system. The technical architecture for the resilience use case entails a more wholesale upgrade to system capability that would also serve the objective of enhanced flexibility. Both purposes have the potential to deliver significant customer benefits but use case development is required in order to determine the appropriate technical solutions and justify the associated expenditure.**
- Accessing real time data from existing and future distributed generators connected to local distribution networks would assist in the management of system resilience – either helping to avoid or responding to major system events such as that which that occurred on 9 August 2019.
  - Accessing real time data should enable DNOs and the Electricity System Operator (ESO) to better understand what is happening during and immediately after a major event e.g. what tripped, how much generation export was lost and how to optimise the real-time response.
  - This information would be required from the vast majority of material generators so that a more complete picture of the event can be obtained and this implies a retrospective and relatively expensive installation programme.
- The data required to operate an active electricity distribution network where flexibility is used as an alternative to network reinforcement is only required for those participating generators.
  - As such, the DNO flexibility use case does not require visibility of all generators as is the case for resilience.
  - However, any investment for the resilience use case would provide the necessary data for operation of new local flexibility markets.
- Potential future changes to the GB black start arrangements would likely require and make available more data for participating generators connected at the distribution level.
- A resilience driven roll-out could also provide more energy system data to be made available to the competitive market to deliver additional customer benefits.
  - The analytics provided by the competitive market could provide new flexibility products and information such as grid carbon intensity data.
  - Having real-time data for system resilience would also help to deliver DSO benefits.
- The industry should develop the use cases associated with real-time data so that the granularity, latency and resilience of the communication system required to deliver customer benefits may be considered.
- Use cases should differentiate between real-time data that provides non-critical, but valuable, information and that which is critical to the control, operation and protection of the system.

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Summary

1. This document provides evidence from Northern Powergrid for the issues and questions raised in Ofgem's call for evidence on the *Visibility of distributed generation connected to GB networks* published on 4 August 2020.

2. The response is in two parts: the first relating to general observations on data exchange, the second part responding to the specific questions raised in the call for evidence.

General observations

Existing data categories

3. There are three general categories for data – that are required by DNOs for network planning, network operations and market operation. The type of data in each area from a granularity and latency context is as set out below.

4. Network Planning: typically 30min average data with low latency is sufficient for network planning.

- Establishing the need for reinforcement / flexibility services
- New connection planning including flexible connections and active network management (ANM)
- Confirmation of correct flexible connections and ANM operation
- Providing transparency re historical loading, distributed energy resource (DER) operation, flexibility service operation
- Confirming compliance with standards e.g. EREC P2 security of supply, regulatory reporting e.g. Long Term Development Statement (LTDS), Grid Code Week 24, Ofgem information requests / investigations

5. Network Operations: typically 30min average data with low latency is sufficient for operational planning, with more granular e.g. 1minute data with latency measured in seconds being required for responding to some faults and emergency incidents / events.

- Safety management
- Operational Planning e.g. Outage planning (relates to planned network outage requests) and planning for flexibility service (relates to network constraint data)
- Emergency planning and response
- Fault / incident management
- Calling off flexibility services that are part of DNO business as usual approaches today

6. Market Operations: typically 30min average data with low latency is sufficient for network and service provision charging.

- Ensuring market delivery of flexibility services
- Paying for flexibility services

Call for evidence drivers

7. There are two drivers behind the Call for Evidence – data to facilitate improved system resilience and data to facilitate a transition to a more flexible electricity system. These are different, although related, drivers.

Resilience

8. Resilience relates to the ability of a system to be immune to a range of credible system disturbances. Analysis following the 9 August 2019 event suggests that some distributed generation didn't perform in a way that was anticipated. Increasing the ability to analyse systems after an event to better understand which systems worked as expected and which didn't, by being able to access historical data, is one of the means of improving system resilience. Historical data could be collected by different means; for example:

   i. Requiring distributed generators to capture and retain a rolling log of export, which is stored when a generator trips for later analysis. Such a snapshot could also record protection relay and circuit breaker status information.

   ii. Requiring distributed generators to capture and send real-time granular data to the DNO, shared with ESO as required, that could be processed and stored for analysis post an event.

9. Appropriate changes, for example to protection settings, could be made based on the analysis that could increase resilience for future events.

10. Whilst both approaches could provide information to improve resilience, the second, although potentially more expensive, has additional capability to improve other areas of transmission and distribution system management, for example enabling the ESO to better respond to a major event.

11. This second aspect of resilience relates to the ESO having sufficient information available immediately after an event to better understand the event itself as it unfolds in terms of the potential immediate consequences and how best to respond in the next minutes and hours. This could require access to real-time or very close to real-time data; for example had the ESO been better able to understand the export from distributed generation that tripped on 9 August 2019, that may have meant supplies could have been restored to customers sooner.

12. In both these resilience use cases, information would be required from the vast majority of material existing (and future) distributed generation so that a more complete picture of the event can be obtained and this implies a retrospective and relatively expensive installation programme.

Operating a flexible electricity system

13. Real-time information can be an essential part of DSO activities such as calling and managing new flexibility services that require enhanced data compared to the market operations that are business as usual today. The new data requirements for new flexibility services are unlikely to be any more detailed than the data envisaged for the resilience use case.

14. As such, any investment in data for resilience would also naturally support the introduction of new and further deployment of existing flexibility services. Alternatively, in the absence of any resilience driven investment, the need for real-time data to deliver flexibility may be carried out in an evolutionary fashion as upgrades are only required for those generators providing services.

15. A wholesale roll-out of enhanced data capture and use from all material generators for the resilience use case could provide an additional whole electricity system benefit. Namely, it would add to the energy system data that could be provided to competitive market operators to enable new flexibility services to any part of the system (not just for DNOs buying flexibility). In addition to supporting more flexibility, the increased data availability could also benefit customers to understand more about where their electricity is generated and the local carbon intensity of the grid.

Interpretation of real-time data

16. There are different types of data that may be considered to be 'real-time', including:

- a continuous stream of low latency (e.g. 1-10 seconds) data from all monitored points simultaneously to a central point
- a stream of low latency data (e.g. 1-10 seconds) from a small selection of monitored points provided on request by control engineers for a relatively short period of time (minutes)

17. The first of these requires a new communications and data management infrastructure – but may be required to best respond to a national event, whilst the second requires a more limited comms system - and most likely to be sufficient to understand a local situation, for example, before closing a circuit breaker, or to monitor the load on a transformer - and is the type of 'real-time' data provide by our current SCADA system.

Requirements driven by use cases

18. It is important to be clear about the use cases for any data requirements when considering the additional planning or operational data that may be required from a total system resilience or flexible electricity system perspective, as it is the use cases that will confirm the need for the extent of the data e.g. real power export, reactive power export, wind speed etc. and also set the technical parameters e.g. latency, bandwidth and volume of the data that will in turn inform the communications infrastructure required to deliver the data to those that will use it. Cross industry groups, including ESO, DNOs and Users, would be best placed to establish these use cases, as they could be wide ranging. Some of these discussions are already taking place via the ENA Open Networks project which is assessing further data exchange and further data publication that could improve whole network planning and operation including the prevention of, live management, and recovery from loss of supply events.

19. Relevant ENA Open Network workstreams and products include WS2 Product 1 on Embedded Capacity Registers (ECRs), WS1B Product 3 on real-time data exchange and WS1B Product 4 on planning data exchange. Work is underway across these products to develop further data exchange.

Alignment with other initiatives

20. There are several data related industry changes currently being that should be taken into account:

- Grid Code Modification Proposal GC0117. This Grid Code modification could potentially result in resetting the large, medium and small boundaries for power stations to the existing level in the north of Scotland. If approved this would provide the ESO with visibility of all generators down to 10MW. (See para 21)
- Distribution Restart. This project explores the possibility of distributed generation providing black start services, which would require a step increase in the volume of data and information from generators to the Black Start Co-ordinators, including DNOs and the ESO. It is hard to envisage this not requiring more resilient and more granular communications for Black Start participants and other DG sites in the Local Joint Restoration Plan areas.
- Grid Code Modification Proposal GC 0139, relating to exchange of planning data between DNOs and ESO, together with the associated Distribution Code Modification Proposal 20-04 considering changes to the data exchange between DNOs and IDNOs

Current ESO requirements for larger generators

21. Generation directly connected to the transmission system and larger embedded generators currently need to provide ESO with operational metering in accordance with Grid Code CC.6.4.4 or ECC.6.4.4. The detailed technical requirements are set out in the Bilateral Connection Agreement between the generator and ESO on Appendix F5 Schedule 2 (page 40).[1]

22. These requirements include real and reactive power and voltage with a granularity of 1 second, and a latency < 5 seconds. Two systems are available to transmit this data to ESO control:

- For Balancing Mechanism (BM) participants, via an ESO provided remote terminal unit (RTU) via secure ESO comms
- For non BM participants e.g. small and some medium generators, via a GPRS / Public internet connection to a ESO comms point for onward transmission to ESO control

23. Particularly for small and medium embedded power stations, there would be merit in aligning the data requirements between DNOs and ESO, as this would facilitate any future changes to the definition of the small, medium and large power station boundaries.

Communication system

24. Communication systems associated with protection and control systems (such as those associated with ANM schemes and flexible connections) are critical to the safe operation of distribution systems and should be under the control of network operators so that they can manage their resilience, reliability and cyber security.

25. Where data is provided for information alone and is not necessarily critical to the operation of the system it does seem reasonable to consider using a third party communication service provider as this is likely to be significantly cheaper and provide information that is of sufficient quality. For

[1] https://www.nationalgrideso.com/document/33976/download

example using a GPRS communications system, similar to that used by the ESO may be sufficient to investigate the operation of distributed generation after an event. There is a need though to consider how critical this information might be to operational activities – for example the loss of information relating to a 10MW generator due to a comms outage when balancing the transmission system may not be critical, but the same comms outage affecting the same generator may be critical in a DSO activity to manage the demand and generation downstream of a Grid Supply Point with a load of 200MW. The difference in criticality is likely to influence the choice of communication system.

26. There is merit in the DNOs evaluating and developing a wide area strategic telecommunications network, such as private LTE, together with being able to access the associated spectrum to meet the future communications requirements associated with DSO activity. This being driven by considerations of resilience, security, increased data need, and volume of connected endpoints.

Responses to specific Ofgem questions

1 DCUSA modification DCP350 will provide data on a number of characteristics for DG greater than 1MW. Are there additional characteristics for DG, such as real-time MW/MVAr output, load factors and protection settings, which would aid in the prevention of, live management, and recovery from loss of supply events?

27. The Embedded Capacity Register (implemented by DCP350) currently only includes static data relating to a DG installation. There is further information as set out in the Distribution Code and Grid Code, relating to the design and operation of the connection that could be included in a revised ECR, if it would be of use to network users. To avoid customer confusion and maximise the efficiency of data collection / publication, the data requirements of the ECR and the Distribution Code and Grid Code should be aligned and harmonised.

28. There are provisions in the Distribution Code for exchange of planning and operational planning data between Users and the DNO, and once any additional data requirements had been established the technical codes would be the appropriate vehicle to implement changes rather than via DCUSA.

29. Any requirement for additional data items should be driven by use cases so that the data meets users' requirements.

30. In terms of the suggested additional data items, we have the following observations:

- Real-time MW/MVA – please see our response to question 2
- Load factors – these could be relatively easily calculated from the half hourly Elexon settlements data
- Protection settings – generators should apply the protection settings set out in the Distribution Code, so there shouldn't be a requirement to record these separately; however some setting information are being collected via the Accelerated Loss of Mains Change Programme (ALoMCP) and this could be included in the Grid Code Week 24 data exchange to provide visibility to the ESO or included in the ECR, depending on which parties would be expected to use the data

31. Further development of the ECR, including expanding the scope to less than 1MW and including additional data items are being developed by the Open Networks Workstream 2 Product 1 team.

2 What value will these additional characteristics provide to improving the planning, security and real time operation of the GB transmission and distribution systems?

32. In general, additional clarity of DG that provides system services, either to ESO or a DNO will be helpful and potentially pave the way for more detailed information being requested from that party, for example in terms of real-time or planning data.

- Information on any ESO services provided by DG will help DNOs understand what assets and what areas of DNO networks may become more important to wider system security at certain times such as during the management of loss of supply events.
- Inclusion of DG of less than 1MW capacity would provide additional information on resource types and locations so that system and network risks can be better assessed.

33. More specifically, for distribution network planning activities the Elexon settlement half hourly power flow data, available from Durabill via our PI data historian, is sufficient at all voltages, although we recognise that voltage information, that can be useful for network planning is not available via Durabill.

34. For distribution operational planning activities, again the half hourly Elexon power flow data is sufficient. Such data is also likely to be sufficient for operational planning of the transmission system, and the coordination of planning between ESO and DNOs.

35. It is for real-time distribution operational activities, including response to fault outages, calling flexibility services and verifying that flexibility services are delivering, where real-time data in a DSO environment could bring benefits. Such real time data could be used in conjunction with ‘on request real-time data’ related to DNO network assets, to help manage individual events.

36. Similarly for transmission operational activities, if the DNO was to provide aggregated distributed generation export either at a licence level or Grid Supply Point level, that is very likely to be of value to the ESO. By way of an example, it should allow the ESO to establish the export from DG exposed to rate of change of frequency (RoCoF) trip or vector shift trip risk and hence help better assess the appropriate level of reserve required at any point in time. There is an SQSS modification being currently being developed in this area.

37. There could be other benefits that customers might value such as increased visibility and granularity of a region’s or the GB’s generation mix at any point in time.

38. As mentioned above, secure real-time data is required to support ANM and flexible connection schemes.

3 What value will the above characteristics provide to improving DSO function delivery by the DNOs or other stakeholders? DSO functions may include network management, flexibility procurement, and service conflict avoidance.

39. As mentioned in our response to question 2, real-time data is required for activities, such as implementing flexibility services, ANM and flexible connections which all form part of our standard DNO activities.

4 At what temporal resolution (instantaneous, seconds, minutes etc.) would real time data on DG be valuable to improve the resilience of the GB electricity system in the prevention of, live management, and recovery from loss of supply events?

40. As mentioned above, for small and medium embedded power stations, there would be merit in aligning the data requirements between DNOs and the ESO, i.e. 1 second granularity with 5 second latency. Transmitting this volume of data across a third party communication service provider system does not seem to present an issue, however there should be a debate as to what is a sensible level of granularity and latency. The latency of Northern Powergrid's primary SCADA system for an on request command is in the region of 4 seconds, and the data granularity is in the region of 1 minute. There may be different requirements associated with an ANM, or flexible connection as there is a trade-off between how close the network is run to its safe operational limits and the communications network performance.

5 What investment would be required for monitoring, collecting, storing and disseminating real time operational data associated with DG? Which party should be responsible for these investments? How does this vary, based on the size of visible DG at 1MW or 50kW?

41. The investment requirements would be driven by the functional requirements of the monitoring, collection, storage and dissemination systems, which in turn would be driven by the use cases. We have considered two different scenarios for transmitting real-time data from distributed generation sites to our DNO control function:

i. *web based* - where there is a separate and new web based system to collect and a time series database system to store and manage real time data; and

ii. *SCADA based* - where data collection and storage is integrated into our SCADA and NMS system.

42. In both cases DNOs would be able to store, analyse and aggregate the data centrally in such a way that it would be consolidated and meaningful for use internally and by ESO.

43. Estimates of total investment required could be created by collaborative industry working using the data and information provided in response to this call for evidence.

Generation volumes

44. If real-time operational data was required from each power station over 1MW, there are currently 600 generation sites affected.

- No. of generators - Yorkshire 400
- No. of generators – North East 200

45. If real-time operational data was required from each powers station over 50kW, there are currently 1500 generation sites affected.

- No. of generators - Yorkshire 1050
- No. of generators – North East 450

Web based

46. In this system, the generator would provide Northern Powergrid with a continuous stream of real-time data from their internal management system via a GPRS / wired broadband connection to a Northern Powergrid time series database system that processed, aggregated and stored the system.

- Such a system would be relatively cheap to provide for each generator, just requiring third party communications termination equipment (£1000) and data service contract (£100 pa).
- Some existing generator monitoring / management systems may be able to provide close to real-time data directly into a Northern Powergrid data system, at relatively low cost to the customer.
- A Northern Powergrid time series database system would be required to manage the data from between 600 – 1500 distribution generation sites (depending on plant registered capacity of interest) at a cost of circa £100k plus ongoing software costs.
- Data links would be required to the ESO would need to be secure, although these wouldn't necessarily need to be ICCP links.

SCADA based

47. In this system, the DNO would create a continuous stream of real time data from CTs and VTs at the DG / DNO interface substation that would be transmitted via dedicated control / protection quality link to an existing Northern Powergrid communications site. Where there is an existing protection requirement or control requirement (e.g. in the case of an ANM or flexible connection) it is likely that there would be an existing, suitable communications link into the Northern Powergrid system that could be utilised to provide real time operational data. Such links would be cyber secure.

48. Where there is no current protection or control requirement for communications, a new communication connection to the Northern Powergrid system would be required. The costs of a new link for each site can vary significantly depending on the connection type and geographic location of the distributed generator.

49. Where the distributed generator is connected via an underground cable a copper or fibre communications cable could be installed relatively cheaply at the time that the connection was constructed (or potentially installed retrospectively if there was spare ducting installed). The

additional cost could be in the order of £5k for new termination equipment at each end of the comms link.

50. Where the provision of cable comms is not possible, a new microwave link would be required. Microwave links are dependent on geography as they require 'line of sight' from the generation site to an existing Northern Powergrid comms node. A microwave link costs in the region of £25k, although costs of the towers to house the equipment can vary depending on the number and height of the towers required. Each tower costs between £5k and £150k depending on the height. A typical average cost per generation site would be in the region of £100k - £25k for the link and £75k for the towers. Assuming that new communications links would be required for 50% of the >1MW generators, ie 300, the total cost of retrofitting such a communications system would be, as a worst case scenario, £30m. However in this case, it would be cheaper to develop, as a strategic enabling investment, a network of 'hopping' point towers to minimise the number of towers required.

51. An alternative solution using private wireless wideband area network could also be used to accommodate the data exchanges envisaged here, although this would require spectrum (as per discussions with Ofcom) and network wide investment to provide the necessary coverage.

Hybrid

52. It would be possible to collect real-time data by a mixture of the two approaches, e.g. transmitting data from a generator's data management system via Northern Powergrid SCADA where there is an existing comms infrastructure , or Northern Powergrid creating real-time data from its own CTs and VTs and transmitting this across a third party comms system.

Implementation models

53. Irrespective of the means of transmitting the real time data there is a need to extract the required real-time data from the generation plant itself and to implement the change.

54. There could be different implementation models:

i. ***DNO led.*** The DNO would install monitoring equipment at the interface substation with the customer. It may be, depending on the data requirements, that some of the equipment already installed for system monitoring (including the associated CTs and VTs) would be suitable. The DNO would install a RTU, arrange the comms, potentially integrated with the other DNO comms requirements relevant for the efficient operation of the generation (e.g. requirement to control the output of the generator, open the metering/synchronising circuit breakers, monitor the status of the CBs etc. and be responsible for managing the data on a per DNO basis).

   The advantages of this implementation method include:

   - Integration with existing / future protection and control based comms systems would be efficient
   - DNOs could be obligated by licence / Distribution Code to install and collect the required data
   - There could be synergies with other initiatives such as Distributed Restart

   A development of this could be for the generator to provide the real time monitoring signals to the DNO (alongside the generator output control) for onward transmission.

ii. ***Generator led***. The generator would install monitoring equipment in their installation. It may be, depending on the data requirements, that some of the equipment already installed for their own system monitoring would be suitable. The generator would arrange the third party comms, via a suitably secure and resilient comms infrastructure and provide the data to a suitability secure DNO interface.

The advantages of this implementation method include:

- Integration with existing generator data systems would be efficient
- Information could more readily be provided for individual generating units within a customer's installation e.g. for the wind turbines and storage
- Potential diversity associated with using different comms systems would introduce resilience

The disadvantages of this implementation method include:

- Historically it has proved difficult to implement retrospective changes with existing generators, particularly where there is a requirement to invest
- The DNO may, in the future need a comms infrastructure for control / monitoring of the equipment at the metering point, or a connection may evolve in to part of an ANM scheme – so there may be duplication

55. Regarding the funding of the comms infrastructure, central management systems and remote equipment at the generator's sites, it would seem reasonable for the shared infrastructure to be funded by the DNO via DUoS, and for the sole use assets at the generator's site to be funded by the generator, although this might present a barrier to decarbonisation.

6 What are the credible technical, regulatory (industry codes, licences and governance) and legal barriers and costs associated with increasing the data collected, stored and shared regarding DG operations, and in obligating parties to do so?

56. Provided that there was a costed and justified set of use cases that had the support of BEIS and Ofgem, changing the network codes to mandate the collection and transmission of the data would be relatively straight forward. Depending on the implementation model selected, the licence and code changes would be different. For example in a DNO led arrangement, the obligations would be placed on the DNO to provide the data with the costs being recovered via the price control mechanisms. Assuming that any requirements would be retrospective, historically it has proved difficult to implement retrospective changes on existing generators, particularly where the generator would incur costs.

57. Some operational and commercial data relating to BM generators is shared, so similar models could be applied to generation connected to distribution systems.