

The Voice of the Networks



Energy Networks Association

Open Networks Project

**The Interactions between
Flexible Connections (ANM)
and Flexibility Services**

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Table of Contents

Document Control	1
Version Control	1
1. Introduction	1
1.1 Context	1
1.1.1 Flexible Connections (ANM enabled)	1
1.1.2 Flexibility Services	2
1.2 Key Characteristics of Flexible Connections and Flexibility Services	4
2. Quantification	6
2.1 Flexible Connections (ANM) Coverage and Volumes	6
2.2 Flexibility Services Volumes	7
3.0 System Needs	9
3.1 Operability currently offered by Flexible Connections (ANM)	9
3.2 Operability currently offered by Flexibility Services	9
4. Comparison of Current Flexible Connections (ANM) and Flexibility Services	10
5. Current interactions of Flexible Connections (ANM) and wider markets	11
5.1 DSO Flexibility Services	11
5.2 ESO Balancing Services	11
5.3 The Capacity Market (CM)	12
6. Developments through ENA Open Networks Project 2020	13
6.1 Customer information and understanding curtailment risk	13
6.2 Alternatives to Curtailment	13
6.3 Procurement	13
6.4 Wider Markets and Other Reforms	14
6.4.1 ESO - DSO Conflict Management and Co-optimisation	14
6.4.2 Interactions with Ofgem's Network Access and Forward Looking Charges Significant Code Review	14
7. Future Considerations	15
7.1 Future considerations: Flexible Connections (ANM)	15
7.1.1 Changes to curtailment value and forecasting (Timeframe – Pilot ED1 / Rollout ED2)	15
7.1.2 Deterministic Curtailment Rules (Timeframe – Pilot ED1 / Rollout ED2)	15
7.1.3 Curtailment Value (Timeframe ED1)	16
7.1.4 Connection Curtailment Uncertainty (Timeframe - ED2)	16
7.2 Future considerations: Flexibility Services	17
7.2.1 Future overlaps in flexibility provision Timeframe ED1	17
7.2.2 Network Operational Efficiency (Timeframe – ED2)	17
7.2.3 Regulatory Changes: Network Access (Timeframe ED2)	17
8. Next Steps	18
8.1 Questions for Stakeholders	18

1. Introduction

This paper considers the interaction between distribution Flexible Connections (enabled with Active Network Management (ANM) technology) and Flexibility Services. It sets out the historical context; describing the two resources and the system need(s) they address, including their characteristics and the current levels of interaction.

It also considers how the connections and services may need to evolve in the future and in particular, how more interaction could be facilitated in the short and medium term (within RIIO-ED1) and into the future (RIIO-ED2).

1.1 Context

Traditionally, distribution networks were predominantly passive with electricity, generated by transmission connected plant, flowing in one direction from the transmission system to customers connected to the lower voltage distribution networks. However, with the growth of embedded generation at all voltage levels, and new smart technologies, power flows are increasingly bi-directional both within the distribution networks and at the Transmission - Distribution (T-D) Boundary. Distribution Network Operators (DNOs) are now required to actively manage these flows to maintain safe and secure supplies of electricity economically and efficiently.

Connecting to distribution networks under the current regulatory “shallow-ish” access rules may be uneconomically viable as the generator connecting to an export-constrained network can incur reinforcement costs above the point of connection and the cost of transmission works, if triggered by their asset. Finding solutions that provided faster, more cost effective access to the distribution networks without reinforcement has been a major focus for DNOs. Accommodating the growth and management of distribution connected flexible assets is a prerequisite for the GB transition to a net zero carbon future.

All DNOs now offer Flexible Connection options; these can provide faster, cheaper access arrangements for customers that allow their export or import to be managed (often through real-time, automated DNO controls) based upon contracted and agreed principles of availability of capacity. Two (non-Intertrip) examples of flexible connections are “Timed Connections” and “Flexible Connections (ANM)” where the latter is enabled through Active Network Management (ANM) schemes.

This document is concerned primarily with Flexible Connections (ANM) and their interaction with assets providing Flexibility Services.

1.1.1 Flexible Connections (ANM enabled)

Investment in network capacity is driven largely by peak usage but where the outputs from customers’ assets are variable, the overall network requirements can be less (because the customers are unlikely to be all exporting or importing at their peak simultaneously). If the variability of these assets can be optimised or managed flexibly this provides the DNOs with an opportunity to leverage more of the existing network capacity, deferring the need for reinforcement. It is well understood for conventional demand using passive design techniques, but new low carbon technologies are typically more variable and have a greater potential for coincident operation. This is the core principle underpinning Active Network Management (ANM): its use can speed up connections and materially reduce connection costs, primarily for the benefit of those customers who are able to operate flexibly.

ANM may be implemented when a traditionally passive network has no further capacity to accommodate the unconstrained import or export from a proposed new or modified connection. It is not retrospectively imposed on existing connections and more information on the best practice approach can be found in the [ENA Active Network Management Good Practice Guide](#).

Customers under ANM measures voluntarily opt into arrangements where their access to the distribution network can be constrained at times of peak power flows, in return for faster connections at a reduced capital cost. To inform this decision, customers are provided with information on the potential curtailment. The process, timing and type of data provision varies to some degree by DNO and more detailed information is set out in the ENA Paper [DNO Provision of Constraint Information](#) Annex A also provides an abstract of the key differences at the time of being made a connection offer.

Currently there are two approaches for determining curtailment of Flexible Connections, to manage congestion on the distribution system, both are deterministic and rules based:

- Last In First Off (LIFO) where generators are curtailed in reverse order of connection applications. In this way generators are insulated against greater curtailment caused by the connection of later generation; or
- Pro-rata where curtailment is shared equally across all generators in the impacted AMN zone, exporting in the moment of the constraint.

The risk of curtailment lies entirely with the customer throughout the lifetime of the connection agreement, albeit the volume and / or frequency is often limited to a defined window and / or number of actions. The DNO has sole control over any curtailment using the ANM system which has integral failsafe modes to eliminate any technical or regulatory risk to the DNO of associated unsafe network operation.

The technology behind ANM can also be used for demand constraints, and although there are some instances of it being deployed, the vast majority of current ANM connections are to facilitate the connection of distributed generation and energy storage on already congested networks.

The earliest ANM schemes in GB were implemented as part of innovation projects, but as the technology has matured, all DNOs have integrated such approaches into their Business as Usual practices. Whilst the DNOs are at different stages of roll out it is evident that Flexible Connections (ANM) have been very successful in enabling faster, cheaper connections and work is under way to harmonise best practice across all the DNOs. Further information can be found in the [ENA Curtailment Process and ANM Reliability Good Practice Guide](#).

1.1.2 Flexibility Services

The growth in flexible resources, typically distributed generation, storage or demand response assets that operate flexibly, have also provided the local networks with additional tools to actively manage constraints in the networks.

Historically, where a DNO faced a network constraint, it had to undertake network reinforcement to relieve that constraint, passing these costs back to connected or connecting customers. However, with increasing volumes of flexible demand and generation connected to its networks, the DNO has more alternatives; albeit regulatory incentives dictate that the DNO takes the most economic option. As described above, where constraints are due to the connection of new generation, ANM schemes are currently the preferred mechanism for

maximising use of existing network capacity and avoiding the need for network reinforcement. However, as ANM only increases utilisation and does not create additional capacity, it is not well suited in solving constraints arising from general load growth. In this instance, procuring flexibility from customers behind constraints can be a cost-effective alternative method to relieve constraints and ultimately minimise costs to consumers. For relieving demand constraints by procurement of flexibility services, we mean that the DNO is paying for the service. Flexibility Service Providers (FSPs) have to date been typically generation assets which can provide generation turn up, Demand Side Response (DSR) portfolios which can provide demand turn down, or storage assets which can provide both. Flexibility Services may be dispatched in real-time or scheduled against anticipated time periods when constraints would otherwise occur.

Currently, the DNOs procure four Flexibility Service products for active power through market tenders. Whilst at high-level the products procured deliver the same output, currently there are some differences in the approach taken to dispatching these Flexibility Services, as illustrated in Table 1 below. The ability to offer Flexibility Services does not alter any connection agreements and does not change the network access available to the participant. As these are optional commercial services, the participant is only bound by contractual terms and not by any automated equipment controlling flows at the DNO/customer interface.

In addition, as part of the DNOs' commitment to growing Flexibility Services they have all committed to providing a fair and clear approach to the dispatch of Flexibility Services to meet the system needs by setting out the terms and the methodology adopted. This includes transparency on the decision making and criteria underpinning the dispatch of services. Commonality around dispatch is being considered as part of the wider Open Networks WS1A programme.

Table 1: Summary of DNO Flexibility Services procured

DNO Requirement	Payment and Dispatch Structure	
Sustain	To manage an ongoing requirement to reduce peak demand	Typically, dispatch is scheduled well in advance for a fixed fee
Secure	To manage peak demand on the network, usually weekday evenings	Predominantly paid based on utilisation, but with some use of availability payments also. Timing of dispatch varies by DNO (e.g. WPD dispatch one week ahead while UKPN dispatch in real-time)
Dynamic	To support the network during fault conditions, often during maintenance work	Typically dispatched at short notice with low availability payments and high utilisation payments
Restore	To support the network during faults that occur as a result of equipment failure	Typically dispatched at short notice with low availability payments and high utilisation payments

1.2 Key Characteristics of Flexible Connections and Flexibility Services

The key differences between a Flexible Connection (ANM) and a Flexibility Service are the procurement mechanisms and dispatch controls.

- **Flexible Connections (ANM)** are connection options where, in return for a faster cheaper connection, the participant accepts a contractual, mandated requirement for their usual power flows to be changed by the **DNO** remotely, in real-time, through automation. The amount of change, or curtailment, varies as per the connection agreement.
- The **Flexibility Service** is a commercial mechanism which requires participants to deliver a change in their usual power flows in real-time or at times requested by the **DSO**. It is a market-led initiative that, through procurement exercises, finds customers' assets located within constrained networks that are able to deliver flexibility to help manage constraints. Customers can choose not to respond to the dispatch signal (albeit with commercial consequences in some areas).

Table 2 below examines and compares a number of other important differences between the two flexible resources.

Although there is no linkage between the two, in the future, as the volume of flexible assets increases, the two resources may become more interactive and / or interchangeable. This is discussed more in Section 3.

Table 2: A Summary of the Key Differences Between Flexible Connections and Flexibility Services

	Flexible Connection	Flexibility Services
Nature of Participation	Curtailement is mandatory and uncompensated; as set out in the connection agreement .	Participation is voluntary and the flexibility services provided are rewarded as set out in the commercial contract .
Procurement Mechanism	Customer chooses to have specific, binding [curtailment] terms added to the connection agreement. Choice usually driven by the need to achieve a faster, cheaper connection.	Market led, commercial mechanism (e.g. tenders) requiring customers to deliver flexibility services defined and requested by the DSO. Flexibility Services provision forms a distinct commercial agreement.
Dispatch	Dispatch of curtailment is controlled end to end by DNO systems. Real-time, often automated, controls curtail the customer's output which results in the DNO having response certainty.	Services can be scheduled ahead of time or dispatched in real time. Dispatch can also be through intermediary platforms. The DNO is reliant on the Flexibility Service Provider responding to the dispatch signal. The DNO has less response certainty.
Connection Costs and Compensation	Reduces up front connection charges, however, no compensation for the customer's inability to export during a curtailment.	Connection agreement, and associated connection costs still required. Provider compensated for the provision of Flexibility Services.
Additional Equipment Requirements	Requires ANM control equipment physically on site to manage the connection remotely.	No inherent requirement for physical equipment for the provision of Flexibility Services.
Termination	The connection agreement creates an enduring requirement with binding connection terms (whilst the asset is connected).	Contracts can be terminated subject to the terms and conditions.
Network Access	Limits the customer's access to the distribution network.	Network access is not affected, but there may be commercial penalties for not following an agreed load profile.
Service Driver	Used where the customer is responsible for costs. The curtailment risk sits with the customer.	Used where the network is responsible for costs. The risk of customers not flexing their output sits with the DSO. Penalties for customer non-delivery may feature in future arrangements.
Interaction with other customers.	Curtailement is shared with other customers on the particular ANM scheme by a deterministic approach (Last in, first out; proportional). Operation of non-participating customers with existing connections unaffected.	Flexibility Services are open to any existing customer to participate. Contracts can be awarded to multiple parties; they are usually contracted for a set period of time.

2. Quantification

2.1 Flexible Connections (ANM) Coverage and Volumes

ANM has been used within the GB for well over a decade and the use of Flexible Connections (ANM) has grown and matured over this time. All DNOs have at least 100MW of connections managed via ANM, with some DNOs exceeding 1GW of export managed connections.

Further details of the specific coverage of the Flexibility Connection (ANM) schemes can be found on the individual DNO websites.

DNO	Active Network Management (ANM) Coverage
ENWL	https://www.enwl.co.uk/get-connected/apply-for-a-new-connection/flexible-connections/
NPg	www.northernpowergrid.com/get-connected
SPEN	https://www.spenergynetworks.co.uk/pages/arc_accelerating_renewable_connections.aspx
SSEN	www.ssen.co.uk/ConnectionsInformation/GenerationAndStorage/FlexibleConnections/FlexibleConnectionsOptions
UKPN	https://www.ukpowernetworks.co.uk/electricity/distribution-energy-resources/flexible-connections
WPD	www.westernpower.co.uk/anm-further-info

Most DNOs have committed to roll out full ANM across their licence areas by the end of ED1, so coverage is likely to increase. Many DNOs are also implementing wider-area network management systems with a centralised architecture, which allow power flows to be managed anywhere within the network. Volumes of Flexible Connections will increase, as coverage increases, and as more customers have the option to connect using a Flexible Connection via ANM systems.

Every 6 months, the ENA collates the amount of Flexible Connections enabled with ANM systems and to date DNOs have over 3GW of generation with Flexible Connections (ANM), see Table 3. Later this year, the ENA plans to improve information provision by including more detail, by DNO area, on the type of generation technologies utilising these schemes. In addition, the actual Flexible Connections (ANM) curtailment volumes (MWh) by DNO will also be provided.

In the future, the [System Wider Resource Register](#) (SWRR) ON2020 WS2 P1 will also enable further breakdowns once populated.

Table 3: DNO Flexible Connections (ANM)

DNO Flexible Connections (ANM)	Flexible Connections (MW)
Industry Total - End of 2018	2517.8
Industry Total - End of 2019	3169.6
Industry Total - Projections for 2019	2547.0

2.2 Flexibility Services Volumes

Worldwide, flexibility services are in an early stage adoption, but GB is making good progress in actively using them to avoid or defer conventional reinforcement where it is the most economic solution.

All DNOs have adopted the [Flexibility Commitment Market Principles](#) and have committed to test the market for Flexibility Service solutions ahead of undertaking conventional reinforcement for power flow related constraints during the current price control (RIIO-ED1). In addition, the DNOs are also working with Ofgem and other stakeholders to develop the forthcoming RIIO-ED2 price control framework to ensure the financial incentives that network companies receive are fully aligned with the greater use of Flexibility Services and do not favour the building of new infrastructure where these services are more efficient.

Through the ENA Open Networks project, significant steps towards standardisation of Flexibility Services have also been completed, with DNOs committed to offering common products via common contractual terms. More information on the coverage of each of the DNO Flexibility Services can be found in the [ENA "Flexibility in GB" page](#) and at the following DNO web pages:

DNO	Flexibility Coverage
ENWL	www.enwl.co.uk/zero-carbon/flexible-services
NPg	www.northernpowergrid.com/DSO
SPEN	www.spenergynetworks.co.uk/pages/flexibility.aspx
SSEN	www.ssen.co.uk/ConnectionsInformation/GenerationAndStorage/FlexibleConnections/CurrentCallsForFlexibility
UKPN	smartgrid.ukpowernetworks.co.uk/flexibility-hub
WPD	www.flexiblepower.co.uk

Whilst the market for Flexibility Services is fairly nascent, and volumes low compared to Flexible Connections (ANM), it is clear that the contracted volumes are beginning to ramp up. Volumes of contracted Flexibility Services are increasing as DNOs continue to procure more services to address network constraints. Typically, DNOs are undertaking procurement cycles every 6 to 12 months; Table 4 highlights current growth in flexibility contracts anticipated to end 2020.

Table 4 Flexibility Service Contracts by DNO

DNO Flexibility Tenders		Sustain (MW)	Secure (MW)	Dynamic (MW)	Restore (MW)	Reactive Power (MVar) (if applicable)
ENWL	End of 2018			0	3	
	End of 2019			0	3	
	Projections for 2020			11	2	
NPg	End of 2018				0	
	End of 2019				0	
	Projections for 2020				100	
SPEN	End of 2018	0	0	0	0	0
	End of 2019	0	0	0	0	0
	Projections for 2020	125	125	125	125	30
SSEN	End of 2018	0	0	0	0	0
	End of 2019	0	2	2	2	0
	Projections for 2020	20	150	150	150	30
UKPN	End of 2018		0.3			
	End of 2019		19.29			
	Projections for 2020	20	150			
WPD	End of 2018		23.5	33.8	58.5	
	End of 2019		7.3	115.8	123.1	
	Projections for 2020		47.52	286.05	333.57	
Industry Total - End of 2018		0.0	23.8	33.8	61.5	0.0
Industry Total - End of 2019		0.0	28.6	117.8	128.1	0.0
Projections for 2020		165.0	472.5	572.1	710.6	60.0

Area	Definition
4 Real Power Products	Flexibility that is able to be dispatched by a DNO as a result of procurement from a market and/or tender. Used to solve network constraints. This is typically compensated. End of year figures include all Flexibility that has been procured that year and that which is still live from previous years. This represents Flexibility that has been contracted, and does not include dispatch figures. Projections represent Flexibility required for the upcoming year and include live contracted Flexibility and additional system need (which will be tendered out)
Reactive Power	Reactive Power services procured for voltage control

3.0 System Needs

3.1 Operability currently offered by Flexible Connections (ANM)

Currently, Flexible Connections (ANM) are used, almost exclusively, to facilitate connection of additional generation in constrained network areas. Typically, this involves controlling renewables as these form the largest quantity of recently connected generation. Curtailment by the ANM systems is most likely to occur at times of high export and in particular, when coincident with low network demand exacerbating the constraint. The majority of limits being managed are thermal capacity related.

For example, export curtailment by ANM systems on PV dominated networks is likely to occur in the summer around midday; and for networks dominated by wind generation, the maximum curtailment is likely to be overnight in the summer, at times of high wind coincident with the periods of lowest demand.

Where the network is constrained at times of high generation export and low demand, generation curtailment is required from generators so network limits are not exceeded.

As discussed previously, the current principles of congestion management for flexible connections on the distribution system are rules based; either Last In First Off (LIFO) or Pro Rata. However, in practice, very little curtailment happens. ENA will be reporting on curtailment actions and volumes in the next round of the flexibility statistics update (due approx. August 2020).

3.2 Operability currently offered by Flexibility Services

All DNOs have committed to seek flexibility solutions ahead of undertaking power flow related reinforcement. Currently the overwhelming majority of flexibility schemes require a reduction in network power flows at times of peak demand, which for the GB electricity consumption profile, usually occurs in the Winter early-evenings. Historically, this has been the main driver for demand management (reduction).

To see a reduction in network loadings at times of peak demand, Flexibility Services deliver either an increase in generation export, or a reduction in demand import. This may be delivered by increasing generation production, export from energy storage or a reduction / shift in energy consumption via demand side response.

However, with the increase in renewable generation connections we are now experiencing issues with peaks in generation that require management at other time periods. E.g. excess overnight (wind) generation when demand is low and in the summer months ramping and excess solar PV issues. Both of these issues can be mitigated by reducing generation export and/or demand turn up products at distribution level to reduce the constraint.

4. Comparison of Current Flexible Connections (ANM) and Flexibility Services

Table 5 compares the magnitude, application and likely activation periods of Flexible Connections (ANM) and Flexibility Services to illustrate their current usage and differences. Going forward Flexibility Services could also be used to also provide export turn down and import turn up; which means its utilisation periods could be extended further to help manage periods with high renewable output and / or low demand. Similarly, Flexible Connection trials are also looking at demand turn down (EV Charging Station) to reduce connection charges. This is an illustration of how these two services may overlap with the type of service delivered through Flexible Connections (ANM) and is discussed in the next section. The following table is not exhaustive.

Table 5: Comparison of Current Uses for Flexible Connections (ANM) and Flexibility Services

	Flex Conn (ANM)	Flexibility Services
Used for Thermal Constraints	✓	✓
Used for Voltage Constraints	✓	✓
Used for Fault Level Constraints	×	× (1)
Controls Real Power	✓	✓
Controls Reactive Power	×	✓
Export turn down	✓	×
Export turn up	×	✓
Import turn down	×	✓
Import turn up	×	✓
Current Likely Utilisation Periods	Times of high renewable output and low demand	Times of high demand and low generation

(1) Not currently; being tested in a range of innovation trials

5. Current interactions of Flexible Connections (ANM) and wider markets

5.1 DSO Flexibility Services

Presently, the way that Flexible Connections (ANM) and Flexibility Services are managed – primarily as distinct DNO and DSO services, there is unlikely to be any conflict observed. Currently, ANM controlled generation is not turned down or curtailed to solve demand constraints and activating Flexibility Services such as demand turn down does not increase the level of ANM curtailment.

These differences mean there is no inherent reason why generation with Flexible Connections (ANM) cannot provide Flexibility Services to DNOs; similarly, there is no reason why generators with Flexible Connections (ANM) cannot be compensated for providing these services. The standard contract for flexibility being adopted through Open Networks has no exclusivity clauses preventing assets with Flexible Connections (ANM) from providing Flexibility Services.

As described in 1.1.1 and Annex A, both the DNOs and the customers have relevant information on the nature and likelihood of ANM curtailment windows overlapping with Flexibility Service windows to understand any potential conflict.

It is recognised that more can be done to standardise the information provision across the DNOs and improve the support to customers, to help them understand better the data and the nature of their curtailment risk. Section 6 discusses the developments being progressed with the ENA Open Networks Project to encourage customers to consider more interchangeable flexibility options.

5.2 ESO Balancing Services

There are two areas of potential interaction between Flexible Connections (ANM) and the provision of ESO balancing services;

1. The efficacy of ESO Balancing Services potentially offered by Distributed Energy Resources (DER) embedded within a distribution network with associated Flexible Connections (ANM) may be affected by the ANM operation. This is because the output of a balancing service provider could be negated by the automatic action of another customer within an ANM zone. This is not restricted to just generation managed by ANM systems, but it affects any asset providing ESO Balancing Services within areas of the distribution network containing ANM.

Greater co-ordination between ESO and DNO can remove such issues and this process has been described in ON2019 WS1A P5 paper [‘Conflict Management & Co-optimisation’](#). This document looks at the extra steps the ESO, DNOs and DSOs can undertake collaboratively to identify and manage service conflicts and optimisation.

2. Flexible Connections (ANM) with significant curtailment risk and / or curtailment risks in unsuitable windows may be unable to participate in system critical ESO balancing services (e.g. frequency response). This is due to a lack of certainty in response, potentially reducing liquidity in these markets.

The recent deployment of the Operational Downward Flexibility Management (ODFM) service has clearly highlighted the need for enhanced coordination between the ESO and DNOs and has provided an ideal test-bed opportunity to trial some of the latest Open Networks recommendations.

For the initial roll-out of ODFM, the ESO has worked with each respective DNO to identify all of the customers who had contracted to provide this service. Due to the criticality of the service, those parties connected to ANM schemes have initially been excluded from service provision. However, the ESO is now undertaking further work to assess the future transmission system needs (relating to ODFM as a negative reserve product), whilst in parallel determining practical improvements to the ODFM service which may lead to a relaxation of current non-ANM participation clauses. As part of this work, the ESO will be seeking to work with DNOs in order to trial the principles outlined in WS1A P5 'Conflict Management & Co-optimisation' to broaden participation in this service.

It is envisaged that the overall lessons learnt from the roll-out and refinement of the ODFM service could be applied to other ESO balancing services where providers are currently unable to participate due to connection to ANM schemes. Key to this work is the need for enhanced data sharing which may involve the need for further IT infrastructure between network organisations.

5.3 The Capacity Market (CM)

Customers with Flexible Connections (ANM) can bid into the Capacity Market although the risk of non-delivery (due to an ANM activation) rests with the customer.

Currently, the penalty for any CM provider (regardless of size, location or technology) that fails to deliver during a CM system stress event is a £/MWh rate that is 1/24th of the providers' annual income from the Capacity Market. The penalty is per settlement period that they did not deliver and the total penalty is capped at 100% of annual CM income.

When participating in the CM auction all providers take into account both the risk of a system stress event occurring when their assets are not available (e.g. unplanned outage), and the penalty to which they are exposed, as part of their bidding strategy.

6. Developments through ENA Open Networks Project 2020

A number of measures have been or are in the pipeline to be developed under the ENA Open Network project to ensure Flexible Connection (ANM) customers are also able to offer Flexibility Services.

6.1 Customer information and understanding curtailment risk

To ensure customers understand the nature of their curtailment risk, information on the nature of ANM schemes, how a particular Flexible Connection (ANM) is to be controlled and the associated constraint information is made available from the DNO; in line with the guidance contained in “The Provision of Constraint Information” (ON2018 WS2 P7).

This is a key enabler, as the procurer of flexibility or Balancing Services will require the flexibility provider to provide a warranty that their connection agreement (or any other restriction) does not prohibit provision of services within the relevant service windows. A “blanket ban” on Flexible Connections (ANM) for a particular service window is not generally required as the points where curtailment is likely/unlikely can be identified. To be able to engage effectively customers with Flexible Connections (ANM) will need to have confidence in the information provided and how to use it.

6.2 Alternatives to Curtailment

DNOs will work on methodologies and mechanisms to enable customers of Flexible Connections (ANM) to have more certainty to the capacity allocation against their connection provided through procurement of short-term flexibility. This may be at the request of the ANM customer, where they will cover the costs, or at the request of the network, where the DNO covers the cost. In some circumstances, there may be apportioned costs or curtailment requirements across both ANM customer and network to consider, particularly if flexibility requirements align with ANM curtailment requirements.

DNOs will also consider how flexibility procurement might be used as an option to provide firmness of capacity for Flexible Connection (ANM) customers across a longer-term period, for instance, across the remaining lifetime of the connection. This could be through the DSO procuring the flexibility and / or the customer using a peer to peer trade in the same scheme to avoid a curtailment. The Market Facilitation (non-DSO Services) product (ON WS1A P6) is looking at non-DSO models for this – i.e. capacity trading or peer to peer flexibility markets which might allow an ANM connection to partially buy firmness for time periods. Understanding with stakeholders how existing and future ANM contracts could be amended / terminated would be an important part of this work.

In addition, there may be some potential regulatory issues to consider. E.g. if DNOs procure flexibility to provide additional firmness to a customer with a non-firm connection, how are the costs recovered from the customer and cross subsidies avoided? This is discussed in 7.3.2

Areas of future improvement will be considered for the 2021 work programme within Open Networks.

6.3 Procurement

Flexibility Services will be procured in line with recommendations of [DSO Services Procurement Processes](#) (ON2019 WS1A P2) and the development of the ENA Common Evaluation Methodology (CEM) tool, for delivery December 2020, will provide transparency on how DSO decisions are made to choose the most suitable solution to meet network needs.

Distributed Energy Resources with non-firm connection arrangements will be assessed to understand the probability of curtailment during the service window.

As Flexible Connection (ANM) customers and Flexibility Services become wider in coverage and the likelihood of overlap increases, there needs to be equal opportunities afforded to Flexible Connections (ANM) customers so that they have the option to commercially secure their capacity via third parties. Market facilitation through non-DSO Services, such as peer to peer trading could be an avenue towards enabling this. This is being considered in WS1A P6.

6.4 Wider Markets and Other Reforms

6.4.1 ESO - DSO Conflict Management and Co-optimisation

Processes for identifying potential conflict of services and accompanying mitigations for resolving the conflict have been developed under ON2019 WS1A P5 Conflict Management & Co-optimisation. The ESO, DNOs and DSOs should continue learning from many of the other ENA Open Network initiatives and trials, collaborating with each other, and stakeholders, to identify and implement further service improvements.

6.4.2 Interactions with Ofgem's Network Access and Forward Looking Charges Significant Code Review

Ofgem's Significant Code Review (SCR) will impact how Flexible Connections (ANM) interact with the system and how they are charged. The outcomes of this review will also affect the distribution of charges between customers and the interaction between costs and network access. Some of the issues raised within this paper could be nullified or exacerbated, depending on the changes made within the minded to position of the SCR, particularly with respect to access arrangements.

The ENA Open Networks Project is working with Ofgem to agree which access options should be included in the Flexibility Services (ONP WS1A) programme of work and in particular how the ENA Common Evaluation Methodology (CEM) tool can be used to understand the interaction between ANM and Flexibility Services under the various access options shortlisted.

The ENA, working with Baringa Partners, has developed a Common Evaluation Methodology (CEM) for network investment decisions, to be used by all DNOs from April 2021 for the remainder of RIIO ED1 and beyond. This work is being progressed within the Open Networks Project under Workstream 1A (Flexibility Services) and this is an integral part of this pre-procurement decision-making process. The DNOs will use the CEM tool to decide which intervention to procure to mitigate a reinforcement need, whether that be a Flexibility Service, an asset reinforcement or an alternative innovative solution. The objective is to align approaches across the DNOs and create greater transparency.

7. Future Considerations

Longer term goals - potential improvements with evolution of the system, services and regulation.

The Flexible Connections (ANM) and Flexibility Services products have evolved with different drivers, both delivering benefits to the end consumer. However, as the energy system evolves further and the volumes increase they may begin to overlap and interact with each other. In addition, Ofgem's Access and Forward-Looking Charges (SCR) may also have a fundamental impact on these arrangements and how they are used in the future.

Whilst it is clear that we require both Flexibility Connections (ANM) and Flexibility Services today, there are a number of future considerations, identified below, that will require further examination. This list is not exhaustive; and the overviews are simplistic. All require additional work to determine whether they have merit in further development.

We also note that some of the suggestions with merit could be considered and **implemented (or piloted) within ED1** timeframes whilst others would be better suited to **implementation in ED2** when there is further clarity on the Ofgem Access and Future Looking Charges (SCR) work. Ofgem have shortlisted their options and the final decision is expected in November 2020 for implementation 2023 (start of RII02)

7.1 Future considerations: Flexible Connections (ANM)

7.1.1 Changes to curtailment value and forecasting (Timeframe – Pilot ED1 / Rollout ED2)

While the Flexible Connection (ANM) contracts (and degree of curtailment risk) is often fixed at the point of connection, the value parties place on network access can vary over time, so without a way of allocating this more dynamically, the potential benefits to customers may be reduced.

As the DNO network evolves, and constraints change over time, the curtailment windows determined at connection may need revisions. In addition, as the ESO moves towards procuring flexibility services closer to real-time, more dynamic curtailment information may be required. E.g. for flexibility services procured a week/day ahead, a weekly/daily curtailment forecast could release more flexibility from customers with Flexible Connections (ANM).

Delivering more dynamic, closer to real-time curtailment information for individual DER will require the accurate forecasting and correlation of several data sources e.g. the local and wider system constraint requirements, weather information and actual flows.

7.1.2 Deterministic Curtailment Rules (Timeframe – Pilot ED1 / Rollout ED2)

As the DNO is not associated with the commercial costs of customer curtailment, the allocation of curtailment risk on customers under Flexible Connections (ANM) may be inefficient, particularly if these parties are not best placed to manage the risk.

The current principles of constraint management for flexible connections on the distribution system are deterministic and rules based: Last In First Off (LIFO) or a Pro Rata scheme. This approach provides commercial certainty and simplicity but does mean that generators are not curtailed in any technical or economically efficient order. These simple approaches do not readily convert to a market or price-based approach to curtailment, i.e. where customers

signal their willingness to be curtailed, and each customer's sensitivity to the constraint could be factored in. Potentially this would be a more economically efficient solution and could result in more projects connecting and rewarding those assets that can be operated flexibly, but would require significant developments in real-time data and forecasting systems. Customers would also have to be ready to participate in the complex markets or have a third party manage this complexity for them.

7.1.3 Curtailment Value (Timeframe ED1)

At transmission level the ESO has responsibility for assessing the cost benefit analysis of paying for constraints or to reinforce, both of which are funded through socialised charges.

Under the current regulatory access arrangements at distribution level, DNOs do not have the option to socialise all the charges. Instead they are required to recover reinforcement costs from those customers triggering the constraints: both curtailment risk and costs remain with connecting customers. This is a feature of the regulatory charging regime and access arrangements at distribution level.

The allocation of curtailment risk and associated costs to connecting customers may have a subsequent impact on the efficiency of network operation and/or investment when compared to the total costs and benefits conferred to all network customers. If the future value of curtailed energy for connecting customers exceeds the cost of the relevant network reinforcement, then there is a case for the investment to be made. However, because the DNO is bound by the current charging boundary rules, currently it has no exposure to curtailment costs, and customers may not be aware of the potential value, there is no clear mechanism to signal or trigger network reinforcement and thus alleviate constraints, when economically efficient to do so.

The level of curtailment for a Flexible Connection (ANM) is uncapped and may be significant; although the DNO will provide the generator with an expectation (but not a guarantee) of likely curtailment levels. The curtailment can be a significant proportion of the customer's revenue (~5% curtailment) and this translates ultimately into lost revenue and / or additional financing costs due to the uncertainty.

The Common Evaluation Method (CEM) being developed under ON2020 WS1A P1 has created a tool for assessing the wider system cost benefit analysis when considering ANM versus conventional reinforcement versus Flexibility Services. We plan to use this tool to test Ofgem's shortlisted SCR access options and understand better the interaction between ANM and Flexibility Services.

Ofgem should give consideration to allowing DNOs to recover costs through BSUoS for economic network investment or intervention through Flexibility Services where it can be demonstrated to be economic.

7.1.4 Connection Curtailment Uncertainty (Timeframe - ED2)

It is recognised that non-build solutions are not always a substitute for reinforcement – all solutions need to be compared using a balanced cost benefit analysis. If too many non-build solutions are allowed to connect, or the connecting customers did not have enough information or certainty on the potential curtailments to make an informed decision, this could make their investment case harder, pushing up costs to industry and ultimately consumers. The Common Evaluation Method (CEM) in 7.1.3 can also be used to explore this issue, however, this too requires clarity on the Access and FLC SCR

7.2 Future considerations: Flexibility Services

7.2.1 Future overlaps in flexibility provision Timeframe ED1

With the growth in flexible distributed energy resources (DER) there may be Flexibility Services on the distribution network that could also deliver generation turn down or demand turn up, to manage the generation peaks, and reduce the need to curtail the Flexible Connection (ANM) assets, but careful consideration of where costs are allocated is required. At this point the Flexibility Services can overlap with Flexible Connection schemes and the ANM services and could be mutually beneficial to both types of customers. The DNOs on the other hand have to manage the transference of risk from the ANM “failsafe” system to a “less firm” flexibility provider.

7.2.2 Network Operational Efficiency (Timeframe – ED2)

The current Flexible Connection (ANM) schemes for distributed generation do not provide a signal to demand customers (or storage) to incentivise changes in their demand profiles to reduce curtailment of generation; again, this is due to the current regulatory access arrangements. The correct signals could have the potential to reduce the overall curtailment of generation and therefore increase the utilisation of the network and drive greater efficiency. As the amount of capacity connected under Flexible Connections grows this issue becomes more material.

7.2.3 Regulatory Changes: Network Access (Timeframe ED2)

Charging and access arrangements are currently a major regulatory barrier to accelerating the growth in Flexibility Services. The current “Shallow-ish” access principles for distribution network connections means customers are required to pay upfront cost for connections. Costs can be uneconomic due primarily to the regulatory charging and access methodology, resulting in capacity not being taken forward even though there is demand for it. This is driving the new customers to opt for a Flexible Connection (ANM), and accept the curtailment risk, or withdraw the project.

These Flexible Connection (ANM) schemes successfully mitigate the high connection costs for the connecting customer, in return for automated curtailment without compensation. As a result, currently there is no incentive for the DNO to use and pay for Flexibility Services, in place of curtailing a customer with a Flexible Connection (ANM) “for free”.

Ofgem’s Forward-Looking Charges and Access SCR is looking at a number of significant changes, including both a change to the connection boundary i.e. a “Shallow” access arrangement and allowing payment for connection costs to be recovered over time. These proposals could result in more affordable connection costs against individual customers and less need for Flexible Connections (ANM), as more of the reinforcement cost will fall into the DNO TOTEX allowance, and hence be socialised with bill payers.

In addition, introduction of a market-based approach to the curtailment activity could reduce the overall curtailment risk for the Flexible Connections (ANM). With all flexible assets (whether it be as a Flexible Connection or as a Flexibility Service) competing to provide the curtailment volume, liquidity (and competition) in flexibility markets should also improve.

This is a very simplistic overview; there are potential unintended consequences and these would need to be worked through. Although Ofgem have shortlisted their options for the SCR, the final decision is expected in November 2020 and implementation would be in ED2 timeframes.

8. Next Steps

Flexibility in electricity will enable the UK to electrify heat and transport, using clean sources of power, to facilitate a net zero future. As the whole energy smart flexible system evolves large volumes of flexible resources will be required and customers with Flexible Connections (ANM) and Flexibility Services will co-exist far more. It is important that how they interact is investigated now and subsequent rules agreed to ensure the transition is timely and affordable.

In terms of next steps, Ofgem needs to conclude the review of Future Looking Charges and Access SCR and provide clarity on the future charging and access arrangements. In parallel, the ENA and stakeholders need to progress the activity within the ENA Open Networks Project as highlighted in this document. Tables 6 and 7 summarises the activity.

Stakeholder engagement will be key to identifying the priorities for change and we will also be canvassing views within the Flexibility Consultation with these questions:

8.1 Questions for Stakeholders

- 1 Under the current arrangements do you receive sufficient information, in the right format, and at the right time to be able to manage your curtailment risk effectively?
- 2 Are there barriers preventing customers with assets with Flexible Connections (ANM) providing Flexibility Services to the ESO or DSO today?
- 3 How could DNOs better enable customers with Flexible Connections (ANM) to use Flexibility Services to mitigate the current and future curtailment?

Table 6: Current ENA Open Networks Project Activity

	Activity	Owner	Sources of Information	ONP Product Publish Date	Flexibility Commitment
A1	Procurement of Flexibility Services to be aligned. DNOs to sign up to the recommendations in DSO Services Procurement Processes	DNOs	DSO Services Procurement Processes (ON2019 WS1A P2)	Nov 2020	1 2 3 5
A2	Details and coverage of Flexible Connections (ANM) schemes by DNO	DNOs	DNO websites	BAU Process	2 3 5
A3	Collation of GB information on Flexibility Connections (ANM) and Flexibility Services. Further improvements to be delivered via the System Wider Resource Register (SWRR)	ENA	ENA Website (6 monthly updates). Improvements planned for Q3 2020 System Wider Resource Register ON2020 WS2 P1	BAU process Dec 2020	2 3 5
A4	DNOs committed to offer common products via common contractual terms	ENA and DNOs	DNO Flex Commitment	BAU process	1 2 3 5

	Activity	Owner	Sources of Information	ONP Product Publish Date	Flexibility Commitment
A5	Increasing products for Flexibility Services, in particular using Flexibility Services for export turn up / down	ESO and DNOs	Various constraint management pilots	2020/21	1 2 3
A6	Greater coordination between ESO and DSOs	ENA ONP	Conflict Management and co-optimisation (ON2019 WS1A P5)	July 2020	1 2 3 6
A7	Lessons learned from ODSM summer 2020; revisions to the service being developed to expand opportunities to Flexible Connections (ANM) schemes	ESO with DNOs	Revisions testing the principles within Conflict Management and Co-optimisation Product (ON2019 WS1A P5)		1 2 3 6
A8	<p>Improve certainty of constraint data and curtailment windows.</p> <p>Improve customer information and understanding of curtailment risks:</p> <ul style="list-style-type: none"> - Provision of constraint information and how Flexible Connections are controlled - Customers confident of the information and how to use it 	ENA ONP / DNOs	<p>DNO Provision of Constraint Information (ON2018 WS2 P7)</p> <p>ANM Best Practice Guide published</p>	<p>Dec 2018</p> <p>July 2015</p>	1 2 3
A9	<p>Consider how Flexibility Services could be used to provide more firmness to non-firm Flexible Connections (ANM) connections. Include peer to peer trading / DSO flex procurement and short and long term flexibility provision solutions.</p> <p>Requires Ofgem to address charging barriers</p>	ENA-ONP / Ofgem	<p>The Market Facilitation - non-DSO Services (ONWS1A P6)</p> <p>CEM Cost Benefit Analysis Tool</p>	<p>Dec 2020</p> <p>Dec 2020</p>	1 2 3 4
A10	Equal opportunities for Flexible Connections (ANM) and Flexibility Services to compete in the provision of flexibility.	ENA ONP / Ofgem	The Market Facilitation - non-DSO Services (ONWS1A P6)	Dec 2020	1 2 3 4
A11	Fundamental to future arrangements is Ofgem's determination on the key principles for Forward-Looking Charges and Access SCR. ENA to facilitate by testing Ofgem's shortlist of access options in the SEM to be tested in tool.	Ofgem	Ofgem Forward-Looking Charges and Access SCR decision	Nov 2020	1 2 3 4 6

Table 7: Future Activity for Consideration

	Activity	Owner	Area	Doc Ref	Time frame	Flexibility Commitment
B1	Provision of more dynamic/frequent curtailment information: 1) changes in value over time; 2) changes to the curtailment windows over time.	ENA ONP	Curtailment Value and Forecasting	7.1.1	ED1	2 3
B2	Provision of curtailment information closer to real-time to release more flexibility from assets on Flexible Connections (ANM)	ENA ONP	Curtailment Value and Forecasting	7.1.1	ED1 (pilot) ED2 (roll-out)	1 2 3
B3	Review options to mitigate deterministic curtailment rules	ENA ONP	Deterministic Curtailment Rules	7.1.2	ED1 (pilot) ED2 (roll-out)	2 3 4
B4	<p>Improve DNO exposure to curtailment value. Consider using CEM tool to test Ofgem SCR Access options.</p> <p>Ofgem to consider allowing DNOs to recover costs through BSUs for economic interventions using Flexibility Services in place of reinforcement</p>	ENA ONP (WS3) and Ofgem	Curtailment Value and Forecasting Ofgem SCR (FLC and Access)	7.1.3	ED1	2 3 4
B5	Reduce connection curtailment uncertainty and increase transparency for customers through the use of the CEM tool to achieve the right cost benefit balance between reinforcement, Flexible Connections and Flexibility Services. Requires clarity on Ofgem's FLC and Access SCR	ENA ONP (WS3) and Ofgem	Connection Curtailment Uncertainty	7.1.4	ED2	2 3 4
B6	Investigate future overlaps in flexibility provision. E.g. ability for Flexibility Services to replace / mitigate need for Flexible Connection (ANM) curtailments	ENA ONP (WS1A)	Future Overlaps in Flexibility Provision	7.2.1	ED1	2 3
B7	The current ANM schemes do not provide signals/incentives for demand to change usage to avoid the need for generation curtailment. Solutions dependent on the Ofgem SCR FLC and Access SCR determination.	Ofgem	Network Operational Efficiency	7.2.2	ED2	1 2 3
B8	Determine the most efficient connection boundary for delivering net zero	Ofgem	Regulatory Changes to Network Access	7.3	ED2	1 6

Annex A - Curtailment Assessments an extract from [DNO Provision of Constraint Information](#) 18 Dec 2018

Network companies provide information to customers to better enable them to gain an appreciation of the likely curtailment their flexible connections will experience, and to assist investors in their assessment of the future revenues and risk profile of development opportunities. There are three main approaches to the provision of curtailment information:

- the DIY Assessment
- the DNO Curtailment Assessment
- the Curtailment Index

1.1 Approach No.1 (the DIY Assessment) - SSEN

Under this approach, SSEN provide their customers with relevant network data to enable them to carry out their own curtailment assessment. This data may include:

- Generation Table for location/BSP/GSP;
- Network Connection & Constraints for XXX GSP/BSP and location Generation;
- Demand Data for the location/BSP/GSP, Historic - 1 Year;
- Measurement Point (MP) Settings;
- Historic Outage Data for Constraints;
- ANM Contracted Generation, Last in / First off (LIFO) Stack Positions;
- Communications Availability Data (TSAT);
- Estimated G83 & sub 50kW Generation; and
- Long Term Development Statement (LTDS)

Other examples:

NPG, SPEN and WPD provide historical half-hourly network loading data upon request. SPEN and NPG explicitly withhold any information which they deem to be of a commercially sensitive nature (associated with existing or contracted customers). In addition, customers have access to the modelling data published in the network companies' respective Long-Term Development Statements.

Pros	Cons
Freedom to choose basis of curtailment assessment and who conducts it	Access to personnel with required skills or knowledge to carry out assessment
Customer in control of costs and timescales	Potential restrictions on release of some network data due to commercial confidentiality (e.g. data for existing connected customers)
	Volatility of information, i.e. may change depending upon new acceptances, disconnections, etc.

1.2 Approach No.2 (the DNO Curtailment Assessment) – SPEN, NPG, UKPN, WPD

Alternatively, the network companies may offer to provide a curtailment assessment report. This assessment will typically be developed utilising load flow models and between 1- 2 years' worth of historical loading data, coupled with a predicted output profile of the customer's proposed development, which may be supplied by the customer. The analysis report will present detail on the frequency and duration of events as well as overall MWh Curtailment.

Some sensitivity impacts may be required, including reductions in background demand, heavier than average generation profiles for entrants higher in the LIFO stack, increased failure rates, etc.

Explanation of terms:

“Curtailment assessment” is an estimate of the expected curtailment over time, expressed in terms of MWh or the fraction of expected un-curtailed output. Often, this is based on simulation of Active Network Management (ANM) operation across representative time-frames.

Pros	Cons
Site specific curtailment assessment	Customer has less opportunity to input into scope/detail of report
Studies can be based on a ‘complete’ non-redacted half-hour (HH) data set	Different approaches adopted by different network companies
Customer benefits directly from network company’s knowledge, skills and experience	

1.3 Approach No.3 (The Curtailment Index) - ENWL

A further approach, developed by ENWL, is provided specifically for flexible connections of capacity greater than 200kW. This approach provides a forecast of curtailment, which is based upon the voltage of connection. A Curtailment Index will be provided at the time of connection and will be incorporated into the customer’s connection agreement. This Curtailment Index provides a cap on curtailment. ENWL will review and develop solutions to address any circumstances in which actual curtailment in any cumulative 6-year period exceeds the agreed cap (the Curtailment Index). Regulatory investment criteria will be used to ensure the most efficient solution is taken forward. Under this service, customers will be provided with an annual statement of actual curtailment for the previous 12-month period.

Pros	Cons
Annual provision of ‘actual’ curtailment	Generic nature of curtailment forecast could produce unnecessarily pessimistic results for some customers (not site-specific).
Commitment of intervention where actual (6-year average) curtailment exceeds the Curtailment Index	

Customer Feedback

Customer feedback has reinforced many of the pros and cons identified with the three Approaches. Some customers supported the view that good practice for network companies was the provision of Approach 2, whilst others saw benefits in both Approaches 1 and 2. The following points were made in support of this:

- Smaller organisations being more likely to favour Approach 2; and
- Larger organisations more likely to favour Approach 1, noting they are more likely to have readily available access to resources capable of supporting the assessment evaluation.