transition
Moving to a smart future

Project Deliverable

Services in a Facilitated Market

Scottish & Southern Electricity Networks

Origami
POWER OVER ENERGY

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Executive Summary

The number and capacity of embedded generation projects continues to increase with over 13GW of PV capacity[1] and 7GW of wind capacity[2], which creates an increasing requirement to manage the network issues. To tackle these network issues, Distribution Network Operators (DNOs) have introduced Automated Network Management (ANM), which has successfully enabled a greater penetration of renewable generation at a lower overall cost through curtailment. To mitigate the risk of uncertainty of curtailment impacting the funding further growth of generation, DNOs are looking to access embedded flexibility to address the resulting constraint issues in place of reinforcement. All DNOs have committed to doing this for schemes over £1M[3] which includes SSEN Constraint Management Zones[4]. The first commercially viable contracts for flexibility outside of Innovation trials were announced by UK Power Networks in July 2019[5,6]. Despite the lack of commercial constraint services, the available flexibility from industrial and commercial sites by 2020 was estimated to be up to 9.8GW[7].

Reducing the barriers to entry, which provides easier access to the market and engaging with the owners and operators of embedded flexibility, will increase the level of participation in the provision of flexibility services. In June 2018, the GB Electricity System Operator (ESO) stated it had already achieved its 2020 target of procuring 50% of balancing services from demand response providers (set in June 2015).

Standardising the parameters used to define flexibility will make it easier for owners of that flexibility to consider making the flexibility available to deliver flexibility services, either directly or through a third party. This will increase the level of flexibility available to the market and should Increase the use of that flexibility. More flexibility from different sources could increase the number and type of flexibility services that can be delivered, reducing the effective cost for any individual flexibility service through more liquid markets and resulting in lower costs to consumers. A liquid market is particularly crucial in the delivery of DSO flexibility services where the available pool of flexibility in any area is likely to be small. Add in the effect of making allowances for potential failures to deliver and the available flexibility could be reduced by more than 50% at that time through a combination of over-procurement by the DSO and over-provisioning by flexibility sellers; this should be tested during TRANSITION field trials. As experience of using embedded flexibility increases, the market will become more efficient and maximise the use of the available flexibility by reducing the over-procurement

[1] https://www.solar.sheffield.ac.uk/pvlive/, 7 June 2019

[2] https://www.energydashboard.co.uk/data, 7 June 2019

[3] http://www.energynetworks.org/news/press-releases/2018/december/britain%E2%80%99s-local-electricity-network-operators-launch-ena-flexibility-commitment.html, 13 December 2018

[4] https://theenergyst.com/ssen-procure-flex-across-entire-network-households-evs/, 27 March 2019

[5] https://www.ukpowernetworks.co.uk/internet/en/news-and-press/press-releases/UK-Power-Networks-announces-results-of-UKs-biggest-ever-competitive-Flexibility-tender.html, 15 May 2019

[6] https://theenergyst.com/amp-clean-energy-limejump-powervault-and-moixa-take-ukpn-flex-contracts/, 4 July 2019

[7] https://www.theade.co.uk/assets/docs/resources/Flexibility_on_demand_full_report.pdf, July 2016

(from DO side) and over-provisioning (from provider side). The reliability and availability of flexibility will also affect the efficiency of the market and consideration should be given to allocating a reliability indicator to poorly performing flexibility.

The TRANSITION project, led by Scottish and Southern Electricity Networks (SSEN), is designed to help understand the changes required to traditional distribution network design and operation, to consider new market models, and to trial new flexibility-based services under various scenarios. These scenarios considered the opportunity for real (as opposed to paper-based) P2P services. The issues that will need to be addressed in a future facilitated market were considered across 15 categories which resulted in the identification of 26 new flexibility services. A simple methodology for the selection of five flexibility services to trial was developed that considered whole system value (DSO flexibility services), DSO-ESO co-ordination and interaction and peer-to-peer or third party-to-third party (P2P) trading that allow market actors to address their own issues:

- **DSO constraint management** - unplanned service, requested by DSO[8].
- **Peak Reactive** - planned service, requested by DSO[9].
- **Short-Term Operating Reserve** - planned service requested by ESO.
- **Authorised Supply Capacity Trading** - planned service requested by non-ESO and non-DSO market actor.
- **Offsetting** - planned service requested by non-ESO and non-DSO market actor.

An increasing amount of flexibility has benefits for the DSO, ESO, and GB and is likely to enable greater penetration of renewables through a reduction of system integration costs of low-carbon technologies[10]. This will facilitate cost-effective decarbonisation of the GB electricity system, adding to the estimated value of flexibility at more than £8 billion annually[6]. which could be conservative in the net zero scenario being considered by the Advisory Group on the Costs and Benefits of Net Zero[11]. However, the value for flexibility offered in some markets is insufficient to attract investment in enabling existing assets or attracting new flexible capacity as each market actor values flexibility based on how it uses the flexibility. Moreover, the whole of system benefit includes benefits that are not accessible to all market actors.

[8] This service is similar to ON-P 2018 Workstream 1, Product 2

[9] This service is similar to ON-P 2018 Workstream 2, Product 7

[10] "Value of Flexibility in a Decarbonised Grid and System Externalities of Low-Carbon Generation Technologies for the Committee on Climate Change" by Imperial College and NERA, October 2015

[11] https://www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/, May 2019

1 Introduction

As the number and capacity of embedded generation projects continues to increase beyond 13GW of PV capacity[12] and 7GW of wind capacity[13], there is an increasing requirement to manage the network issues that arise, including overvoltage, protection and thermal ratings of assets. Automated Network Management (ANM) which has enabled a greater penetration of renewable generation at lower overall cost, but the uncertain future level of curtailment has meant a small but increasing number of potential projects have been unable to secure finance and have not been built. Embedded flexibility is being considered by DNOs to address constraint issues in place of reinforcement and all DNOs have trialled sourcing flexibility with Scottish and Southern Electricity Networks signing the first commercial contract for a flexibility platform[14]. Further, the first commercially viable contracts for flexibility outside of innovation trials were announced by UK Power Networks in July 2019[15],[16].

There is also a need for P2P trading between market actors to minimise the effects of constraints on customers and to enable new projects to achieve financial close, supporting GB on its transition towards a net zero target by 2050. As all of these services come into effect, there will be an increased need for interactions between all market actors to avoid any unintended consequences. A particular issue between DNOs and the ESO is that some ANM schemes have increased generation within an ANM scheme to fill the headroom created by an ESO action to reduce generation in that area. As the volume of transactions increases, all affected market actors will need to be aware of the transaction so they can determine the effect on their position, particularly where a market actor is not a commercial counterparty to that transaction, e.g. if an aggregator provides flexibility from a customer site to deliver a service to the ESO, the supplier for that site needs to consider the effect on their Imbalance position.

The ability to deliver these services depends upon the level of embedded flexibility available. In 2016, two studies found that estimates of flexibility available from industrial and commercial sites vary from 3GW of turn-down and 2GW of turn-up[17] to 9.8GW[18] with an additional 4.5GW of flexibility from controllable storage heater demand[19]. In addition, the level of embedded flexibility was discussed in June 2018 at the Power Responsive annual conference where the ESO stated it had achieved a June 2015 target of procuring 50% of balancing services from demand response providers by 2020. This

[12] https://www.solar.sheffield.ac.uk/pvlive/, 7 June 2019

[13] https://www.energydashboard.co.uk/data, 7 June 2019

[14] https://piclo.energy/about

[15] https://www.ukpowernetworks.co.uk/internet/en/news-and-press/press-releases/UK-Power-Networks-announces-results-of-UKs-biggest-ever-competitive-Flexibility-tender.html, 15 May 2019

[16] https://theenergyst.com/amp-clean-energy-limejump-powervault-and-moixa-take-ukpn-flex-contracts/, 4 July 2019

[17] "Industrial & Commercial demand-side response in GB: barriers and potential", Ofgem, October 2016

[18] https://www.theade.co.uk/assets/docs/resources/Flexibility_on_demand_full_report.pdf, July 2016

[19] "Realising the Potential of Demand-Side Response to 2025", BEIS, November 2017

has demonstrated that making it easier to access the market, reducing the barriers to entry, and engaging with the owners and operators of embedded flexibility will increase the level of participation in the provision of flexibility service.

The issues that need to be addressed in a future facilitated market were considered to identify potential flexibility services and these were used to define existing and new services by market actor across 15 categories. This resulted in 26 new flexibility services ranging from the use of embedded flexibility to deliver existing ESO services, e.g. black start, through to niche services, e.g. harmonics. A simple methodology for the selection of five flexibility services to trial was developed that focussed on DSO constraint management, ESO-DSO co-ordination, new flexibility services that do not exist today and flexibility services that allow market actors to address their own issues. The five services selected are defined in outline form to consider the potential providers, the beneficiaries, scheduling and despatch requirements, new flexibility services, and other considerations such as process requirements.

An increasing amount of embedded flexibility has benefits for the DSO, ESO, and GB. It will enable greater penetration of renewables through a reduction of system integration costs of low-carbon technologies[20], facilitate cost-effective decarbonisation of the GB electricity system, and replace some of the flexibility lost through the closure of large carbon-based generating stations. Further, as the flexibility increases, progressively higher volumes of wind and PV could replace nuclear generation, providing additional savings for the end-consumer. It has been estimated the value of flexibility post-2030 is more than £8 billion annually[6]. However, the value offered is insufficient to attract investment to enable existing assets or attract new flexible capacity as the whole of system benefit is not accessible to all market actors. Further, each market actor values flexibility based on how it uses that flexibility (arbitrage, balancing services, frequency regulation, peak management, and network support), which ignores the carbon savings to GB and the option value to GB provided by the flexibility. It is therefore necessary to stack various flexibility service opportunities to realise as much of the whole system value as possible, although this is unlikely to include all of the value of the flexibility.

Finally, recommendations are made for future work. Two particular areas are understanding the international experience of over-procurement and the effect this has on the delivery on flexibility services and the risk factors that should apply where a flexible asset delivers a disproportionate amount of a flexibility service.

[20] "Value of Flexibility in a Decarbonised Grid and System Externalities of Low-Carbon Generation Technologies for the Committee on Climate Change" by Imperial College and NERA, October 2015

2 Background

TRANSITION is designed to help understand the changes required to the traditional distribution network design, maintenance and operation, to consider new market models, and to trial new services under various scenarios. The outcomes from TRANSITION will inform the Energy Networks Association Open Networks Project (ON-P). Workstream 3 of ON-P is developing a more detailed view of the required transition from DNO to DSO, including the impacts on existing organisation capabilities prior to the implementation of the DSO and Workstream 1A Is considering all aspects of flexibility.

TRANSITION will be completed in three stages:

- Phase 1 - design the solution for the Neutral Market Facilitator (NMF) and how it will interact with the existing distribution IT systems; develop the roles and responsibilities of market actors; develop simple rules to enable the delivery of selected services; and determine the location and requirements of a trial in Phase 2.
- Stage Gate (aligned with EFFS and FUSION [21]) - a formal opportunity to review progress, compare outcomes and ensure the programme is still aligned with wider industry initiatives and to determine whether it is still valuable to continue with TRANSITION and continue with Phase 2.
- Phase 2 – procure DSO systems required to undertake the TRANSITION trials, implement a Neutral Market Facilitator solution that enables data exchange between industry actors participating in the trials and trading of flexibility services and conduct a wide scale trial to test the services, roles and rules and inform ON-P.

The ON-P has identified five future worlds[22] that could exist once the role of the DSO has been established which range from a monopsonistic market (World D) through to a distributed (World A) and competitive market (World C). The establishment of the DSO will create the need for new services and enable the transaction of P2P services which is unlikely to include the DSO or ESO as a counterparty. This report considers the DSO, ESO and P2P services that are likely to exist in the DSO world and identifies five services for trialling during Phase 2 of project TRANSITION.

This report identifies what flexibility services may be deployed in a future facilitated market. It considers the need for flexibility, proposes a standardised methodology for defining flexibility to create comparability with other markets, the risks of delivery to ensure the market uses flexibility in the most efficient manner, considers the range of services that could exist in a future facilitated market and identifies five services for trialling under TRANSITION.

[21] The 2017 Network Innovation Competition funded projects "Electricity Flexibility and Forecasting System" (awarded to Western Power Distribution to develop an IT platform to forecast network capacity and identify opportunities to trade flexible network services) and "FUSION" (awarded to SP Energy Networks to test a technical and commercial solution developed in Europe to resolve constraints on the distribution network), https://www.ofgem.gov.uk/system/files/docs/2017/11/ofg1031_innovation_competitions_brochure_web.pdf, 30 November 2017.

[22] http://www.energynetworks.org/electricity/futures/open-networks-project/future-worlds/future-worlds-impact-assessment.html

3 The Need for Embedded Flexibility

Flexibility is defined as "the ability to modify generation and/or consumption patterns in reaction to an external signal (such as a change in price, or a message)[23]. Embedded flexibility, flexibility connected to the distribution network either directly (typically sites with storage or generation that have flexibility but a proportionally small demand) or indirectly (demand site with assets that have flexibility) to the distribution network, could provide one or more flexibility services to support the electricity system, whether locally, regionally, or nationally.

The process for decarbonisation of electricity supply combined with changes of units cost of different generation sources, government policy and connection codes over the last decade has resulted in the gradual replacement of centralised flexible generation with less flexible and intermittent distributed generation. As the capacity and volume of distributed generation increases, the electricity grid will need to be more flexible and adaptable than it is today to maintain existing levels of reliability and security of transmission and distribution grids. Further, the move from a DNO to more proactive DSO will increase the need for embedded flexibility and introduce the opportunity for real (as opposed to paper-based) P2P services.

3.1 Standardised Flexibility Curves

Flexibility on electricity networks is provided by distributed energy resources which can be defined by a standardised flexibility curve as illustrated in Figure 1 using parameters outlined in Table 1.

The parameters for any flexible asset will determine its ability to provide a particular flexibility service and may affect the overall price of delivery and the future availability of that flexible asset.

[23] "A Smart, Flexible Energy System - A call for evidence", BEIS and Ofgem, November 2016

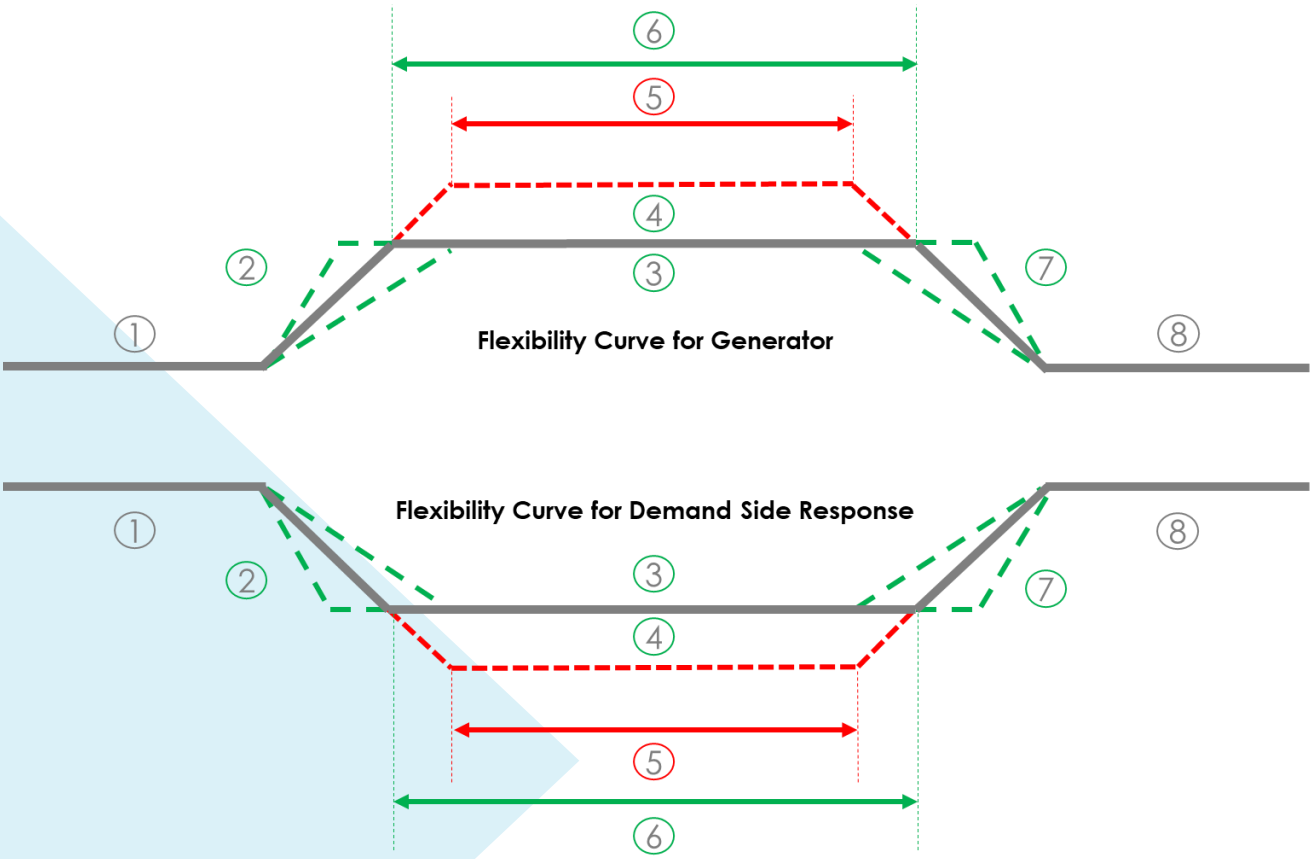


Figure 1- Standardised Flexibility Curves for Generators and Demand Side Response

Table 1 - Parameters for Standardised Flexibility Curves (ignoring bounce-back)

Item	Definition for the purposes of this report	Balancing Mechanism Definition
1	Notice to start delivering flexibility	Notice to Deviate from Zero
2	Delivery of flexibility	Ramp Up Rate
3	Minimum amount of flexibility	Stable Export Limit (generator) Stable Import Limit (demand side response)
4	Maximum amount of flexibility	Maximum Export Limit
5	Minimum duration of flexibility delivery	Minimum Non-Zero Time
6	Maximum duration of flexibility delivery	Maximum Delivery Period
7	Reduction of flexibility	Ramp Down Rate
8	Minimum time before next use	Minimum Zero Time
9	Number of cycles over a defined period	N/A

3.2 Accessing Flexibility

All flexibility services can be considered as either Triggered or Dispatched. A Triggered service is one where there is a very quick delivery of flexibility following the breach of a pre-determined threshold, e.g. system frequency or the level of demand and this usually requires local detection to ensure speedy delivery. A Dispatched service is one where service delivery Is scheduled some time ahead of need, e.g. the delivery of a service that is predictable. There are five steps to accessing Triggered and Dispatched services as summarised in Table 2.

Table 2 – Methodology for accessing Triggered and Dispatched Services

Step	Definition	Triggered Services	Dispatched Services
Evaluation	Determine the flexibility services that an asset should be capable of delivering, subject to testing the asset can meet the requirements of the flexibility service(s).	X	X
Approval	Prove an enabled asset can meet the requirements of the flexibility service and be approved by the beneficiary of the flexibility service as capable of delivering that flexibility service.	X	X
Availability	Declare flexibility as ready to deliver the flexibility service.	X	X
Arming	Placing a flexible asset in detection mode for triggered flexibility services to ensure immediate dispatch.	X	-
Dispatch	Issue a manual or automatic signal for a flexible asset to commence delivery of a flexibility service.	-	X

4 Delivery Risk

Delivery risks include a number of factors that are discussed in this section 4:

- the level of flexibility available;
- the combined effect of over-procurement and overprovisioning;
- the risks of non-delivery or under-delivery; and
- the delivery and measurement.

These issues are acute at lower voltage levels and / or in smaller geographic areas where there is less flexibility available to deliver flexibility services.

4.1 Level of Flexibility Available

The ESO has succeeded in engaging with the owners and operators of embedded flexibility to increase the level of participation by making it easier to access the market and reducing the barriers to entry. This has increased the involvement of embedded flexibility in tendering for ESO flexibility services with some monthly tenders comprising more than 50% embedded flexibility. Unfortunately, this is not sufficient to stimulate or facilitate local markets as the ESO doesn't not have the same locational issues or requirements as a DSO when sourcing flexibility.

Locational services will rely on the delivery of local flexibility at lower voltage levels where the availability of suitably located flexibility is likely to be limited and assets are likely to be of smaller capacity. Engagement with developers, owners and operators of the flexibility is more critical to success. Further, it is imperative that such flexibility is identified, enabled, and utilised in the most cost-effective manner to maximise the flexibility available.

4.2 Combined Effect of Over-procurement and Overprovisioning

It is important the contracted level of flexibility is delivered to protect distribution assets, enable assets that would otherwise be constrained to increase their demand or generation and minimise contractual penalties for failure to deliver. To overcome these issues, the DSO will purchase more than the level of flexibility required (over-procurement) and the flexibility provider will also purchase more than the level of flexibility required (overprovisioning).

The ENA Engineering Technical Reports 130 and 131 provides a methodology for assessing the security contribution from distributed generation (referred to as the “F-factor”, the ratio of the flexibility likely to be delivered and the capacity of the asset providing that flexibility). These F-factors were used in Low Carbon London (a Low Carbon Networks Fund innovation

project)[24] to determine the security contribution from various generators of a similar rating but did not consider the risk where the generators were of different and / or disproportionate ratings in a pool of generators[25].

Further, Low Carbon London also defined a new set of "F-factors" for demand side response to provide DNOs with an indication of the amount of "over-procurement" likely to be required to provide the necessary confidence that the required level of response will be delivered[26]. This principle was extended by the Electricity Market Reform Delivery Body who introduced De-Rating Factors for the contribution of short-duration storage to security of supply[27]. This area should be investigated during the trials to inform how maximum use can be made of available flexibility.

Given the limited flexibility within a given local area, consideration needs to be given to the combined effect of over-procurement by the DSO and a similar approach by the provider of flexibility. These considerations are particularly important as the consequences of this combined approach could result in a potentially sub-optimal and expensive solution. This is summarised in Table 3.

Table 3 - Combined Effect of Over-Procurement and Overprovisioning

Term	Calculation	DSO	Providers
Capacity required		5.0MW	
DSO over-procurement (see note 1)		40%	
DSO Capacity Purchased, in MW[28]	(5MW + (5MW * 40%))	7.0MW	
Capacity required			7.0MW
Providers' overprovisioning (see note 2)			50%
Providers' capacity purchased to deliver 7MW	(7MW + (7MW *50%))		10.5MW
Excess flexibility to allow for potential failure to deliver	**((10.5 - 5.0) / 5.0)**	**110%**	

Note 1 - using an F-Factor of 60% assuming three demand side assets from Low Carbon London
Note 2 - assumes overprovisioning factor for an aggregator commercially incentivised to deliver from a variety of flexibility sources

[24] https://innovation.ukpowernetworks.co.uk/projects/low-carbon-london/, 14-August 2019

[25] "Distributed Generation addressing security of supply and network reinforcement requirements", UK Power Networks, September 2014.

[26] "Industrial and Commercial Demand Response for outage management and as an alternative to network reinforcement", UK Power Networks, September 2014.

[27] "Duration-Limited Storage De-Rating Factor Assessment – Final Report", National Grid Electricity Transmission plc, 2017

[28] http://www.networkrevolution.co.uk/wp-content/uploads/2015/04/IC-Final.pdf, (section 5.6.2 on the application of F-Factors to generation), 2015

The combined effect of over-procurement and overprovisioning could reduce the available flexibility that could be despatched by more than 50%. This should be considered in the structure, compensation, and penalties in any contract. Potential solutions include over-delivery by the flexibility provider leading to penalties that increase over time from no penalty through a small penalty and a large penalty to termination. This issue should be tested during the trials.

4.3 Risks of Non-Delivery and Under-Delivery

Once contracted, there are two main delivery risks in relation to the delivery of flexibility; availability and reliability as outlined in Table 4. If flexibility Is not delivered as instructed, this may result in one of two issues that may not be economically sustainable for GB and customers:

- the price of securing additional flexibility at short notice; or
- an adverse effect or damage to one or more distribution network assets.

Table 4 - Main Risks of Non-Delivery

Type of Risk	Risk of Non-Delivery
Availability	• the flexibility provider is not available to provide the contracted flexibility service at any time. • the availability of flexibility changes at some point prior to delivery. • the flexibility provider is not available to deliver the contracted flexibility service when required.
Reliability	• the flexibility does not commence delivery when expected. • the flexibility is not delivered at the instructed level. • the flexibility is not delivered for the contracted or instructed duration.

In October 2015, National Grid Electricity Transmission published standard terms for the provision of frequency response, "Bridge Firm Frequency Response Agreement - Static Response" to encourage aggregators and large organisations to enter the static frequency response market. The penalty for non-delivery was to reduce the payment based on the ratio of the actual availability in a Settlement Period to the availability declared (Availability Outturn) as summarised in Table 5 below.

Table 5 - Penalty for Non-Delivery of under the Bridge Firm Frequency Response Agreement - Static Response

Availability Outturn (in any Settlement Period, (actual availability) / (declared availability))	Payment
90% to 100%	100% * Availability Fee

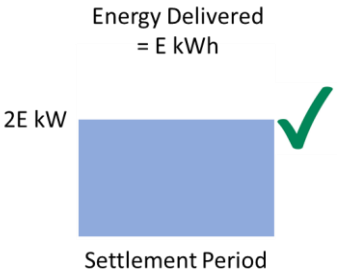
50% to 90%	50% * Availability Fee
Less than 50%	0% * Availability Fee

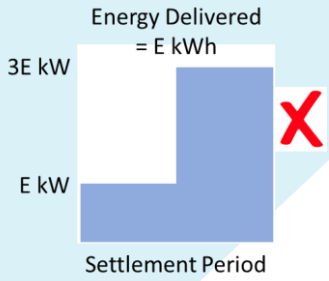
The penalty regime reflected the additional risk for new providers of the service, although it could be considered harsh if 49% of a portfolio was available as declared. In addition, there was the possibility of termination for persistent failure to deliver service,

Consideration should be given to allocating a reliability marker or request additional testing for flexibility that has either poor availability or poor reliability.

4.4 Delivery and Measurement

Flexibility services should always be delivered at the agreed level at every measurement interval, i.e. if a provider of flexibility has to deliver a service of E kWh in a Settlement Period then it should be at delivered at the rate of 2E kW for the entire Settlement Period (subject to ramping characteristics and an appropriate error of measurement). The frequency of measurements will depend upon the service being delivered, e.g. a critical service may involve meter readings collected at intervals of seconds that are provided in near real time whereas a less critical service may involve meter reading collected at intervals of minutes that are provided post-event.





The delivery of flexibility should be confirmed by an appropriate metering solution that may involve sub-metering. The MPAN on a demand site may only be suitable if an agreed baseline methodology has been agreed due to the underlying variation of demand.

5 Identification of Potential Services in a DSO World

5.1 Methodology

In order to identify potential services in a DSO world, it is important to consider the issues that will exist, and the following methodology was employed:

- Consider issues that will need to be addressed from a distribution network, demand customer and generator customer perspective (the ESO has been excluded as they are in the process of reviewing their services through the System Needs and Product Strategy process), including potential services that could address the trilemma (low cost, resilient, and low carbon);
- Define services for each issue and determine a definitive list of potential services;
- Develop and apply a methodology for potential services to be trialled under project TRANSITION; and
- Define the potential services to be trialled under project TRANSITION.

5.2 Issues that Need to be Addressed

The issues were identified through consideration of the needs and wants of the distribution network, demand customers, and generator customers from a fundamental perspective, including flexibility services that could address the trilemma. The following issues were identified:

- Management of planned or unplanned outages;
- Thermal overload of distribution network assets;
- Capacity constraints of distribution network assets;
- The consequences of any increase in distributed generation and demand;
- Management of voltage on the distribution network system;
- Reduction of distribution network losses;
- Management of Import and export on a customer site;
- Management of the level and profile of demand on a site; and
- Creation of financial certainty.

5.3 List of Potential Services

As discussed in section 3.2, all services are either Triggered locally or scheduled for Dispatch at a future time. A list of potential services versus the need to be addressed are identified in Appendix 1 and these potential services are described in Appendix 2. Potential services can be grouped in the following service types:

- Recovery following planned or unplanned outage;
- Planned increase or reduction of metered output;
- Conditional increase or reduction of metered output;
- Planned increase or reduction in metered output;
- Conditional increase or reduction in reactive power;
- Planned increase or reduction in harmonics generated;
- Conditional increase or reduction in harmonics generated;
- Conditional reduction or increase in import or export level; and
- Conditional or planned P2P services.

5.4 Methodology for potential services to be trialled under TRANSITION

For TRANSITION to be effective, the services trialled should encompass issues that will exist and need to be addressed in any of the Future World scenarios. The range of services should address the following issues;

- Constraint management services (planned and unplanned);
- Requires co-ordination between the DSO and the ESO;
- New services that do not exist in today's market; and
- Services that benefit market actors in addressing their own issues.

Table 6 considers the ability of each service type to address the above issues.

Table 6 - Shortlisting Potential Flexibility Service Types for the Trial

Service Type	Issue to be addressed in Future World			
	Constraint management	Requires ESO-DSO co-ordination	New flexibility services	Market actors address own issues
Recovery following planned or unplanned outage	X	X	X	
Planned increase or reduction of metered output		X	X	X
Conditional increase or reduction of metered output	X	X	X	X
Planned increase or reduction in metered output	X		X	X
Conditional increase or reduction in reactive power			X	X
Planned increase or reduction in harmonics generated			X	
Conditional increase or reduction in harmonics generated			X	
Conditional reduction or increase in import or export	X	X	X	X
Conditional or planned P2P services	X		X	X

From the above table, services to be trialled should address;

A. Recovery following planned or unplanned outage;

B. Conditional increase or reduction of metered output;

C. Planned increase or reduction in metered output;

D. Conditional reduction or increase in import or export; and

E. Conditional or planned P2P services.

5.5 The Five Flexibility Services for the TRANSITION Trial

From the above, five services were identified for the TRANSITION trial as outlined in Table 7.

Table 7 - Five Flexibility Services for TRANSITION Trial

Service (Appendix)	Delivery	Recovery following planned or unplanned outage	Conditional increase or reduction of metered output	Planned increase or reduction in metered output	Conditional reduction or increase in import or export	Conditional or planned P2P services
DSO Constraint Management (Appendix 3)	Triggered	X	X	X		
Peak Management (Appendix 4)	Despatched			X	X	
Short-Term Operating Reserve[29] (Appendix 5)	Despatched			X	X	
Authorised Supply Capacity Trading (Appendix 6)	Despatched				X	X
Offsetting (Appendix 7)	Despatched and / or Triggered		X	X	X	X

[29] Although the ESO is not a project partner, this service has been included to trial the prioritisation of access provisions and the communication channels to improve the value of the trial to and further inform ON-P

6 Value of Flexibility in a DSO World

Increasing the level of flexibility available to deliver flexibility services will benefit the DSO, ESO, and other market actors. It will also enable greater penetration of renewables through a reduction of system integration costs of low carbon technologies and facilitate the cost-effective decarbonisation of the GB electricity system. This flexibility includes domestic demand-side flexibility which could contribute more flexibility than the industrial and commercial sector if it can be cost-effectively enabled. Further, as the flexibility increases, progressively higher volumes of wind and PV could replace nuclear generation, providing additional savings and benefits to GB and customers. As such, establishing market frameworks that facilitate access to demand-side flexibility and enable its whole system value to be realised are critical to deliver the low carbon future and system benefits that are expected.

6.1 Value of Flexibility

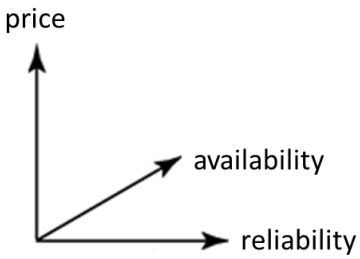
It has been estimated the value of flexibility post-2030 is more than £8 billion annually[6] at a system carbon intensity of 50gCO_2/kWh. However, the value offered in some markets or for some flexibility services is insufficient to either attract investment in enabling existing flexibility or attracting new flexibility. The primary reason is that the whole of system benefit includes benefits that are not accessible to all market actors. As a result, the value for flexibility is insufficient to attract investment to enable existing assets or attract new flexible capacity as the whole of system benefit is not accessible to all market actors. Further, each market actor values flexibility based on how it uses that flexibility (arbitrage, balancing services, frequency regulation, peak management, and network support), which ignores the carbon savings to GB and the option value to GB provided by the flexibility. It is therefore necessary to stack various flexibility service opportunities to realise as much of the whole system value as possible, although this is unlikely to include all of the value of the flexibility.

The value of flexibility in the GB market today ranges from £1/MWh for ESO tendered frequency response services through to £600/MWh for WPDs Restore service[30]. It is interesting to note that static frequency response overnight has a £0/MWh value to the ESO, reflecting the range of solutions that the ESO can deploy. The wide margin between the ESO and DNO services reflects the maturity of the ESO frequency response market which is highly competitive with low barriers to entry and multiple providers when compared to nascent DNO constraint flexibility services.

The choice of any flexibility offer should consider three factors, each with their own weighting;

[30] https://www.flexiblepower.co.uk/faqs, 7 June 2019

- the **price** of the service which includes all availability, arming, and utilisation costs;
- the **availability** of the asset to provide a flexibility service when it is required at the contracted capacity for the required duration; and
- the **reliability** of the flexibility to deliver on time and to specification when requested.



6.2 Standardisation

As the flexibility market develops, there is a need to reduce barriers to entry and provide easy market access to improve market liquidity and ensure GB maximises the benefit from the available flexibility. Many of these issues have been addressed as the ESO flexibility services have developed. However, as the number of competing flexibility services increase, the lack of standardisation will become a barrier to entry and the following areas should be considered when designing new DSO flexibility products to minimise the burden on new flexibility providers;

- standardised contracting framework agreement across all DSOs;
- use of the same flexibility service definitions and parameters;
- consistent evaluation methodology for determining the value of a flexibility service across all DNOs; and
- standardised minimum thresholds (and, potentially, transaction size) for each flexibility service.

An additional benefit of standardisation will be to increase the capacity and volume of flexibility services, which increases market liquidity and increases price competitiveness

7 Recommendations for Further Work

The following areas should be considered further under TRANSITION Phase 2 as they were out of the scope of this report:

- investigate the international experience of over-procurement and the effect this has on the delivery on flexibility services;
- investigate the allocation of F-Factors and De-Rating factors to maximise the use of available flexibility.
- investigate the risk factors that should apply where a flexible asset delivers a disproportionate amount of a flexibility service in a pool of flexible assets and consider the experience of the ESO in this area;
- investigate and trial a variety of potential procurement, contractual and despatch solutions to maximise the use of available flexibility, including over-delivery and penalties that increase as non-delivery increases;
- determine when non-firm connections can be used as flexibility (if at all), especially ANM connections;
- develop the flexibility services outlined in Appendices 3-7 during TRANSITION Phase 2, including;
  - the appropriate contractual framework and terms;
  - which services can be delivered in parallel (service stacking);
  - the acceptable level of under-delivery and over-delivery (if any); and
  - non-price incentives, e.g. corporate social responsibility and societal value of carbon.
- investigate the level and frequency of ESO-DSO and DSO-third party communication during TRANSITION Phase 2; and
- review of the factors outlined in section 6.2 when designing new DSO flexibility products to minimise the burden on new flexibility providers.

Appendix 1 - List of Potential Services by the Need to be Addressed

Purpose of Service (Table 1 of 4)	Recovery following planned outage	Recovery following unplanned outage	Increase of metered output	Reduction of metered output
Instruction Time	▪ ahead of time	▪ ahead of time	▪ ahead of time	▪ ahead of time
Measurement	▪ kW, kWh	▪ kW, kWh	▪ kW, kWh	▪ kW, kWh
Current Services				
ESO	▪ n / a	▪ n / a	▪ Demand Turn Up ▪ Short-Term Operating Reserve	▪ Demand Turn Up ▪ Short-Term Operating Reserve
DNO	▪ n / a	▪ n / a	▪ Constraint Management (planned)	▪ Constraint Management (planned)
Other Market Actors	▪ n / a	▪ n / a	▪ Change in Authorised Supply Capacity	▪ Change in Authorised Supply Capacity
New Services				
ESO	▪ n / a	▪ Black Start ▪ Constraint Management (voltage)	▪ Demand Turn Up ▪ Short-Term Operating Reserve ▪ BM Actions	▪ Demand Turn Up ▪ Short-Term Operating Reserve ▪ BM Actions

Purpose of Service (Table 1 of 4, contd)	Recovery following planned outage	Recovery following unplanned outage	Increase of metered output	Reduction of metered output
DSO	▪ Managed Return to Service	▪ Managed Return to Service	▪ Constraint Management (planned) ▪ Permanent Profile Change ▪ Reverse Power ▪ Loss Management ▪ Phase Balancing ▪ Export above Authorised Supply Capacity	▪ Constraint Management (planned) ▪ Permanent Profile Change ▪ Reverse Power ▪ Loss Management ▪ Phase Balancing ▪ Import above Authorised Supply Capacity
Other Market Actors	▪ Managed Return to Service ▪ Interruptible Import / Export	▪ Managed Return to Service ▪ Interruptible Import / Export ▪ Trade ESO Obligations	▪ Planned Offset ▪ Trade ESO Obligations ▪ Wholesale Trading ▪ Contracts for Differences ▪ Power Purchase Agreements ▪ Virtual Power Purchase Agreements ▪ Virtual Power Plant ▪ Weather Products ▪ Within Gate Closure Balancing ▪ Change in Authorised Supply Capacity ▪ Financial or physical options	▪ Planned Offset ▪ Trade ESO Obligations ▪ Wholesale Trading ▪ Contracts for Differences ▪ Power Purchase Agreements ▪ Virtual Power Purchase Agreements ▪ Virtual Power Plant ▪ Weather Products ▪ Within Gate Closure Balancing ▪ Change in Authorised Supply Capacity ▪ Financial or physical options

Purpose of Service (Table 2 of 4)	Conditional increase of metered output	Conditional reduction of metered output	Increase of reactive power	Reduction of reactive power
Instruction Time	▪ immediate response	▪ immediate response	▪ ahead of time	▪ ahead of time
Measurement	▪ kW, kWh	▪ kW, kWh	▪ kVAr, kVArh	▪ kVAr, kVArh
Current Services				
ESO	▪ Firm Frequency Response (Dynamic and non-Dynamic)	▪ Firm Frequency Response (Dynamic and non-Dynamic)	▪ n / a	▪ n / a
DNO	▪ n / a	▪ n / a	▪ n / a	▪ n / a
Other Market Actors	▪ n / a	▪ n / a	▪ n / a	▪ n / a
New Services				
ESO	▪ Firm Frequency Response (Dynamic and non-Dynamic)	▪ Firm Frequency Response (Dynamic and non-Dynamic) ▪ Intertrip	▪ Enhanced Reactive Power	▪ Enhanced Reactive Power
DSO	▪ Constraint Management (post-fault) ▪ Voltage Management ▪ Export above Authorised Supply Capacity	▪ Constraint Management (post-fault) ▪ Voltage Management ▪ Import above Authorised Supply Capacity	▪ Constraint Management (planned) ▪ Voltage Management	▪ Constraint Management (planned) ▪ Voltage Management
Other Market Actors	▪ Unplanned Offset ▪ Trade ESO Obligations ▪ Interruptible Import	▪ Unplanned Offset ▪ Trade ESO Obligations ▪ Interruptible Export	▪ Authorised Supply Capacity Trading ▪ Trade ESO Obligations	▪ Authorised Supply Capacity Trading ▪ Trade ESO Obligations

Purpose of Service (Table 3 of 4)	Conditional increase of reactive power	Conditional reduction of reactive power	Increase in harmonics generated	Reduction in harmonics generated
Instruction Time	▪ immediate response	▪ immediate response	▪ ahead of time	▪ ahead of time
Measurement	▪ kVAr, kVArh	▪ kVAr, kVArh	▪ harmonics required	▪ harmonics required
Current Services				
ESO	▪ n / a	▪ n / a	▪ n / a	▪ n / a
DNO	▪ n / a	▪ n / a	▪ n / a	▪ n / a
Other Market Actors	▪ n / a	▪ n / a	▪ n / a	▪ n / a
New Services				
ESO	▪ n / a	▪ n / a	▪ n / a	▪ n / a
DSO	▪ Constraint Management (post-fault) ▪ Voltage Management	▪ Constraint Management (post-fault) ▪ Voltage Management	▪ Constraint Management (planned)	▪ Constraint Management (planned)
Other Market Actors	▪ Trade ESO Obligations	▪ Trade ESO Obligations	▪ n / a	▪ n / a

Purpose of Service (Table 4 of 4)	Conditional increase of harmonics generated	Conditional reduction of harmonics generated	Conditional reduction of import or export
Instruction Time	immediate response	immediate response	immediate response
Measurement	harmonics required	harmonics required	kVA
Current Services			
ESO	▪ n / a	▪ n / a	▪ n / a
DNO	▪ n / a	▪ n / a	▪ n / a
Other Market Actors	▪ n / a	▪ n / a	▪ n / a
New Services			
ESO	▪ n / a	▪ n / a	▪ Intertrip
DSO	▪ Constraint Management (post-fault)	▪ Constraint Management (post-fault)	▪ Constraint Management (float to zero import or export) ▪ Constraint Management (part interruptible supply) ▪ Interruptible Import / Export
Other Market Actors	▪ n / a	▪ n / a	▪ Trade ESO Obligations

Appendix 2 - Brief Description of Services

Service		Beneficiary			Description
		ESO	DSO	Third Parties	
1	Authorised Supply Capacity Trading			New	Short-term "trading" of Authorised Supply Capacity (import or export) between two parties (neither being the DSO or ESO) within the same primary sub-station area. If there is a constraint on a particular 11kV circuit or secondary sub-station, the parties need to be supplied from the same 11kV circuit or secondary sub-station.
2	Balancing Mechanism Actions	Exist			The variation of the import or export level of a (generation or demand) BMU following an instruction from the ESO either within a Settlement Period or (in limited cases) prior to the start of a Settlement Period.
3	Balancing Mechanism Actions	New			The variation of the import or export level of a (non-generation or non-demand) BMU following an instruction from the ESO either within a Settlement Period or (in limited cases) prior to the start of a Settlement Period.
4	Black Start	Exist			The provision of generated output that can start independently without any external supply when there is a wide area or GB-wide unplanned outage of the electricity transmission network following an instruction from the ESO.
5	Constraint Management (despatch ahead of delivery)	Exist	Exist		The scheduled reduction of import from or export to the transmission network or the distribution network due to a planned and / or unplanned outage of an ESO or distribution network asset that reduces available capacity in an area.
6	Constraint Management (float to zero import or export)		New		Reduction of import from or reduction in the export to the distribution network to zero, following an instruction from the DSO.

Service		Beneficiary			Description
		ESO	DSO	Third Parties	
7	Constraint Management (part interruptible supply)		New		Reduction of the non-firm portion of a customer's Authorised Supply Capacity to zero following an instruction from the DSO.
8	Constraint Management (post-fault)		New		A conditional and / or immediate reduction of import from or export to the distribution network due to an unplanned outage of a defined distribution asset during a planned outage of another asset that reduces available capacity in an area.
9	Constraint Management (voltage management)		New		A planned reduction of import from or export to the distribution network due to a known loading issue on a distribution network asset that could otherwise reduce available capacity in an area.
10	Contracts for Differences			New	A contract in which the buyer agrees to pay a fixed price for an agreed capacity or volume of electricity for an agreed duration. If the market price is greater than the fixed price, the buyer receives the difference and if the market price is less than the fixed price, the seller receives the difference.
11	Demand Side Response	Exist	New	New	The reduction of demand or increase of embedded generation following an instruction.
12	Demand Turn Up	Exist	Exist	New	The increase of demand or reduction of embedded generation following an instruction from the ESO.
13	Embedded Black Start	New			The provision of generated output that can start independently without any external supply when there is a wide area or GB-wide unplanned outage of the electricity transmission network following an instruction from the ESO. These units are connected to the DSO network and usually rated at less than 50 MW.
14	Exceeding Authorised Supply Capacity (import or export)			New	Planned increase in demand over a short-period of time in response to the excess generation within the same generation-constrained area of the network designed to avoid generation curtailment.

Service		Beneficiary			Description
		ESO	DSO	Third Parties	
15	Fast Reserve	Exist			The rapid and reliable delivery of active power through increasing output from generation or reducing consumption from demand.
16	Frequency Response (Enhanced)	Exist			A dynamic frequency response service where the active power (kW) changes proportionally in response to changes in system frequency above a threshold and delivered within one second.
17	Frequency Response (Firm, Dynamic)	Exist			A frequency response service where the active power (kW) changes proportionally in response to changes in system frequency above a threshold and delivered within 10 seconds.
18	Frequency Response (Firm, non-Dynamic)	Exist			A frequency response service where the active power (kW) is delivered within 10 seconds (in the case of primary frequency response) or 30 seconds (in the case of secondary frequency response).
19	Interruptible Import / Export		New		An amount of import or export capacity that is made available to the DSO to use as part of a flexibility service.
20	Intertrip		Exist		Preventative tripping of a remote location to avoid further spread of fault.
21	Loss Management		New		Request to decrease demand or increase generation in active (kW) and reactive (kVAr) power to reduce network losses.
22	Managed Return to Service		New		Planned increase in import / export capacity for a connection to support the reinstatement of the network following an unplanned or planned outage.
23	Offset (immediate, conditional)			New	The conditional reduction of generation to restore a site (and, therefore, the local network) to its level of Authorised Supply Capacity; the conditionality usually arises when there Is a network issue or the loss of the offsetting demand.

Service		Beneficiary			Description
		ESO	DSO	Third Parties	
24	Offset (planned, dispatched)		New		The planned increase of demand to enable the same magnitude of planned increase of generation a short time later (and vice versa) where both the demand and generator customers are in the same constrained area. This can result in the increase in export and / or import above the Authorised Supply Capacity for each customer whilst resulting in a net-zero impact on the constraint.
25	Permanent Profile Change		New		Adjustment of demand or generation to change the shape of the demand or generated profile (active and/or reactive power).
26	Phase Balancing		New		Adjusting active and / or reactive demand or generation on a single-phase connected asset in coordination with other assets on the feeder to equalise power flow across phases.
27	Portfolio Balancing			New	The use of flexibility to balance a portfolio ahead of real-time to support a trading strategy or minimise imbalance.
28	Power Purchase Agreements			Exist	Agreement between two parties, usually a generator and a supplier.
29	Reactive Power (Power Potential)	Exist			Planned adjustment of reactive power consumption or generation proportional to active power in response to the requests at the regional reactive power market (at the Grid Supply Point level) following an instruction to arm from the ESO.
30	Reverse Power (demand reduction behind meter)		New		Planned reduction in demand behind the meter allowing for generation to exceed the demand and export energy beyond the meter.
31	Short-Term Operating Reserve	Exist			The planned increase of embedded generation or reduction of import following an instruction from the ESO.

Service		Beneficiary			Description
		ESO	DSO	Third Parties	
32	Trade System Operator Obligations			New	Transaction between a generator or supplier that has contracted with the ESO or DSO for another generator or supplier to deliver a service or flexibility service on their behalf.
33	Virtual Power Plant	Exist	Exist	New	A network of decentralised flexible generating units, flexible power consumers and batteries that are aggregated and dispatched centrally to provide flexibility services for the ESO, DSO, portfolio balancing, and for trading purposes.
34	Virtual Power Purchase Agreements			New	Transaction between two or more parties to aggregate the output from a number of similar or dissimilar sources of flexibility so they can be used as a distributed power station for the purposes of enhancing power generation, as well as trading or selling power on the electricity marke
35	Voltage Management		New		The planned use of flexibility to adjust the active and / or reactive power of a flexible asset to maintain or support the network voltage.
36	Weather Products		New	New	The use of weather information from hours ahead to months ahead to predict the effect on flexible assets and the network, e.g. rainfall for generation or lightning for DSO planned maintenance.
37	Wholesale Trading			New	The use of aggregated flexibility to support discrete trades on the electricity markets ahead of Gate Closure, Typically months ahead to hours ahead of real-time.
38	Within Gate Closure Balancing	New		New	The use of aggregated flexibility from embedded flexibility to support the delivery of flexibility services to the ESO.

Appendix 3 - DSO Constraint Management

Purpose of Flexibility Service	To reduce the demand on a distribution network asset immediately under certain system conditions and at certain times of day for a maximum duration, e.g. support the network during fault conditions, during maintenance work or where a constraint is forecast, using a DSO triggered service.
Potential Providers of Flexibility Service	The following connected to the distribution network asset that can meet the Service Parameters; ▪ owners of generator assets that can increase their generation; ▪ owners of storage assets that can either increase their export or reduce their demand; ▪ owners of demand assets that can reduce their demand; and ▪ aggregators of embedded flexibility that increase the generation or reduce the demand of their portfolio
Beneficiaries of Flexibility Service	▪ the affected DSO, through the optionality available until there is a more certain future; ▪ owners of embedded flexibility (existing and new) who obtain additional revenue; ▪ aggregators who benefit from the revenue from flexibility services; and ▪ customers connected to the distribution network asset who benefit from DSO managing the distribution network constraints in efficient and economical manner by using a mixture between capital and operational tools
Service Parameters	▪ notice to start delivering flexibility - TBC ▪ maximum time to deliver service from Notice to start delivering flexibility - TBC ▪ minimum amount of flexibility - TBC ▪ minimum duration of flexibility delivery - TBC ▪ maximum duration of flexibility delivery - TBC
Testing	▪ to be determined once the service has been developed further

Scheduling Requirements	▪ service initiated by a signal following the breach of a threshold with the speed of response dependant on the criticality of the service; ▪ due to conditional nature of flexibility service, dispatching is usually not possible; and ▪ flexibility selected to deliver the flexibility service can be "armed" (dispatched) ahead of an availability window and deliver the flexibility service quickly if the system condition occurs.
Despatch Requirements	▪ availability – declaration of the availability of the flexibility to provide service; ▪ arming – flexibility readied to deliver service once the trigger occurs to signal the beginning of delivery window; and ▪ delivery - automatic despatch of flexibility once the service is initiated.
Delivery Requirements	▪ the flexibility service requires the delivery of a contracted level of kW between a minimum and a maximum duration from the trigger; and ▪ service duration is either fixed or until the system condition no longer exists (if earlier)
Measurement Requirements	▪ kW measured at the flexible asset, measured every [TBC]; and ▪ kWh measured at the flexible asset, measured every [TBC]
Is Reserve Flexibility Possible?	▪ [TBC - depends on criticality of service]
Other Considerations	▪ determine how the service is initiated, the parameters of the service, and the frequency of measurement; ▪ determine whether flexible assets can work in series to provide the required duration; ▪ consider what services can be stacked (if any); and ▪ determine the payment level and the payment structure (availability, arming, and utilisation).

Appendix 4 – Peak Reactive

Purpose of Flexibility Service	To reduce the apparent power (kVA) using local reactive power (kVAr) to increase the headroom of a particular distribution network asset under certain system conditions and at certain times of day for a maximum duration. Typical application is to manage the peak demand in winter or to manage peak distributed generation during summer using a DSO instructed service.
Potential Providers of Flexibility Service	The following connected to the DSO asset that can meet the Service Parameters; ▪ owners of generator assets that can change their reactive power level; ▪ owners of storage assets that can change their reactive power level; ▪ owners of demand assets that can change their reactive power level; and ▪ aggregators of embedded flexibility that can change their reactive power.
Beneficiaries of Flexibility Service	▪ the ESO through increased competition from providers of reactive power services and reduced purchasing requirement; ▪ the affected DSO through the provision of optionality available until there is a more certain future, to manage losses on network, and increase capacity on network; ▪ owners of embedded flexibility (existing and new) who obtain additional revenue; ▪ aggregators who benefit from the revenue from flexibility services; and ▪ customers connected to the distribution network asset who benefit from lower losses and investment costs.
Service Parameters	▪ notice to start delivering flexibility - TBC ▪ maximum time to deliver service from Notice to start delivering flexibility - TBC ▪ minimum amount of flexibility - TBC ▪ minimum duration of flexibility delivery - TBC ▪ maximum duration of flexibility delivery – TBC
Testing	▪ to be determined once the service has been developed further

Scheduling Requirements	▪ scheduling is only required to determine if a flexible asset is to be armed as the service is triggered by a signal from the distribution network asset
Despatch Requirements	▪ availability – if a flexible asset is declared available to provide the flexibility service, it needs to be "armed" ahead of an availability window so they can deliver the service quickly if required ▪ arming - required as there is an automatic despatch once the service is initiated ▪ delivery - automatic despatch once the trigger is received; the speed of response depends on criticality of the service
Delivery Requirements	▪ the flexibility service requires the delivery of a contracted level of reactive power for between a minimum and a maximum duration ▪ service duration is either fixed or until the system condition no longer exists (if earlier)
Measurement Requirements	▪ kVAr measured at the flexible asset, measured every [TBC] ▪ kVArh measured at the flexible asset, measured every [TBC]
Is Reserve Flexibility Possible?	▪ yes
Other Considerations	▪ understand the experience of Power Potential (to the extent relevant) ▪ determine how the service is initiated, the parameters of the service, and the frequency of measurement. ▪ consider whether assets can work in series to provide the required duration ▪ consider what services can be stacked (if any) ▪ determine the payment level and the payment structure

Appendix 5 – Short-Term Operating Reserve

Purpose of Flexibility Service	To provide the ESO with access to sources of extra power to help manage the system when actual demand on the system is greater than forecast or there is an unforeseen generation unavailability which occurs more often than previously due to the imbalances caused by the growth of intermittent wind and solar generation. This is an ESO scheduled service.
Potential Providers of Flexibility Service	The following connected to the distribution network that can meet the Service Parameters; ▪ owners of generator assets that can increase their generation; ▪ owners of storage assets that can either increase their export or reduce their demand or import; ▪ owners of demand assets that can reduce their demand; and ▪ aggregators of embedded flexibility that increase their generation or reduce their demand
Beneficiaries of Flexibility Service	▪ the ESO through lower cost of balancing the system ▪ the affected DSO as enabled flexibility could be available for DSO flexibility services (although the DSO may lose access to flexibility that provides an ESO service) ▪ owners of embedded flexibility (existing and new) who obtain additional revenue; ▪ aggregators who benefit from the revenue from flexibility services; and ▪ all customers connected to any distribution network (even if not in the trial area) through lower balancing costs
Service Parameters	▪ notice to start delivering flexibility - TBC ▪ maximum time to deliver service from Notice to start delivering flexibility - TBC ▪ minimum amount of flexibility - TBC ▪ minimum duration of flexibility delivery - TBC ▪ maximum duration of flexibility delivery – TBC
Testing	▪ to be determined once the service has been developed further

Scheduling Requirements	▪ scheduled by the ESO and out of scope ▪ requires liaison between the ESO and DSO prior to any action being taken to avoid unintended consequences; the Power Potential project could provide experience on the communications between ESO and DSO and the effectiveness of such engagements; and the EFFS project could support thinking on constraints and ON-P outputs.
Despatch Requirements	▪ Availability – declaration of availability to the ESO to provide the service; ▪ Arming – the majority of non-BMU STOR providers have a 20 minutes notice period to allow for co-ordination with STOR providers so arming is not required; and ▪ Despatch - STOR instructions are currently issued to non-BMUs via a STOR Dispatch PC, but service providers will move to the Platform for Ancillary Services once available.
Delivery Requirements	▪ delivery is provided on a committed or flexible basis and should be sustained at the contracted level for a minimum or 2 hours ▪ after the end of a delivery period, service providers should be capable of providing service again within 20 hours
Measurement Requirements	▪ [kW] at the flexible asset using an approved metering solution or at the MPAN, measured every 1 minute
Reserve Flexibility Possible?	▪ could be provided by an aggregator (normal service delivery) or by a direct provider (if there is sufficient redundancy of approved flexibility).
Commercial Considerations	▪ STOR is an established process that is changing the initiation mechanism; it is uncertain whether this simplifies or complicates matters; ▪ the ESO and DSO need to make arrangements to ensure the despatch of particular flexibility providers does not result in unintended consequences and how this is communicated to the flexibility provider ▪ require a process for the ESO and DSO to determine whether a particular service provider should eb allowed to deliver that service ▪ consider the consequences on a flexibility provider if one of the ESO or DSO wants a particular service provider to provide a flexibility service, but the other does not (and the contractual consequences).

Appendix 6 – Authorised Supply Capacity Trading

Purpose of Flexibility Service	To allow customers supplied from the same [primary / grid] sub-station to share their Authorised Supply Capacity (import or export) for a period of time to help address specific customer issues, e.g. resolve generation constraints or trade Authorised Supply Capacity when not required. This service requires prior approval by the DNO and to ensure it does not create a constraint. This is a P2P scheduled service.
Potential Providers of Flexibility Service	▪ any customer supplied from the same [primary or grid] sub-station that wishes to increase or reduce their Authorised Supply Capacity; ▪ this service requires customers that wish to exceed their Authorised Supply Capacity (import or export) to request a revised system study from the DNO every [12] months. This analysis will have one of three outcomes; – unconditional approval, subject to providing details of the transactions (and supporting data) after the event; – conditional approval of each transaction prior to commencement of delivery of the flexibility service between the buyer and seller and subject to providing details of the transactions (and supporting data) after the event; or – no approval.
Beneficiaries of Flexibility Service	▪ the affected DSO through additional export from embedded generation projects (existing and new) and additional use of system revenue; ▪ existing customers within the same [primary or grid] sub-station who can monetise spare or unused Authorised Supply Capacity (import or export) for a period of time to help address specific issues of other customers; ▪ customers (existing and new) within the same [primary or grid] sub-station who can gain access to unused Authorised Supply Capacity (import or export) for a period of time to help address specific issues and improve project economics; ▪ the organisation that buys electricity from the generator involved in the transaction; ▪ all customers connected to any distribution network (even if not in the trial area) through increased embedded generation and the potential to avoid the costs of new power stations;
Service Parameters	▪ notice to start delivering flexibility - TBC ▪ maximum time to deliver service from Notice to start delivering flexibility - TBC ▪ minimum amount of flexibility - TBC ▪ minimum duration of flexibility delivery - TBC ▪ maximum duration of flexibility delivery – TBC

Testing	▪ to be determined once the service has been developed further
Scheduling Requirements	▪ if the DNO is required to approve each transaction prior to commencement of delivery of the flexibility service, the DNO should confirm approval or non-approval within agreed timescales before any delivery of the flexibility service; and ▪ flexibility will be scheduled to adhere to the timings within the transaction.
Despatch Requirements	▪ transactions are contractually binding once agreed but are conditional until DNO approval is provided (if required); ▪ once a transaction is unconditional there is self-despatch of the service; and ▪ there is the potential for an interruption to the service if there is any adverse network issue outwith the control of the DNO.
Delivery Requirements	▪ the buyer of the service can use the additional Authorised Supply Capacity between the start time and the end time of an agreed transaction; ▪ the seller of the service assumes it cannot use the reduction of the Authorised Supply Capacity between the start time and end time of an agreed transaction and can use the reduction of the Authorised Supply Capacity from the end time of an agreed transaction.
Measurement Requirements	▪ [kVA at MPAN], measured every [TBC]
Reserve Flexibility Possible?	▪ not applicable
Other Considerations	▪ require a process for the approval of buying / selling Authorised Supply Capacity, including any fees payable to the DSO; ▪ require a process for the approval by the DNO to transactions (if required) and the timings for such approval; ▪ need to consider the consequences if a customer exceeds their Authorised Supply Capacity (as amended by any transaction) ▪ the extent of any monitoring and control system which could be a barrier to participation ▪ consider charging customers for each kVAh to create a compensation mechanism and compensation pot ▪ if the DNO or DSO terminates a transaction after the DNO has provided approval of that transaction, compensation is payable unless the termination was due to a fault on the network outwith the reasonable control of the DNO in which case no termination is payable ▪ consider how other market actors are informed about transactions that could affect them

Appendix 7 – Offsetting

Purpose of Flexibility Service	To allow any demand, storage and generation customers supplied from the same constrained [primary or grid] sub-station to offset the increase in demand of one customer with the same level of increase in export of the other customer. The net effect of the transaction is zero so there is no effect on the constrained [primary or grid] sub-station as a result of this transaction.
Potential Providers of Flexibility Service	▪ any generator customer within the constrained [primary or grid] sub-station area that wishes to increase their exported volume; ▪ any demand customer within the constrained [primary or grid] sub-station area that wishes to monetise their flexibility; ▪ this service requires customers that wish to exceed their Authorised Supply Capacity (import or export) to request a revised system study from the DNO every [12] months. This analysis will have one of three outcomes; – unconditional approval, subject to providing details of the transactions (and supporting data) after the event; – conditional approval of each transaction prior to commencement of delivery of the flexibility service between the buyer and seller and subject to providing details of the transactions (and supporting data) after the event; or – no approval.
Beneficiaries of Flexibility Service	The following connected to the same constrained [primary or grid] sub-station; ▪ the affected DSO through increased revenue from increased export and usage of their network; ▪ owners of generator assets that can increase their generation; ▪ owners of storage assets that can either increase their export or reduce their demand or import and vice versa; ▪ owners of demand assets that can reduce their demand or increase their demand in response to price signals; ▪ aggregators of embedded flexibility that increase their generation or reduce their demand and vice versa ▪ the organisation that buys or sells electricity to the parties to the transaction; and ▪ all customers connected to any distribution network network (even if not in the trial area) through increased embedded generation and the potential to avoids the costs of new powers stations.
Service Parameters	▪ notice to start delivering flexibility – TBC ▪ maximum time to deliver service from Notice to start delivering flexibility - TBC

	▪ minimum amount of flexibility - TBC ▪ minimum duration of flexibility delivery - TBC ▪ maximum duration of flexibility delivery – TBC
Testing	▪ to be determined once the service has been developed further
Scheduling Requirements	▪ if the DNO is required to approve each transaction prior to commencement of delivery of the flexibility service, the DNO should confirm approval or non-approval within agreed timescales before any delivery of the flexibility service; and ▪ flexibility will be scheduled to adhere to the timings within the transaction.
Despatch Requirements	▪ transactions are contractually binding once agreed but are conditional until DNO approval is provided (if required); ▪ once a transaction is unconditional there is self-despatch of the service; and ▪ there is the potential for an interruption to the service if there is any adverse network issue outwith the control of the DNO.
Delivery Requirements	▪ in order to maintain a safe network, the demand should be increased in increments with the export increased by the same increment until one cannot increase any further; ▪ during delivery, the level of demand flexibility should be regularly monitored to ensure there is an [immediate] and corresponding reduction in the level of the Increased generation to maintain a safe network; ▪ at the end of the transaction, the additional export should reduce in increments followed by a similar incremental reduction in the demand until the generation has returned to its Authorised Supply Capacity (export) level.
Measurement Requirements	▪ [kW at asset level], measured every [1] minute
Reserve Flexibility Possible?	▪ n/a
Other Considerations	▪ require a process for the approval of exceeding Authorised Supply Capacity, including any fees payable to the DSO; ▪ require a process for the approval by the DNO to transactions (if required) and the timings for such approval; ▪ need to consider the effect of planned / unplanned changes that affect the transaction once it has been approved by the DSO;

	▪ need to consider the consequences if a customer exceeds their Authorised Supply Capacity (as amended by any transaction) ▪ the extent of any monitoring and control system (could be a barrier to participation) ▪ consider charging customers for each kVAh to create a compensation mechanism and compensation pot ▪ if the DNO or DSO terminates a transaction after the DNO has provided approval of that transaction, compensation is payable unless the termination was due to a fault on the network outwith the reasonable control of the DNO in which case no termination is payable ▪ consider the number of coincidental transactions that can be in effect ▪ consider how other market actors are informed about transactions that could affect them

transition

Moving to a smart future

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