Open Networks Project

WS1A P8

Apportioning FC(ANM) Curtailment Risk

July 2021 | Version 1

The voice of the networks

DOCUMENT CONTROL

Authorities

Version	Issue Date	Authorisation	Comments
1	30/07/2021	Open Networks Steering Group	

Related documents

Reference 1	
Reference 2	

Change history

Version	Change reference	Description

Distribution

Publicly published

TABLE OF CONTENTS

Introduction

About ENA

Energy Networks Association (ENA) represents the owners and operators of licenses for the transmission and/or distribution of energy in the UK and Ireland. Our members control and maintain the critical national infrastructure that delivers these vital services into customers' homes and businesses.

ENA's overriding goals are to promote UK and Ireland energy networks ensuring our networks are the safest, most reliable, most efficient and sustainable in the world. We influence decision-makers on issues that are important to our members. These include:

- Regulation and the wider representation in UK, Ireland and the rest of Europe
- Cost-efficient engineering services and related businesses for the benefit of members
- Safety, health and environment across the gas and electricity industries
- The development and deployment of smart technology
- Innovation strategy, reporting and collaboration in GB

As the voice of the energy networks sector, ENA acts as a strategic focus and channel of communication for the industry. We promote interests and good standing of the industry and provide a forum of discussion among company members.

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 project 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 Project 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 project 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.

2021 Open Networks Project 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

Cadent Your Gas Network | electricity north west Bringing energy to your door | ESB NETWORKS | gtc

nationalgrid | nationalgridESO | Northern Gas Networks | Northern Ireland Electricity Networks

NORTHERN POWERGRID | Scottish & Southern Electricity Networks | SGN Your gas. Our network. | SP ENERGY NETWORKS

UK Power Networks Delivering your electricity | WALES&WEST UTILITIES | WESTERN POWER DISTRIBUTION Serving the Midlands, South West and Wales

ENA associates

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

Background

Flexible Connections and Curtailment

With increasing applications to connect new (typically renewable) generation to distribution networks, conventional design studies were indicating insufficient capacities for new connections without significant, and costly, network reinforcement. With customers being exposed to the costs and delays associated with these reinforcements, many applications were being withdrawn.

In order to address this issue, and make more new connections possible, DNOs introduced Flexible Connections, controlled by Active Network Management (ANM) schemes. These Flexible Connections exploit the natural diversity and intermittency associated with renewable generation as well as the natural variation in network loadings, and allow new connections to be made with most of the additional power generated being accommodated in the “troughs” of the network load cycle. At times when the network load cycle is at a natural peak, ANM controlled generation may be curtailed in order to avoid overloads and therefore maintain network security and integrity.

In short, customers opting for Flexible Connections are able to connect without incurring lengthy delays and/or large reinforcement costs in return for occasionally reduced access to the network (i.e. curtailment).

Flexible Connection Contracts and Curtailment Risk

The contracts currently being employed by DNOs for customers with Flexible Connections typically give the DNO a potentially unlimited ability to curtail the customer’s load. In order to give the customer an indication of their actual curtailment risk, DNOs undertake studies involving a combination of historical network loading data and assumptions relating to parameters such as customer load profiles to produce a customer-specific curtailment assessment.

Currently, this curtailment risk is seen by many stakeholders to sit disproportionately with customers on Flexible Connection contracts, with those contracts providing no binding limits on the amount of curtailment that a DNO can impose.

To address these concerns, and to develop options for apportioning curtailment risks more evenly, a product group, P8 “Apportioning Curtailment Risk”, has been established as part of the ENA’s Open Networks Project Workstream 1A “Flexibility Services”.

Apportioning Curtailment Risk

High Level Outline

As part of this workstream product's deliverables, a matrix of risks relating to Flexible Connection (ANM) curtailment has been produced and approved by WS1A. The next task for the product group is to consider options for addressing these identified risks.

The matrix groups the identified risks into three broad categories:

1. Quality / Accuracy of Assessments / Forecast risks in the immediate / short term for customers
2. On-going relevance of assessments for customers
3. Operational Risks for Networks

Group 1 – Short Term Reliability of Assessments – Customer Risk

It is recognised that the key solution to managing these risks is to improve the quality of curtailment assessments provided to customers. DNOs are currently engaged in significant efforts to continue the roll-out of improved monitoring, modelling, and data acquisition systems and this area is further being addressed within the Open Networks Project in general and, more specifically, by WS1A P9 and WS1B P6.

An additional suggestion emerged from a recent stakeholder engagement exercise for a curtailment assessment / forecast incentive scheme. This suggestion was discussed at length at a recent meeting of the WS1A FC(ANM) group and while it was recognised that there was merit to it, it was considered inappropriate at this stage, largely owing to the known gaps in data and monitoring currently being addressed.

Group 3 – Operational Risks – Network Risk

These risks are largely covered by the ANM systems currently being employed by DNOs while issues relating to coordination with ESO are being addressed through other work, for example the recently completed NIA project (jointly undertaken by WPD and NGESO) "Optimal Coordination of Active Network Management Schemes and Balancing Services Market" which has explored in detail the options for avoiding situations where ESO-procured flexibility is nullified by ANM system actions. It was noted that management of operational risks ensures the security of the network and, as a consequence, security of supply for all customers.

Group 2 – On-Going Relevance of Curtailment Assessments – Customer Risk

Management of risks attributed to on-going, future changes in network loadings was seen as potentially the most difficult issue to address. While forecasts of future uptake of Low Carbon Technologies (LCTs) such as electric vehicles, heat pumps, solar PV, and battery storage by domestic as well as industrial consumers are available, there is a wide range of impacts, including increased curtailments, depending on the scenario being considered.

The group suggested, however, that such changes in the absence of Flexible Connections would be seen directly as increased loadings on network assets, triggering load-related reinforcement. Such loading changes in areas where flexible connections exist, however, may be masked by increased levels of curtailment, with ANM systems managing loads within existing asset capabilities. As a result, reinforcement would not be triggered, increasing the burden on ANM connected customers and deterring new connection applications as a result of excessive curtailment forecasts.

It should be noted here that network reinforcement can be achieved either with traditional asset-based solutions (e.g. replacement of transformers, overlaying cable circuits, re-conductoring overhead lines) or, where cost effective, with Flexibility Services (e.g. demand turn-up / turn-down). Where normal load-related reinforcement triggers are being masked by ANM curtailment, therefore, connected customers would be denied any opportunities to tender for flexibility service provision.

Broadly speaking, therefore, it was felt that, over time, increases in curtailment seen by customers on flexible connections should be considered as triggers for load-related reinforcement.

Proposal for a cap-and-collar approach

The rest of this paper focuses on Group 2 risks and how ongoing increases in curtailment could be used to provide a trigger for load related reinforcement (including flexibility services), limiting the curtailment risk for Flexible Connections controlled by ANM schemes.

Outline

While more work is needed to develop details, the group proposes the following general approach to the process:

As part of a customer's flexible connection offer, they would be provided with an assessment of their likely curtailment experience along with a cap representing the maximum level of curtailment they should be subject to. The level of the cap would incorporate an agreed amount of headroom on top of the assessed likely level of curtailment, which would allow for some degree of load growth over time.

While further work is needed in order to determine how curtailment should be measured (in terms of energy and/or time periods), the reaching of a curtailment cap by a customer should constitute a trigger for load-related reinforcement, noting again that such reinforcement should include the use of flexibility services where economically advantageous over "traditional" asset-based reinforcement.

Without the introduction of such a cap, there is a risk that necessary network reinforcement (DNO funded via socialised costs) would not be carried out, with customers on flexible connection contracts essentially bearing those costs in the form of energy curtailment.

One issue that then needs to be addressed is how to manage the time period between a cap-related triggering of reinforcement and placement of flexibility contracts (subject to availability) or completion of capital works.

With load-related reinforcement works being funded out of socialised costs, and with the beneficiaries of the works largely being those customers on flexible contracts, it could be argued that the cost burden for the reinforcement does not fall equitably. In order to address this, one suggested solution would be to spread the increased curtailment burden among all the affected flexibly connected customers, on the impacted ANM scheme, by making use of a curtailment collar.

Again, further work is needed to provide a detailed method, but the principal would be to allow ANM systems, in particular those operating with LIFO (last-in-first-out) stacks, to temporarily change the stack order so that customers with low curtailment levels, below a collar value, would be curtailed first - the collar value representing a minimum level of curtailment that a customer should expect. This minimum level would be set below the assessed, expected level of curtailment. Such curtailment instructions outside the standard LIFO arrangement would be limited to the period of time starting with a customer in the LIFO stack breaching their curtailment cap (triggering load related reinforcement) and ending either when the reinforcement is completed or when customers' collar levels of curtailment have been reached, whichever occurs soonest.

A step-by-step illustration of the cap-and-collar principle is presented below, while a high level impact assessment is presented at Appendix A.

Illustration of the Proposal

Using a hypothetical ANM LIFO stack of 5 generation customers, with customer A being the "last in", and therefore "first off", and customer E as the "first in". Assuming that all 5 customers are subject to the same network constraint (e.g. SGT reverse-power flow) and that all customers have 100% sensitivity to the constraint (i.e. a reduction of 1MW of output at the customer's point of connection results in a 1MW reduction in power flow at the point of constraint), the levels of constraint experienced by each customer might be as illustrated below in Figure 1:

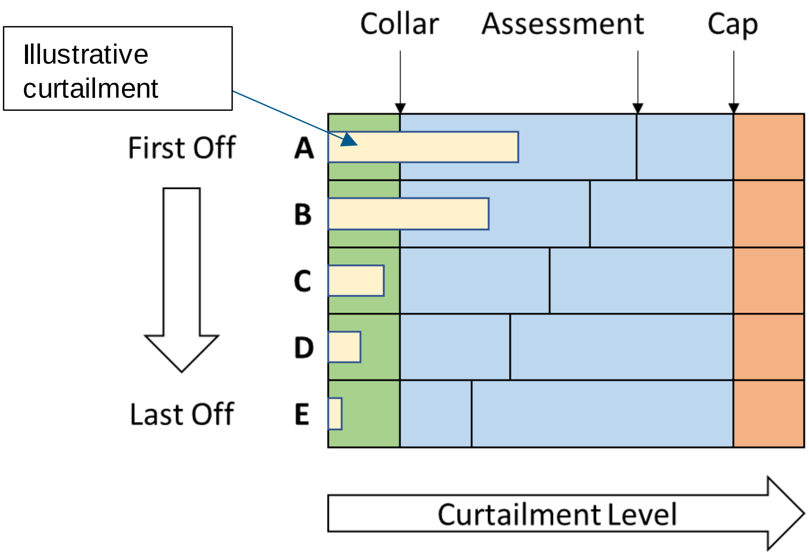

Figure 1 – Example LIFO Stack Curtailment Experience Shortly After Connection

In this example, the last-in customers A and B experience the majority of the curtailment required to manage the constraint, but all 5 customers' curtailment levels (the white bar) are well below the DNO assessment provided at the time of the connection offer.

Over time, a combination of energy efficiency measures, micro-generation installation (e.g. domestic rooftop solar), or other scenarios resulting in a decrease in overall net demand at the constraining GSP, results in the curtailment experienced rising – predominantly affecting customers **A** and **B** due to more frequent "low level" curtailment events. With higher-level events not seeing any increase, customers **D** and **E** would be largely unaffected, with customer **A** now experiencing curtailment levels slightly above the DNO assessment as illustrated in Figure 2:

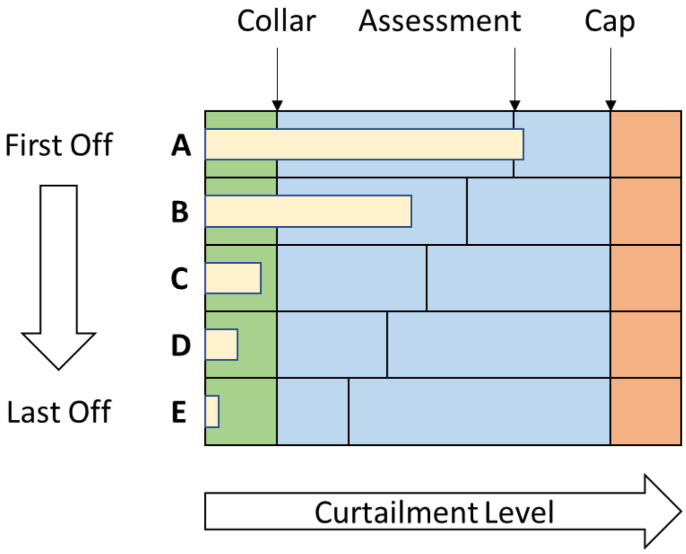

Figure 2 – Example LIFO Stack Curtailment Experience after Some Background Changes

If the background load changes continue, such as to further increase low level curtailment events, customers **A** and **B** would continue to see curtailment levels increase, with customer **A** eventually reaching their cap value (Figure 3):

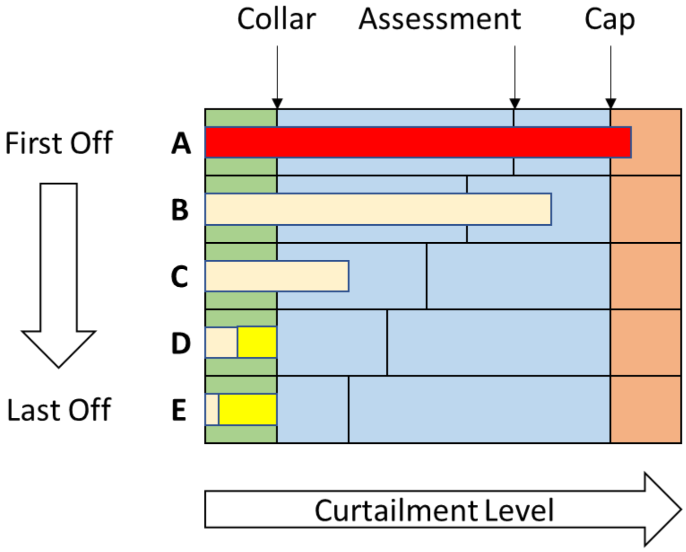

Figure 3 – Example LIFO Stack Curtailment Experience after Further Background Changes

With a cap in place as proposed, the curtailment experienced by customer **A** would then trigger load-related reinforcement, including the procurement of flexibility services. With customer **A** now experiencing curtailment levels above the cap level, and reinforcement scheduled, the ANM system would be able to bypass the normal LIFO process and make use of unused collar values (highlighted yellow in Figure 3) associated with customers

D and **E** (customers A, B and C in this example have all experienced curtailment above their collar values), effectively moving customer **D** to the "first off" position in the queue, followed by customer **E**, then back to customer **A**. When customer **D** then experiences curtailment above the collar level, customer **E** then becomes the "first off" customer. Once customer **E**'s collar has been fully utilised, the LIFO queue reverts to customer **A** as the "first off". This LIFO bypass is a temporary arrangement whilst the reinforcement is built / flexibility services procured.

Quantifying Curtailment

In order to determine cap and collar values of curtailment, a suitable measure needs to be agreed upon. While the most accurate measure would involve determine the amount of energy curtailed, deriving this quantity would need extensive modelling and "hindcasting" and would be open to variations in interpretation of, for example, weather data in the case of renewable generation sites. A simpler method would be to measure curtailment on a time basis – a cumulative period of time during which a customer experienced a curtailment instruction / signal, and this is the method that is proposed here.

At the time of writing, the OFGEM minded-to position on its Access and Forward Looking Charges Significant Code Review (Access SCR) makes the same proposal.

Key issues identified for further consideration:

1. The method by which appropriate values for caps and collars are derived will need careful consideration, including whether values should be universal across all LIFO customers or individually assigned.
2. Customers will have both upper and lower bounds of curtailment to allow for more robust risk assessment; this will result in some customers, higher in the LIFO stack, experiencing a small amount of curtailment which, although well below the level set out in the original FC(ANM) contract, maybe greater than what has been experienced to date.
3. The method initially retains a LIFO approach (where currently used) but by setting minimum curtailment levels is able to temporarily deviate when the network has become sufficiently congested to trigger reinforcement. The applicability of this new approach to established constrained zones, and existing customers, would need careful consideration.
4. This approach could be simplified by the removal of the collar mechanism, leaving just the cap.

Alternative Approaches

Instead of allowing for DNO funded reinforcement, an alternative approach would be to allow the development of a peer-to-peer flexibility market, so that curtailed generators could potentially procure a “demand turn up” service where, for example, a reverse power flow constraint exists. One advantage of this approach is that it does not involve any DNO funded (via socialised costs) activities but the main drawback to this approach would be that it does nothing to limit a flexibly connected customer’s exposure to the risk of increasing levels of network congestion and curtailment. Additionally, it provides no mechanism to fund expansion of networks where needed.

Another alternative approach might involve an incentive scheme similar to that used to manage Customer Interruptions and Minutes Lost (CI / CML). DNOs might, for example, have a licence-area wide target for curtailment of customers, with rewards for beating that target and penalties for missing.

Conclusion and Next Steps

At the initiation stage of this workstream product it was recognised that OFGEM’s Access SCR might have an impact on this work. OFGEM have recently published its minded-to decision proposing a change to distribution network connection boundaries – demand connections will no longer be exposed to network reinforcement costs, and generation connections will only be exposed to reinforcement costs associated with the same voltage level they connect at. This will reduce the demand for flexible connections associated with distribution network constraints except where they would allow a faster connection, the flexible contract being time-limited in order to allow DNO funded reinforcement works to be completed and the new connection treated as “firm”.

The proposals outlined above are therefore considered low regret with respect to the possible final outcome of the Access SCR, and the group proposes that work continues as planned, with the following key aims:

- Identify solutions / options to address the key issues identified
- Assess appropriateness for existing and new FC(ANM) customers
- Take the work to the Focus Group for a deep dive with stakeholders
- Complete a detailed Impact Assessment; with quantification where possible.
- Work with Ofgem to agree the Regulatory treatment of the proposal

Steering Group Approval

Does the Steering Group agree:

1. The solution remains a low regret option even with the Ofgem Minded to Decision
2. As a result, we should explore the detail with stakeholders
3. Spend time and resource on a fuller Impact Assessment and quantify the costs and benefits
4. Work with Ofgem to explore the Regulatory treatment of the solution

Appendix A: High Level Impact Assessment

Impact Assessment – Applying a Curtailment CAP and COLLAR	
Affected Party	**Impact**
• New LIFO Customer	• Cap: Customer receives a contractual upper bound for curtailment risk where previously this risk was unlimited. The cap will be of greatest material benefit to customers at the "last in" end of the LIFO queue. • Collar: Customer receives what is essentially a lower bound for curtailment risk, although this risk only becomes apparent when another LIFO queue participant reaches their curtailment cap. For "first in" customers, who should expect the lowest levels of curtailment, this collar may result in curtailment that might otherwise not have been experienced. For "last in" customers it is less likely that the collar would be used as these customers are more likely to have experienced significant curtailment up to their cap. Both experiences are [likely to be] within the curtailment forecasts / risks set out in the original FC(ANM) connection contract. However, in practice the "first in" customers may, to date, be accustomed to very little / no curtailment. • Increases in curtailment as a result of application of the collar will be temporary, with all affected customers benefitting from the associated reinforcement.
• DNO	• This approach to apportioning curtailment risk will result in greater reinforcement costs where curtailment levels see significant increases over time. • Better signals triggering more timely reinforcement and facilitating both load growth and new connections more effectively and efficiently with flexibility services and, where required, traditional asset reinforcement. • Additional costs to reconfigure ANM systems to accommodate more complex curtailment modelling
• Existing LIFO Customer	• In practice the "first in" customers may, to date, be accustomed to very little / no curtailment. Introducing a collar would increase the likelihood of a small amount of curtailment on a temporary basis (whilst reinforcement or flexibility services are procured). The curtailment would be well within the curtailment forecasts / risks set out in the original FC(ANM) connection contract.

	• For customers amending their connection agreements to accommodate the cap-and collar approach, the impacts will be very similar to those for new customers. Long standing "first in" customers would be the most exposed to increases in actual curtailment levels experienced, although these are still likely to be significantly below DNO assessments, and collar values, due to conservatism in the assessment approach. • Defined cap limiting curtailment risk • Reinforcement / flex services procurement triggered earlier reducing long term curtailment risk • Increases in curtailment as a result of application of the collar will be temporary, with all affected customers benefitting from the associated reinforcement

Energy Networks Association
4 More London Riverside
London SE1 2AU
t. +44 (0)20 7706 5100

w. energynetworks.org
@EnergyNetworks

The voice of the networks