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Energy Networks Association

Open Networks Project

DNO Flexibility Services Revenue Stacking

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Table of Contents

List of Figures

List of Tables

1 Executive Summary

Operators of flexible assets seeking to maximise value from their assets have numerous options for their trading strategy. Sources of revenue include trading energy on the wholesale market; providing balancing services to the National Grid Electricity System Operator ("the ESO"); capitalising on opportunities created by imbalance pricing; and more recently providing flexibility services to Distribution Network Operators (DNOs). Each revenue stream comes with associated commercial and regulatory complexity, and almost all of them are subject to ongoing development.

A key issue for providers of flexibility when choosing which revenue streams to use is the extent to which those revenues can be "stacked" with revenues from providing other services. In some cases that will involve stacking in the same time period by providing multiple services simultaneously; in others it will be based on moving between revenue streams in different time periods to take advantage of opportunities at different times of the day, referred to as "jumping" between the most optimal revenues.

This report has been prepared by Cornwall Insight and explores the extent to which flexible asset operators can stack revenue streams, with a particular focus on the way in which services being procured by DNOs integrate with other, more established revenue streams.

Flexible asset providers are able to move between revenue streams in different time periods much more readily than they are able to stack multiple revenue streams in the same time period. In some instances, there are necessary barriers to stacking in the same time period – for example to ensure that an asset is available to deliver frequency response services to the system in the event of an unexpected infeed loss and is not rendered unable to deliver that frequency response service because it is providing another service to another party.

Contract terms or regulatory arrangements cause an unnecessary barrier to revenue stacking in some instances. For example, the Capacity Market rules include a series of services which an asset may provide without risk of penalty under the Capacity Market, but this does not include balancing services which have been recently introduced by the ESO or services procured by DNOs.

There are opportunities for greater coordination across both the services being procured and the timescales for procurement and dispatch.

The issues which flexibility services procured by DNOs are seeking to resolve are typically highly locational but also predictable in advance. For example, flexibility procurement could enable reinforcement of a given substation to be deferred. That can only be procured from flexible assets connected to that substation (highly locational) but DNOs will be aware of, and monitoring, the approaching reinforcement over a long period of time (predictable).

Conversely, the issues which services such as frequency response and reserve seek to resolve are typically non-locational but unpredictable. For example, frequency response and reserve services to stabilise the system in response to the loss of a large generator can be provided across a wide area (non-locational) but the timing of dispatch (e.g. in response to an infeed loss) cannot be predicted in advance (unpredictable).

Better coordination of procurement timeframes could aid coordination of services, avoiding locking parties out of certain services due to the interaction between procurement timescales. A flexibility procurement platform which can be used by multiple procurers and multiple providers of flexibility may be beneficial in this respect, with the potential to enable co-ordinated procurement and delivery of flexibility across the system as a whole. However, to facilitate this there is also a need to develop a set of clear principles and primacy rules for addressing flexibility service conflicts between the transmission and distribution networks. These will need to balance the technical requirements / risks for the whole system with the needs of a flexibility procurement platform, value for FSPs and ultimately the end consumer.

This report makes a series of recommendations and options to address the barriers and opportunities identified. Taking these forward will require work to be undertaken by several parties including: the

DNOs, the ESO, the ENA Open Networks Project, Ofgem, and BEIS. In addition, input from Flexibility Service Providers (FSPs) and other stakeholders will also be key to inform the design and development of suitable solutions.

2 Introduction

2.1 Context

There are many revenue streams available to operators of flexible assets for the provision of network and system support services. In order to maximise the value from those assets, Flexibility Service Providers (FSPs) are increasingly seeking to dynamically "stack" revenues – which can mean both the stacking of multiple streams in the same time period, as well as moving between revenue streams in different time periods to take advantage of opportunities at different times of the day, referred to as "jumping" between the most optimal revenues.

This report has been prepared by Cornwall Insight to consider how revenues from providing flexibility services to Distribution Network Operators (DNOs) can be incorporated into an FSP's revenue stack and any barriers which exist to such revenue stacking.

2.2 DNO Flexibility Services

Where a DNO faces a network constraint, it has historically had no realistic alternative than to undertake network reinforcement – physically increasing the capability of the network by installing more (or larger) network assets – to relieve that constraint. With increasing volumes of flexible demand and generation connected to its networks, that is no longer the case. In instances where constraints are caused by the connection of new generation, Active Network Management (ANM) schemes are effective mechanisms for maximising use of existing network capacity and avoiding the need for network reinforcement. ANM schemes are already in use in many areas in GB. But ANM is less effective in dealing with constraints arising from general load growth. In this instance, procuring flexibility from FSPs behind constraints can be a cost-effective alternative method to relieve constraints, avoiding expensive network reinforcement and ultimately minimising costs to consumers.

FSPs are typically generation assets which can provide generation turn up, Demand Side Response (DSR) portfolios which can provide demand turn down or storage assets which can provide both.

DNOs currently procure four flexibility services (known as "products") for active power, as shown in Table 1. While the high-level products procured are the same, there are some differences in the approach taken to dispatching flexibility services which have a key impact on stacking – these are discussed throughout.

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

Table 1: Summary of DNO Flexibiltiy Services procured

2.3 Other flexibility revenue options

Alongside DNO Flexibility Services, this report considers the potential for FSPs to derive revenues from:

- Trading power on the wholesale market
- Taking on a Capacity Market (CM) obligation
- Using short term flexibility, either through:
    - Participating in the Balancing Mechanism (BM)
    - Providing Replacement Reserve (RR)
    - Actively chasing imbalance revenues through Net Imbalance Volume (NIV) chasing
- Providing response and/or reserve services to National Grid Electricity System Operator ("the ESO") including:
    - Firm Frequency Response (FFR)
    - Fast Reserve (FR)
    - Short Term Operating Reserve (STOR)

Many of these more established flexibility revenue streams are administered by the ESO. The contractual and practical implications for stacking ESO services are reasonably well understood, albeit subject to change over time as the ESO develops the services it procures. By contrast, the options for FSPs to stack DNO Flexibility Services with the ESO's services is not well established.

The aim of this report is therefore to provide an overview of current and prospective revenue streams for FSPs, and to present and understand the barriers to FSPs stacking revenues from DNO Flexibility Services with those from other revenue streams.

2.4 Approach

Cornwall Insight has considered the ability of FSPs to stack revenues in the same Settlement Period (half-hour), and to access different revenue streams across different time periods. Where we refer to "adjacent time periods", this generally refers to either the previous or next Settlement Period. However, some services are procured in blocks of Settlement Periods – for those services when referring to adjacent time periods we are referring to the Settlement Period prior to the start or after the end of an availability block.

In many cases, FSPs are able to conceptually split the capacity of their asset to provide multiple services. We do not consider such splitting in this report, with the focus being on the revenues available for a given MW in respect of each service rather than splitting that MW across multiple services.

We have only considered market-based revenue streams. There are other signals to which FSPs can respond, for example time of use signals in network charges, embedded benefits and losses adjustments. Those are underlying revenues which all FSPs will access by default, rather than through choosing to enter a competitive process.

2.5 Report structure

The main body of this report considers each of the current flexibility options listed in Sections 2.3. An overview of each is provided, followed by consideration of how revenues from that service can be stacked with all other services, including DNO Flexibility Services. This is followed by a section with some specific considerations for stacking of revenue streams, including procurement timeframes and penalties for non-delivery. Finally, we consider possible future revenue streams.

3 Current revenue streams

3.1 Wholesale market

Trades on the wholesale market are for active power only, taking place from around two or three years ahead of delivery until the start of each half-hour Settlement Period. While trades can take place within this wide time window, both market liquidity and the ability of some participants to access markets varies depending on the length of time to delivery – not all participants will choose to trade across such a wide time horizon. Trading can be financial or physical, with physical trading predominantly between licensed generators and offtakers – typically licensed suppliers.

3.1.1 Overview

There is no size limit on generators or offtakers participating in the wholesale market but most trades are subject to a minimum 1MW. Smaller generators are typically unlicensed and so sell their power via a Power Purchase Agreement (PPA) under which they agree to sell all power generated to an offtaker which in turn trades that power on the wholesale market. Trades can be bilateral, multilateral or through a platform. The ESO can also trade (outside of the BM). The structure of wholesale trading is summarised in Figure 1.

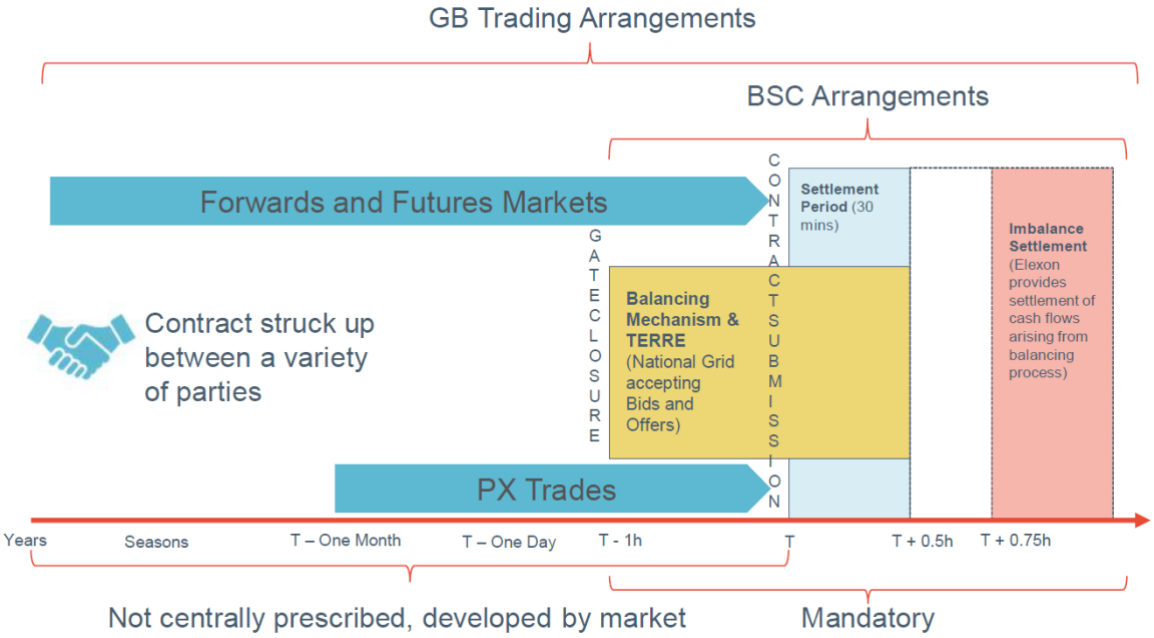

Figure 1: Timing of the BM, source: Cornwall Insight

Balance Responsible Parties (BRPs) are required to notify Central Systems (administered by Elexon and governed by the Balancing and Settlement Code (BSC)) of their contract positions to enable Energy Imbalance Volumes to be calculated. This is done by submitting notifications to the Energy Contract Volume Aggregation Agent (ECVAA). Notifications are submitted in relation to the relevant BSC Party's Production and/or Consumption Energy Accounts[1].

Following each Settlement Period, each BRP's imbalance position is calculated as the difference between its traded position and its Allocated Volumes. Allocated Volumes for each BRP are the sum of metered or profiled volumes for the Balancing Mechanism Units (BMUs) which are associated with that BRP. If the BRP had higher demand/lower generation than its traded position, it has a "short" imbalance position; if it had lower demand/higher generation than its traded position, it has a "long" imbalance position.

[1] Each BSC Trading Party has two energy accounts – a Production Account (historically used for generation volumes) and a Consumption Account (historically used for demand volumes).

Any imbalance (either short or long) attracts the single imbalance price, which is calculated based on the cost of the marginal balancing actions taken by the ESO.

3.1.2 Opportunities and risks for flexible assets

Wholesale prices are becoming increasingly volatile, creating arbitrage opportunities for flexible assets. Similarly, imbalance prices are increasing both in volatility and magnitude, so the impact of non-delivery of traded position (or failing to trade) is increasing.

3.1.3 Stacking with other revenue streams

In general, the revenues from selling power on the wholesale market can be stacked with other revenue streams. But if an FSP dispatches to take advantage of revenues available for another flexibility service, without an adjustment or trade to account for this, it could drive imbalance for the BRP. For example, assuming all other generation and demand within a given BRP's portfolio operated exactly as expected, an FSP generating more than expected will drive a long imbalance position for the BRP's portfolio as a whole.

This is resolved for services procured by the ESO through Applicable Balancing Services Volume Data (ABSVD). This is effectively a retrospective adjustment to the traded position for the BRP in question. ABSVD is not currently used for DNO Flexibility Services but may be in the future – this is being examined as part of the IntraFlex project[2].

Revenues from the wholesale market are also not stackable with tendered firm response and reserve services (e.g. Firm Frequency Response, FR and STOR) in the same time period, as those services require a generator to be in a position to ramp up output in response to a signal from the ESO – which it cannot do if it is already generating to meet its traded position in the wholesale market. ABSVD ensures that an FSP which is dispatched for any of these services does not result in imbalance for the BRP.

Stacking wholesale market revenues with DNO Flexibility Services varies depending on the timing of dispatch. Products which are dispatched close to real time – the Dynamic and Restore products and for some DNOs the Secure product – are not stackable and provision of these services risks creating imbalance for the relevant BRP. This could be resolved if an adjustment (similar to ABSVD) were made.

Stacking revenues from products which are dispatched in advance – the Sustain product and for some DNOs the Secure product[3] – is possible but is reliant on close coordination between the FSP and BRP. In theory, if notified in advance by the FSP that it intends to dispatch for provision of a DNO Flexibility Service, the BRP can trade its wholesale position to align with that dispatch schedule. However, depending on the timing of the FSP to BRP notification, the BRP may incur trading costs and so may be unwilling to trade such volumes. To avoid incurring high costs of this nature, there may be conditions within the FSPs PPA with the BRP which restrict the timing for the provision of forecast output by the FSP to the BRP. Such conditions would restrict stacking DNO Flexibility Service and wholesale market stacking.

2 https://www.westernpower.co.uk/projects/intraflex

3 For example, WPD provide a dispatch schedule for the Secure product at the week-ahead stage

3.1.4 Summary of stacking

Table 2 shows which flexibility services can be stacked with revenues from the wholesale market.

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods
CM	Yes	Yes
BM	Yes	Yes
RR	Yes	Yes
NIV Chasing	Yes	Yes
FFR	No – cannot sell power on wholesale market as required to be available to ramp output as required. Imbalance risk resolved through ABSVD	Yes
FR		
STOR		
DNO Sustain	Yes, subject to agreement from the BRP and close coordination between FSP and BRP	Yes
DNO Secure	Varies by DNO. When dispatched in advance, then yes, subject to agreement from the BRP and close coordination between FSP and BRP. When dispatched close to real time: no, and dispatch risks driving imbalance for BSC Party.	Yes
DNO Dynamic	No, and dispatch risks driving imbalance for BSC Party	Yes
DNO Restore		

Table 2: Stackability of wholesale market revenues with other revenue streams

3.2 Capacity Market

The Capacity Market (CM) is designed to fix the "missing money" problem – the gap between the 'energy-only' price in the wholesale market and the price needed to incentivise investment in new generation capacity.

3.2.1 Overview

Capacity Providers must be at least 1MW in size but can be aggregated and must demonstrate their ability to provide capacity three times per year via Satisfactory Performance Days.

Procurement is by competitive auction for delivery in three ("t-3") and four years ("t-4") with a top-up auction for delivery next year ("t-1"). Parties who are unsuccessful in winning contracts can bilaterally take on another Capacity Provider's obligation (i.e. through secondary trading).

The ESO will issue a Capacity Market Notice if it anticipates a tight supply margin (available supply capacity less than 500MW more than forecast demand). A CM Stress Event follows if a System Stress Event[4] occurs at least four hours after the ESO has issued a CM Notice. The obligation on Capacity Providers is to dispatch in a CM Stress Event. Payment is on a £/kW/year basis with additional payments available for over-delivery in the event of a CM Stress Event.

[4] A Settlement Period in which a System Operator Instigated Demand Control Event occurs where such event lasts at least 15 continuous minutes (whether the event falls within one Settlement Period or across more than one consecutive Settlement Periods, and where the event falls across multiple consecutive Settlement Periods, each of those Settlement Periods will be a "System Stress Event").

Should a Capacity Provider fail to meet its obligation, it can reallocate volumes to another party, provided that other party has registered to participate in the CM Volume Reallocation process.

Unlike some other flexibility services, the CM does not require generation assets to vary output compared to a baseline – the only obligation is to dispatch in a CM Stress Event, regardless of whether the asset would have dispatched anyway. However, for DSR a baseline is retrospectively determined based on half hourly usage for the six weeks leading up to a CM Stress Event.

There are two types of penalty under the CM:

- Termination fees (related to availability rather than delivery under a CM Stress Event) between £5,000 and £35,000.
- Capacity Providers that fail to deliver sufficient volumes to meet their obligation during a CM Stress Event (and are unable to reallocate volumes to another provider during the volume reallocation window) may be subject to CM penalties.

3.2.2 Opportunities and risks for flexible assets

The CM offers a reliable revenue stream based primarily on being available to provide capacity. As a result, it is a relatively low risk revenue option. The revenue available is heavily influenced by de-rating factors (reflecting the length of time for which a provider can deliver capacity) – which are particularly low for short duration storage.

3.2.3 Stacking with other revenue streams

As noted in Section 3.2.1, Capacity Providers who fail to meet their obligations in a CM Stress Event (and are unable to reallocate volumes to another provider during the volume reallocation window) may face CM penalties.

However, Capacity Providers who do not deliver their obligation because they were engaged in a Relevant Balancing Service at the time of the CM Stress Event are not penalised. The CM Rules include a list of "Relevant Balancing Services" which includes the BM, STOR, FR and FFR currently. As a result, Capacity Providers can freely participate in the BM, STOR, FR and FFR without risk of penalty. Changes can be proposed to add additional products to Relevant Balancing Services – for example, a change is being progressed to add Trans European Replacement Reserve Exchange (TERRE) balancing products. In the meantime, a Capacity Provider offering a TERRE balancing product (or any other new balancing products that are not included in the list of relevant balancing services) could face a CM penalty.

There is no obligation not to provide other services under the CM but providing a service that is not covered by Relevant Balancing Services could expose a CM provider to penalties should a CM Stress Event occur.

However, CM Stress Events are likely to be limited. Assets owners will typically consider the risk of participating in other services which may mean they fail to deliver a CM obligation to be an acceptable risk. This includes DNO Flexibility Services.

3.2.4 Summary of stacking

Table 3 shows which flexibility services can be stacked with revenues from the CM.

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods
Wholesale market	Yes	n/a – CM contract is year-round and 24 hours a day, not in "windows" as with some other services
BM	Yes	
RR	Yes – but despite there being no obligation not to provide the service there remains a risk of penalty without changes to the list of Relevant Balancing Services	
NIV Chasing	Yes	
FFR	Yes	
FR	Yes	
STOR	Yes	
DNO Sustain	Yes – but despite there being no obligation not to provide the service there remains a risk of penalty without changes to the list of Relevant Balancing Services	
DNO Secure		
DNO Dynamic		
DNO Restore		

Table 3: Stackability of CM with other revenue streams

3.3 Balancing Mechanism

The BM is the main mechanism for balancing the system and managing transmission constraints in real time. It operates from one hour before delivery, although the ESO can also take early actions with certain generators or by trading on power exchanges.

3.3.1 Overview

For each Settlement Period, the BM operates from 1 hour before the start of that Settlement Period ("Gate Closure") until the end of that Settlement Period, as shown in Figure 2. Participation is mandatory for licensed generators and suppliers. Larger distribution-connected generators also participate via a Bilateral Embedded Generation Agreement. Smaller generators and DSR above 1MW can participate through Virtual Lead Parties.

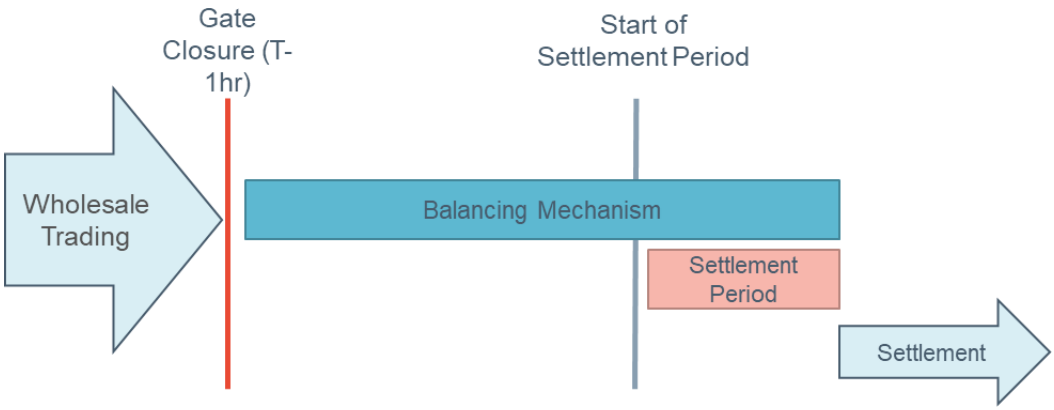

Figure 2: Timing of the BM

All BM Participants provide Final Physical Notifications (FPNs) by BMU ahead of Gate Closure which reflect that BMU's expected output or demand. BM Participants also submit:

- Bids, which for generators represent the price that generator would be willing to pay to reduce its output compared to its FPN
- Offers, which for generators represent the price that generator would require to increase its output compared to its FPN

The ESO selects the lowest cost "stack" of Bids and Offers to resolve constraints and balance the system in each Settlement Period to dispatch through Bid Offer Acceptances (BOAs). BM Participants are then paid as bid. There is effectively no restriction on prices for Offers[5], but prices for Bids that are behind transmission constraints are limited to short run marginal cost, accounting for maintenance, ramping down and reasonable profits from opportunity cost. A non-delivery payment mechanism ensures a party is never better off having not delivered in the BM – but equally, no penal charge is applied for non-delivery.

3.3.2 Opportunities and risks for flexible assets

There are lucrative opportunities available in the BM, particularly for the most flexible assets (those which can ramp up quickly).

But dispatch in the BM is determined by the lowest cost combination of BOAs to meet the ESO's system needs so there is no guarantee that any asset will be called on for a given period – so the primary risk is of not being dispatched and losing other revenue opportunities.

3.3.3 Stacking with other revenue streams

Participation in the BM is fully compatible with wholesale market and CM. It is generally not compatible with other balancing services, as noted in the sections on each of those services. However, going into Gate Closure with an FPN that is not zero will alter the actions available that can be taken by the ESO for that provider.

For DNO Flexibility Services, there is no regulatory barrier to BM participation but there is a risk of penalty for non-delivery if an FSP is dispatched under both in the same time period. Unlike the CM, this is relatively likely to occur (unlike the CM, BOAs are issued in every Settlement Period), so we consider the two to be not stackable in the same time period.

If a single FSP were to participate in both DNO Flexibility Services and the BM, it is not clear which party (DNO or the ESO) has the final "veto" on which service is provided if the FSP were dispatched by both.

There is no restriction on participation in other services in other time periods.

5 Central systems impose a de facto £99,999 limit on offers, but that limit does not typically influence bidding behavior.

3.3.4 Summary of stacking

Table 4 shows which flexibility services can be stacked with revenues from the BM.

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods
Wholesale market	Yes	Yes
CM	Yes	Yes
RR	Yes	Yes
NIV Chasing	No	No
FFR	No – BM participation would render an FSP unavailable for any of these services	Yes
FR		
STOR		
DNO Sustain	No – while there is no regulatory barrier, there is a high likelihood of being unable to deliver if dispatched under both BM and DNO Flexibility Services, so we consider them to be incompatible	Yes
DNO Secure		
DNO Dynamic		
DNO Restore		

Table 4: Stackability of BM revenues with other revenue streams

3.4 Replacement Reserve

RR has been developed to enable harmonised procurement of balancing services across European transmission operators and was introduced by Project TERRE. It is used by the ESO as the first tool for "approximate" balancing which is then refined through the BM.

3.4.1 Overview

RR is delivered in 15-minute blocks, and to an ideal prescribed shape which details the ramp up and ramp down rates required either side of the delivery block, as shown in Figure 3. Auctions take place ahead of each RR delivery period, which lasts an hour and has four individual RR blocks, i.e. four RR blocks are included in a single hourly auction. Payments for accepted RR bids are set at the clearing price for the auction in each pricing zone.

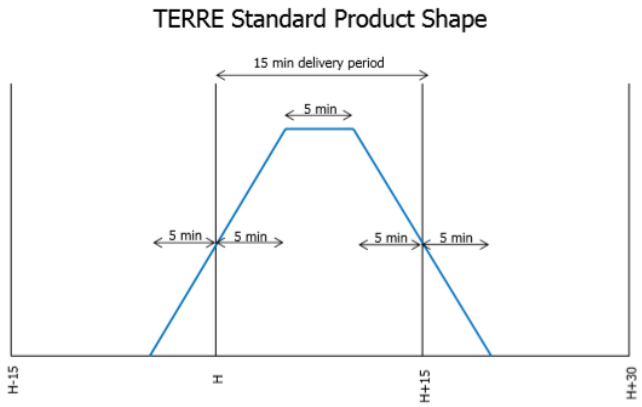

Figure 3: RR ideal shape, source: Elexon[6]

6 https://www.elexon.co.uk/wp-content/uploads/2017/09/08_278_06_P344_AR-Project-TERRE-Assessment-Report-v1.0.pdf

Many of the features of RR are common with the BM. For example, providers must be at least 1MW but can be aggregated, the communications systems for dispatch are common and a non-delivery payment mechanism ensures a party is never better off having not delivered RR.

An RR provider will receive no payment if they deviate from the ideal shape but will also not be penalised.

3.4.2 Opportunities and risks for flexible assets

RR is a standard product with parties competing to provide the service across Europe, subject to the capability of interconnection. Parties can bid to provide both RR and BM services. RR will typically have lower value but will be called first - leaving opportunities should the ESO issue further BOAs through the BM to resolve any remaining imbalance.

3.4.3 Stacking with other revenue streams

Provision of RR is fully compatible with the wholesale market (albeit an asset's traded position may limit its ability to provide RR, for example if it is already generating at its maximum capacity) and BM. Under current arrangements, providing TERRE services while under a CM contract may expose the FSP to CM penalties, but this may be resolved by adding RR to the list of Relevant Balancing Services in the CM Rules. As with the BM, RR is not compatible with other balancing services.

For DNO Flexibility Services, there is no regulatory barrier to RR provision but there is a risk of penalty for non-delivery if an FSP is dispatched under both in the same time period. Unlike the CM, this is relatively likely to occur (unlike the CM, RR is dispatched in every Settlement Period), so we consider the two to be not stackable in the same time period.

If a single FSP were to participate in both DNO Flexibility Services and RR provision, it is not clear which party (DNO or the ESO) has the final "veto" on which service is provided if the FSP were dispatched by both.

There is no restriction on participation in other services in other time periods.

3.4.4 Summary of stacking

Table 4 shows which flexibility services can be stacked with revenues from providing RR.

<table>
<tr><th>Revenue Stream</th><th>Stackable in same time period</th><th>Stackable in adjacent time periods</th></tr>
<tr><td>Wholesale market</td><td>Yes</td><td>Yes</td></tr>
<tr><td>CM</td><td>Yes – but despite there being no obligation not to provide the service there remains a risk of penalty</td><td>Yes</td></tr>
<tr><td>BM</td><td>Yes</td><td>Yes</td></tr>
<tr><td>NIV Chasing</td><td>No</td><td>No</td></tr>
<tr><td>FFR</td><td rowspan="3">No – BM participation would render an FSP unavailable for any of these services</td><td rowspan="3">Yes</td></tr>
<tr><td>FR</td></tr>
<tr><td>STOR</td></tr>
<tr><td>DNO Sustain</td><td rowspan="4">No – while there is no regulatory barrier, there is a high likelihood of being unable to deliver if dispatched under both BM and DNO Flexibility Services, so we consider them to be incompatible</td><td rowspan="4">Yes</td></tr>
<tr><td>DNO Secure</td></tr>
<tr><td>DNO Dynamic</td></tr>
<tr><td>DNO Restore</td></tr>
</table>

Table 5: Stackability of RR revenues with other revenue streams

3.5 Active NIV Chasing

NIV Chasing involves capitalising on high imbalance prices by deliberately taking the opposite imbalance position to system imbalance (the NIV) for which the cash-out price is paid. It is typically used to describe capacity that can respond to imbalance price signals in real time.

3.5.1 Overview

In theory, any BM Participant can have an intentional long position (by generating more or consuming less than they have traded in the ex-ante markets) and be paid the imbalance price for that imbalance. However, participants with BMUs (i.e. typically larger assets) must submit data to the ESO before Gate Closure (one hour before the start of the Settlement Period) including an FPN. This means that it cannot adjust its position after this point, so must base its decision to take a long imbalance position entirely on a pre-Settlement Period assumption on the imbalance price.

Conversely, flexible capacity which does not have to submit an FPN (i.e. is not a BRP and is included within a supplier BMU for which an FPN is submitted) can decide whether to take an imbalance position during a Settlement Period. For example, if it observes the ESO accepting high Offers in the BM, indicating that the system is short and the cash-out price will be high, it can dispatch and, all else being equal, push the position of its BRP long. The BRP in question will then be paid the cash-out price for its Long position, with the benefit typically shared with the FSP under the terms of its PPA. An example of the NIV Chasing process is summarised in Figure 4.

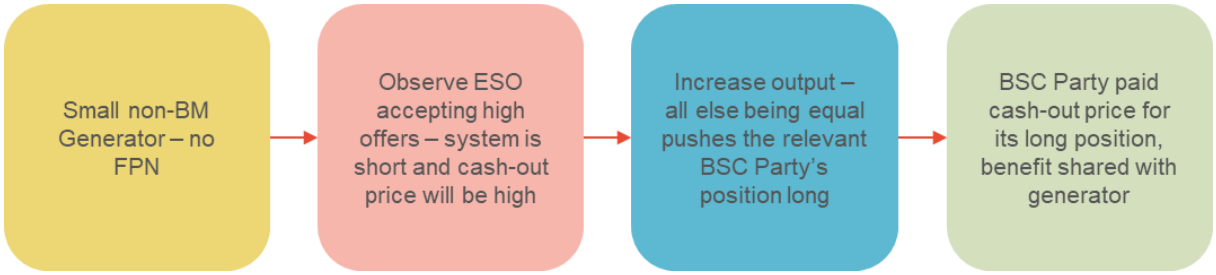

Figure 4: NIV Chasing process

Unlike other services considered, NIV Chasing is not a procured service; rather it involves assets self-dispatching in real time in response to forecasts of market signals.

3.5.2 Opportunities and risks for flexible assets

NIV Chasing is a high-risk revenue stream requiring accurate prediction of the imbalance price. Inaccurate prediction of the overall system imbalance could result in an FSP pushing its BRP's imbalance position in the same direction as the system imbalance, with associated exposure to charges calculated based on the cash-out price. There is also a risk to FSPs of losing money compared with trading in the wholesale market ahead of time if they dispatch and the imbalance price is low.

A further risk is the increasing proportion of time periods with negative prices, which increases the risk of being exposed to charges rather than deriving revenues.

3.5.3 Stacking with other revenue streams

NIV Chasing is exclusive from almost all other revenue streams:

- Cannot participate in the BM – BM requires an FPN and Bids and Offers to deviate from that FPN; to actively NIV chase the provider needs the flexibility to change output in response to its expectation of the imbalance price
    - It takes around two weeks to leave the BM – so effectively not stackable with the BM in adjacent time periods either
- Cannot provide other balancing services or DNO Flexibility Services as this would result in losing the flexibility to self-dispatch

While participation in other services (e.g. DNO Flexibility Services) could result in the imbalance price being paid for volumes dispatched, we do not consider this "active" NIV chasing; rather it is simply a knock-on impact of providing another service – so they are not stackable.

3.5.4 Summary of stacking

Table 6 shows which flexibility services can be stacked with revenues from NIV Chasing.

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods
Wholesale market	No	Yes
CM	Yes	Yes
BM	No	No
RR	No	No
FFR	No – NIV Chasing requires freedom to self-dispatch which is not possible under all of these services	Yes
FR		
STOR		
DNO Sustain	No – NIV Chasing requires freedom to self-dispatch which is not possible under all of these services	Yes
DNO Secure		
DNO Dynamic		
DNO Restore		

Table 6: Stackability of NIV Chasing revenues with other revenue streams

3.6 Frequency Response

Frequency Response is the provision of short-term flexibility in response to drops in frequency. It is used by the ESO to keep the system operating as close to 50Hz as possible.

3.6.1 Overview

In GB, Firm Frequency Response (FFR) is the main frequency service. Two variants of response are currently procured:

- Static – an agreed amount of energy/DSR is delivered if frequency drops to a given level. Static providers must dispatch if frequency hits pre-defined trigger levels. For example, a Static provider may be required to increase generation if frequency drops to 49.7Hz or below.
- Dynamic – generation output/demand rises and falls automatically in line with system frequency. Dynamic providers must dispatch automatically in response to changes in system frequency on a second by second basis.

Three FFR products are procured within these two variants:

- Primary – response provided within 10 seconds of an event, which can be sustained for a further 20 seconds
- Secondary – Response provided within 30 seconds of an event, which can be sustained for a further 30 minutes
- High (dynamic only) – response provided within 10 seconds of a high-frequency event, which can be sustained indefinitely

The ESO is in the process or removing the Static variant of FFR and replacing the three dynamic FFR products with three new products: Dynamic Containment, Dynamic Moderation and Dynamic Regulation.

FFR has historically been procured by the ESO by monthly tender. That approach is being phased out and replaced with weekly auctions. Recent tenders and auctions have cleared around £5/MW/hr. It is procured in "availability windows" which align with Electricity Forward Agreement (EFA) blocks – four hour periods starting at 0300, 0700, 1100, 1500, 1900 and 2300.

Delivery of the service is monitored on a second by second basis to ensure that the plant is responding to changes in system frequency according to its contract. If not, availability and nomination payments for the window of non-delivery are set to zero, with contract termination if non-availability occurs more than three times in any given month.

3.6.2 Opportunities and risks for flexible assets

FFR is a low risk revenue stream for FSPs as payment is based primarily on availability, although can include other payment structures. Over recent years, the number of providers has steadily increased, with a corresponding increase in market liquidity and reduction in clearing prices.

3.6.3 Stacking with other revenue streams

Providers bidding for FFR contracts nominate EFA blocks for which they will be available. Provision of almost all other services in an EFA block for which an FSP has a contract for Frequency Response would render a provider unable to fulfil its Frequency Response obligation; hence this is effectively an exclusive service, except for the CM for which FFR is a Relevant Balancing Service. In other EFA blocks this exclusivity does not apply.

3.6.4 Summary of stacking

Table 7 shows which flexibility services can be stacked with revenues from FFR.

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods [adjacent EFA blocks in this context]
Wholesale market	No	Yes
CM	Yes	Yes
BM	No	Yes
RR	No	Yes
NIV Chasing	No	Yes
FR	No	Yes
STOR	No	Yes
DNO Sustain	No	Yes
DNO Secure	No	Yes
DNO Dynamic	No	Yes
DNO Restore	No	Yes

Table 7: Stackability of Frequency Response with other revenue streams

3.7 Fast Reserve

FR is used to "fill the gap" between frequency response and STOR in response to, for example, unexpected loss of large generating plant from the system. It is provided by capacity which, while

being too slow to provide frequency response can ramp output relatively quickly. Figure 5 shows the interaction between FFR, FR and STOR.

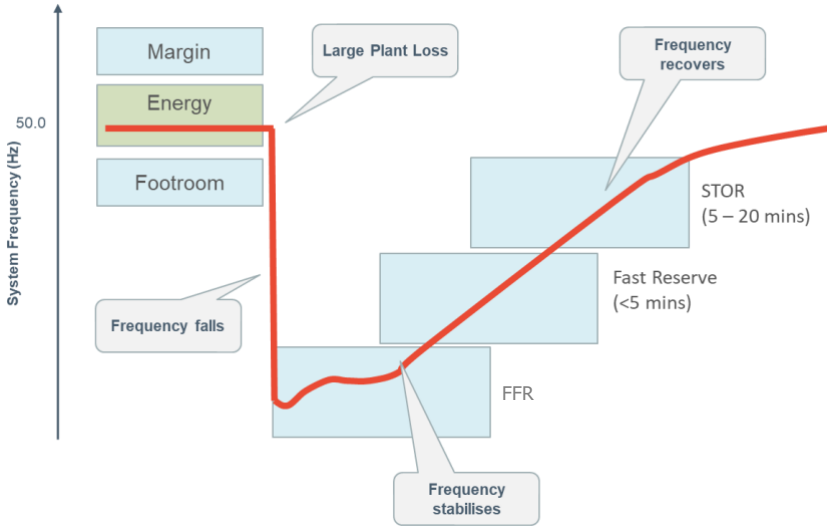

Figure 5: Timing of FFR, FR and STOR in response to large plant loss

3.7.1 Overview

Under normal circumstances, the ESO tenders for FR services monthly. However, these have been suspended since January 2020 while the ESO seeks clarity on the application of the Clean Energy Package and its implications for FR.

Providers must be at least 25MW (can be aggregated) and must be able to ramp output at 25MW per minute within two minutes of an instruction from the ESO, with the ability to maintain that response for at least 20 minutes. An availability (£/MW/hr) and utilisation (£/MWh) fee are paid.

Service providers send availability declaration to the ESO by EFA block. If they cannot provide the service, they must notify the ESO and they will not receive availability payments for that period. Where the provider has declared availability but cannot deliver, they are in default and payments can be withheld and contracts terminated by the ESO.

3.7.2 Opportunities and risks for flexible assets

Payment is based on a combination of availability fees (in £ per hour in each availability period) and utilisation fees (in £ per MW per hour paid in respect of energy delivered). Some revenue is protected through the availability payment, but the total revenue derived will vary significantly depending on whether the asset is dispatched which is inherently unpredictable.

3.7.3 Stacking with other revenue streams

Providers bidding for FR contracts nominate which EFA blocks for which they will be available. Provision of almost all other services in an EFA block for which a provider has a contract for FR would render a provider unavailable to fulfil its FR obligation; hence this is effectively an exclusive service, except for the CM for which FR is a Relevant Balancing Service. In other EFA blocks this exclusivity does not apply.

3.7.4 Summary of stacking

Table 8 shows which flexibility services can be stacked with revenues from FR.

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods [adjacent EFA blocks in this context]
Wholesale market	No	Yes
CM	Yes	Yes
BM	No	Yes
RR	No	Yes
NIV Chasing	No	Yes
FFR	No	Yes
STOR	No	Yes
DNO Sustain	No	Yes
DNO Secure	No	Yes
DNO Dynamic	No	Yes
DNO Restore	No	Yes

Table 8: Stackability of FR with other revenue streams

3.8 Short Term Operating Reserve

STOR retains generators on standby over key periods of the day. It is split into two key services: Committed STOR and Flexible STOR.

3.8.1 Overview

Provision of STOR differs between assets which are in the BM and those which are not. Committed STOR is provided by both BM and non-BM providers with two tender rounds each year between 2 and 24 months ahead of delivery. Flexible STOR is only provided by non-BM providers with weekly availability declarations. All providers must be at least 3MW but can be aggregated.

Providers must be able to dispatch within a maximum of four hours of an instruction from the ESO, but dispatch times within 20 minutes are preferable to the ESO. The response must be sustained for at least two hours and have a recovery period of less than 20 hours.

Generation assets are required to ramp from zero output to meet a STOR requirement, so effectively have a zero baseline. But STOR can be provided by DSR, for which a baseline is needed. Providers calculate a fixed or variable baseline demand for the site (or portfolio) in advance of each availability window, which is typically based on minute by minute metering data from the preceding three days.

Should a provider fail to deliver, availability and nomination payments for the window of non-delivery are set to zero, with contract termination if non-availability occurs more than three times in any given month.

3.8.2 Opportunities and risks for flexible assets

Payment for STOR is based on a combination of availability fees (in £ per MW per hour in each availability period) and utilisation fees (in £ per MWh paid in respect of energy delivered). Some revenue is protected through the availability payment, but the total revenue derived will vary significantly depending on whether the asset is dispatched which is inherently unpredictable.

3.8.3 Stacking with other revenue streams

Providers bidding for STOR contracts nominate availability windows for which they will be available. Provision of almost all other services in an availability window for which a provider has a contract for STOR would render a provider unavailable to fulfil its STOR obligation; hence this is effectively an exclusive service, except for the CM for which STOR is a Relevant Balancing Service. Outside of nominated availability windows, this exclusivity does not apply.

3.8.4 Summary of stacking

Table 9 shows which flexibility services can be stacked with revenues from STOR.

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods [adjacent to start or end of an availability window in this context]
Wholesale market	No	Yes
CM	Yes	Yes
BM	No	Yes
RR	No	Yes
NIV Chasing	No	Yes
FFR	No	Yes
FR	No	Yes
DNO Sustain	No	Yes
DNO Secure	No	Yes
DNO Dynamic	No	Yes
DNO Restore	No	Yes

Table 9: Stackability of STOR with other revenue streams

3.9 Stacking DNO Flexibility Services

An FSP can only dispatch for any one DNO Flexibility Service at a given time. But they may be able to make their asset available for the provision of multiple services, with the DNO then having full visibility of which assets it can call upon to provide each of its services in any given location at any time.

The DNO Sustain service requires dispatch to a pre-determined profile, so can never be stacked in the same time period with other services but can be stacked in adjacent time periods. The remaining three are dispatched at shorter notice. We think there is no reason why an FSP should not be available to provide multiple DNO Flexibility Services and be dispatched by the DNO appropriately.

However, an FSP cannot stack availability for DNO Flexibility Services with those procured by the ESO as provision of services to one operator may render that participant unable to meet its obligation to the other.

3.9.1 Summary of stacking

Table 10 and Table 11 show which flexibility services can be stacked with revenues from the DNO Sustain service and other DNO Flexibility Services respectively.

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods [adjacent to start or end of an availability window in this context]
Wholesale market	Yes – dispatched in advance so can trade to that position subject to agreement and close coordination between FSP and BRP	Yes
CM	Yes – but despite there being no obligation not to provide the service there remains a risk of penalty	Yes
BM	No – already dispatching to a set profile so cannot flex output in response to a BOA	Yes
RR		
NIV Chasing	No – already dispatching to a set profile so cannot flex output in response to expected value from the cash out price	Yes
FFR	No – already dispatching to a set profile so cannot increase output if called under one of these services	Yes
FR		
STOR		
DNO Secure	No – already dispatching to a set profile so cannot flex output in response to a further instruction from the DNO	Yes
DNO Dynamic		
DNO Restore		

Table 10: Stackability of DNO Sustain service with other revenue streams

Revenue Stream	Stackable in same time period	Stackable in adjacent time periods [adjacent to start or end of an availability window in this context]
Wholesale market	Varies by DNO and service. When dispatched in advance for Secure service: yes, subject to agreement and close coordination between FSP and BRP. When dispatched close to real time: no, and dispatch risks driving imbalance for the BRP.	Yes
CM	Yes – but despite there being no obligation not to provide the service there remains a risk of penalty	Yes
BM	No – while there is no regulatory barrier, there is a high likelihood of being unable to deliver if dispatched under both BM and DNO Flexibility Services, so we consider them to be incompatible	Yes
RR		
NIV Chasing	No – NIV Chasing requires freedom to self-dispatch which is not possible under all of these services	Yes
FFR	No – if called by both DNO and ESO, likely to be unable to meet both obligations	Yes
FR		
STOR		
DNO Sustain	No – other services than Sustain require ability to dispatch at short notice while Sustain requires dispatch to a set profile	Yes
DNO Secure	Yes – while an FSP can only provide one service at any time, the DNO has full visibility of which services it is available for and so can optimise dispatch	Yes
DNO Dynamic		
DNO Restore		

Table 11: Stackability of DNO Flexibility Services other than Sustain with other revenue streams

4 Summary of revenue stacking

In general, services are readily stackable in adjacent time periods, but less so in the same time period.

Same Time Period	Whole-sale	CM	BM	RR	NIV Chase	FFR	FR	STOR	DNO Sustain	DNO Secure	DNO Dynamic
DNO Restore	No	Yes **	No	No	No	No	No	No	No	Yes ***	Yes ***
DNO Dynamic	No	Yes **	No	No	No	No	No	No	No	Yes ***	
DNO Secure	No *	Yes **	No	No	No	No	No	No	No		
DNO Sustain	Yes	Yes **	No	No	No	No	No	No			
STOR	No	Yes	No	No	No	No	No				
FR	No	Yes	No	No	No	No					
FFR	No	Yes	No	No	No						
NIV Chase	No	Yes	No	No							
RR	Yes	Yes **	Yes								
BM	Yes	Yes									
CM	Yes										

* Varies by DNO. Some dispatch for Secure in advance (e.g. week-ahead for WPD) so the relevant BRP can trade to that position. Others dispatch closer to real time.
** No obligation not to provide but could expose the provider to risk of CM penalty.
*** Cannot dispatch for both Restore and Dynamic or Secure services in the same time period, but DNO has visibility of all services for which an FSP is available so can optimise dispatch.

Table 12: Stackability of revenue streams in the same time period

Adjacent Time Period	Whole-sale	CM	BM	RR	NIV Chase	FFR **	FR **	STOR *	DNO Sustain	DNO Secure	DNO Dynamic
DNO Restore	Yes	n/a ***	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
DNO Dynamic	Yes	n/a ***	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
DNO Secure	Yes	n/a ***	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
DNO Sustain	Yes	n/a ***	Yes	Yes	Yes	Yes	Yes	Yes			
STOR	Yes	n/a ***	Yes	Yes	Yes	Yes	Yes				
FR	Yes	n/a ***	Yes	Yes	Yes	Yes					
FFR	Yes	n/a ***	Yes	Yes	Yes						
NIV Chase	Yes	n/a ***	No	No							
RR	Yes	n/a ***	Yes								
BM	Yes	n/a ***									
CM	Yes										

* In the context of STOR, we are considering time periods adjacent to availability windows rather than adjacent half hour periods
** In the context of FR and FFR, we are considering adjacent EFA blocks rather than adjacent half hour periods
*** CM contract is year-round and 24 hours a day, not in "windows" as with other services

Table 13: Stackability of revenue streams in adjacent time periods

5 Key considerations for revenue stacking

In this section we consider three important factors for a flexible asset when considering whether to stack revenues from different streams:

- Baselining, i.e. the level against which delivery of the service in question will be assessed
- Procurement timescales for different services
- Penalties for non-delivery

5.1 Baselining

Baselining determines how delivery performance is assessed and is therefore a key issue for all procurers of flexibility services. It is important that FSPs are rewarded for actions taken to change usage to a different level than would otherwise have been the case, rather than simply for continuing with the same behaviour. This relies on an accurate baseline against which delivery can be assessed. There are fundamentally different approaches taken for different services in this regard.

5.1.1 Wholesale market

Parties contract with one another in the wholesale market, with the BSC Parties (or their nominated agents) submitting their traded position ahead of the start of each Settlement Period. The actual delivery of volumes is not an issue for wholesale market trades; the original trade is kept whole and non-delivery is dealt with through imbalance settlement for the BRP. Further, wholesale trading takes places at a contractual or portfolio level, rather than an asset specific level, so there is effectively no need to baseline.

5.1.2 Capacity Market

For generation assets in the CM, there is no baseline. The only requirement is to provide capacity in a CM Stress Event regardless of how they would have otherwise dispatched had a CM Stress Event not occurred.

For DSR and storage assets, a baseline is set retrospectively based on half hourly data for the six weeks prior to the CM Stress Event.

5.1.3 BM and RR

Each participant effectively defines its own baseline through its FPN.

5.1.4 NIV Chasing

There is no formal baseline for assets wishing to NIV Chase. But they are seeking to drive an imbalance position for the portfolio of which they are part, i.e. for the BRP of the BMU which they are contained within (typically their registered supplier). An FSP seeking to NIV Chase may agree an effective baseline with its supplier in order for the supplier to appropriately share the benefits (or costs if the FSP dispatches in line with the net imbalance in error) with the FSP.

5.1.5 FFR

The baseline is availability to provide the service, which is determined ex-post based on second-by-second metering data which will confirm whether the provider responded to changes in frequency as contracted.

5.1.6 FR and STOR

For generation assets, the baseline is zero, from which the provider will ramp up if called.

For DSR, a baseline is determined based on metered data over the previous three days.

5.1.7 DNO Flexibility Services

DNOs take different approaches to baselining. This is a challenging aspect of DNO Flexibility Service procurement. Unlike in the BM and RR, there is no mechanism in place for the provision of FPNs, and it would likely be disproportionate to require small assets to provide such notifications for the purpose of DNO Flexibility Services. It would also likely be disproportionate to set a zero baseline which requires flexible assets to be held on "standby" (akin to FR and STOR) as it would drive up clearing prices by stopping FSPs accessing other revenue streams when not dispatched by the DNO.

As a result, DNOs are setting baselines based on metered volumes. Here there is a balance to be struck between avoiding rewarding FSPs for using the network as they otherwise would have done (i.e. paying FSPs despite providing no benefit) and excessive complexity from determining dynamic baselines based on metered data.

Some DNOs set a fixed baseline for the duration of a contract with an FSP at the start of a contract based on metered volume of the assets in question in key time periods in the prior year; others use more dynamically varying baselines based on metered output in recent weeks. Both have advantages and disadvantages and effect the way in which revenues can be stacked for different assets.

Assets with limited run time (e.g. storage and DSR) operating to a fixed baseline are likely to be forced to operate close to their baseline until called to be confident of being in a position to ramp output (or decrease demand in the case of DSR) and sustain it for the required period when dispatched. In this way, those assets are genuinely dispatching in response to the signal from the DNO but will face more challenges when seeking to stack revenues from other streams.

Conversely, fuelled assets will not face this constraint and so may dispatch for other services before being called by the DNO. Hence the fixed baseline will enable revenue stacking but risks FSPs being rewarded for an action which they would have taken anyway when called by the DNO.

When using a variable baseline, assets which do choose to dispatch for other services will see this feed into their future baseline which will increase as a result as their metered output will be high in the periods used to determine the baseline. So, the variable baselining approach is likely to favour assets with shorter run time which are less likely to be operational in the "reference" time periods used to set the baseline and likely to be less favourable to assets stacking multiple revenue streams.

5.2 Procurement and dispatch timeframes

The timeline for procurement and dispatch has a fundamental impact on business models as it impacts the time at which commitment to a given service is required, which may preclude participation in more lucrative services which are procured later.

Procurement timescales for the services in question are summarised in Figure 6.

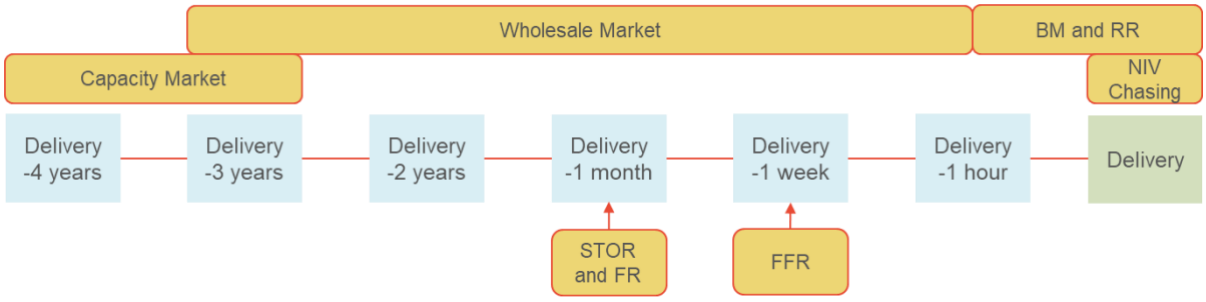

Figure 6: Procurement timescales

The earliest procurement is the CM, beginning 4 years ahead of delivery. This is because the CM is designed to stimulate development of new capacity. As noted in Section 3.2, the CM is stackable with most other services, so providers wishing to participate in CM auctions can typically do so without risk of losing revenue from other services in the future.

The wholesale market also begins to operate well in advance. But FSPs are unlikely to trade so far in advance and will typically trade closer to time to take advantage of arbitrage opportunities.

In general, ESO-procured services are moving closer to delivery:

- Committed STOR has traditionally been procured in advance, but the outlook is uncertain following the suspension of procurement in January 2020
- FFR auctions have previously been monthly but are in the process of moving towards weekly

5.2.1 DNO Flexibility Services

DNOs take different approaches to the timing of procurement, commitment to availability from an FSP and dispatch.

For the Sustain service, delivery is typically committed well in advance (e.g. one month) and dispatch is fully scheduled at that point.

For the Secure product, there are different timescales for commitment required, with some DNOs requiring commitment to availability well in advance (e.g. within specified time windows on certain days for an entire season or year) followed by real time dispatch. The need to provide upfront commitment is a challenge for FSPs seeking to stack revenues, where the need to commit to providing services to the DNO may result in that asset being unable to capitalise on more lucrative revenues which come available closer to delivery.

Some DNOs take a weekly availability approach to commitment for the Secure product, with a dispatch schedule also set at the week ahead stage. This can enable FSPs to move between revenue streams week-on-week as opportunities arise, with the downside of creating volatility for the volume of flexible capacity declaring itself available to the DNO week-on-week.

5.3 Non-delivery penalties

Weak non-delivery penalties may lead asset providers into stacking incompatible services and taking the risk of non-delivery. The costs of this are ultimately borne by the customer, with flexibility procurers having to over-procure to compensate. The penalties in place differ significantly across different services, as shown in Figure 7.

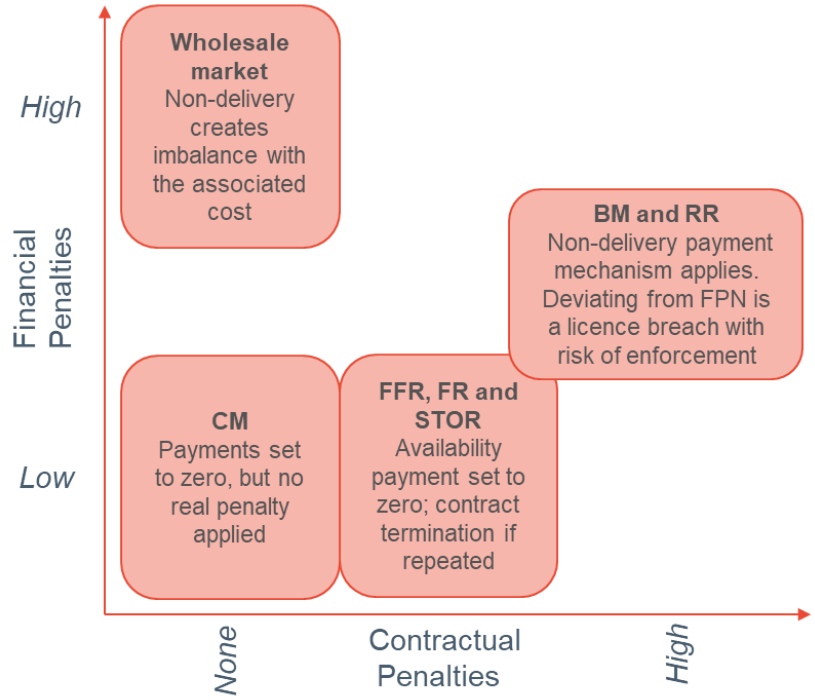

Figure 7: Non-delivery penalties

Most flexibility services have relatively weak non-delivery penalties, except the BM where participation is a requirement of the Grid Code and so non-delivery is effectively a licence breach which can have severe consequences.

Better alignment of non-delivery penalties may help network companies (and the system more generally) to optimize flexibility procurement by avoiding creating incentives for FSPs to over-commit and take the risk of exposure to non-delivery penalties for some services which are weaker than others.

Some FSPs may choose to stack some of the services we have identified as non-stackable due to weak non-delivery penalties. We have identified services as non-stackable if there is a risk of non-delivery penalty; in reality, FSPs will determine whether the risk and magnitude of non-delivery penalties outweighs the benefits of additional stacking.

6 Future revenue streams

There are several ongoing initiatives which are investigating different procurement methods for flexibility services, some of which are summarised in this section.

6.1 Reactive power (Power Potential)

Power Potential[7] is a well-established innovation trial running since late 2017, which is procuring active and reactive power in the UKPN South East region.

Distributed Energy Resources (DER) bid to provide reactive power availability at the day-ahead stage for EFA blocks. The project is split into a number of 'waves'. The first wave (September 2020 start) is focused on testing, with the second wave (November 2020) including commercial elements and competitive bidding. When submitting competitive bids for reactive power, providers indicate an availability price (£/MVAr/hour) and a utilisation price (£/MVArh).

Providers must complete mandatory technical trials, which require a Framework Agreement that reflects its technical capabilities, and commissioning and integration testing, with the project's Distributed Energy Resources Managements System (DERMS). DERMS is located in UKPN's control room.

Power Potential providers agree not to offer any services that would "impair delivery which it is committed to provide from the DER Unit under any other agreement or arrangement with UKPN or the System Operator (other than Regional Development Plan services)". For reactive power provision under Power Potential, this means that the service can be provided in conjunction with an active power balancing service, if the existing service is not compromised.

Going forward, the provision of reactive power may present an additional opportunity for technologies which can flex their reactive power level independently of their active power demand or generation, and so will be able to stack the provision of reactive power services and active power services in the same time period.

6.2 Black start (Distributed ReStart)

Distributed ReStart[8] is an innovation project investigating whether DER can provide the black start service currently provided by large, carbon-intensive generators. The project is expected to run until the end of March 2022 with full operation of any identified solution depending on the extent to which the solution relies on 1) the rollout of new equipment on the distribution network and at DER connections; and 2) the implementation of any code changes.

Providers are likely to be mixed with storage and virtual synchronous machines expected to provide voltage stability. Procurement processes are not yet known – the service has yet to be fully defined, with procurement to be considered later in the project.

There are practical challenges for dispatching a distributed black start service, most notably with communications links. The ESO currently has dedicated fibre links to black start stations, enabling two-way communication in the event of a black out. This is unlikely to be practical for the provision of distributed services from many more providers, but any distributed solution is likely to need a resilient communications ability (e.g. to properly coordinate the reconnection of demand with the reconnection of DER).

The black start service is unlikely to be exclusive with other revenue streams as it is only needed in very specific circumstances in which all other services are effectively redundant.

This is a potential additional revenue stream for flexible assets. The costs and risks are not yet known but could be material given the ESO's reliance on black start in critical situations.

7 https://www.nationalgrideso.com/innovation/projects/power-potential
8 https://www.nationalgrideso.com/innovation/projects/distributed-restart

6.3 Stability pathfinder

The stability pathfinder[9] is a proof of concept initiative which aims to lower the ESO's costs by contracting for stability services such as Inertia, Short Circuit Levels and fast acting voltage support.

A phase one tender was held in winter 2019-20 for either three years or six years (varying by region) from April 2021. The second phase is looking at up to 2030 procurement with a latest start of 2024. The phase one service was only available to CVA registered BMUs with EDT/EDL. Phase two will look at providing contracts for all types of participants, but only those connected to specific nodes in Scotland. Any services are likely to favour transmission connected projects where network impedance is lower.

Phase one was only open to 0MW providers and synchronous technology (i.e. no active power to be provided, only reactive power and/or voltage support). While some providers may need to provide or use some active power in order to provide the service, trading that power on the wholesale market is effectively an operating cost/benefit rather than stacking of revenue opportunities.

Phase two is open to a broader range of technology types and MW providers building into assessment the adverse impact of market distortion as a result of active power export alongside stability. However, phase two is still seeking to procure additional capability compared with what the ESO expects to be available inherently in the energy market.

This is a potential additional revenue stream for assets that can provide stability capability in addition to those services available to the ESO in the Balancing Mechanism. Whilst some stacking may not be possible for operational reasons the ESO aims to provide information on service stacking as part of each tender exercise.

6.4 Constraint management pathfinder

The constraint management pathfinder[10] seeks to assess alternative options to the BM for relieving constraints and reducing the need for network investment.

The ESO is looking to develop the Constraint Management service (following an RFI in February 2020) and announce a decision on tender in September 2020. The service is expecting participants to vary their active power output triggered by a fault event within protection timescales i.e. as rapid as 150ms. The contracts are expected to be between 1-10 years starting in 2021-22 with an expected high level of year-round availability. The pathfinder is likely to look at the main North to South constraint on the Cheviot boundary with a view to potential roll out to other areas of the network. The service is looking at having participants on either side of the boundary i.e. generator turn down/demand turn up in Scotland and generator turn up/demand turn down in England.

The ESO is investigating stacking, and whether or not services could feasibly be provided without interfering with the availability of the provider. There may ultimately be two services – one of which is known in advance so will be more readily stackable than the other which will rely on providers being available to dispatch at short notice.

6.5 High voltage pathfinder

The high voltage pathfinders[11] seek to resolve high voltage issues on the transmission system by comparing long-term reactive power services with regulated network asset build.

9 https://www.nationalgrideso.com/publications/network-options-assessment-noa/network-development-roadmap
10 https://www.nationalgrideso.com/publications/network-options-assessment-noa/network-development-roadmap
11 https://www.nationalgrideso.com/publications/network-options-assessment-noa/network-development-roadmap

The ESO has recently completed tender for both short-term requirements (up to April 2021) and long-term requirements for a nine-year period from April 2022. Payments will include an availability payment in £/hr and may also include a dispatch payment depending on the tender.

The first pathfinder was focused on the Mersey area only to providers who could provide a long-term reactive power absorption service for a nine-year period. Contracts were awarded in May 2020 to two commercial providers – operating a reactor and battery. The ESO worked with the local DNO (SP Manweb) so embedded connections could participate alongside transmission connections. Providers needed to be capable of providing more than 15MVAr from single or aggregated units with a single point of dispatch, and the ability to reach their MVAr target within 30minutes and within the appropriate location.

Providers can offer other balancing services so long as this does not impact the reactive range tendered. It is not yet clear what capability providers will have to deliver the reactive power service alongside other active power services – this will depend on the extent to which providers can control active and reactive power independently from one another.

The next high voltage pathfinder will focus on the Pennine area, including North East England. Timelines will be announced over the 2020 summer period.

7 Conclusion

Barriers to stacking remain but can be resolved by coordinated action between all parties seeking to procure flexibility. In particular:

- Barriers to revenue stacking which are only caused by contract terms rather than any practical reason should be avoided
    - This is most notable for the CM, where there is no reason why DNO Flexibility Services should not be classed as Relevant Balancing Services alongside the BM and ESO services such as STOR
    - The ESO committed in its System Needs and Product Strategy (SNaPS) to enabling parties to "optimise wherever possible the use of their assets by offering multiple services to multiple market participants including DNOs". To do so will require both DNO Flexibility Services and services procured by the ESO services to adapt
- Coordination issues arise when both the DNO and the ESO are seeking to procure flexibility from the same FSP. To minimise these issues, there is a need for both the DNO and the ESO to have visibility of each other's actions.
    - DNO issues are typically highly locational but also predictable in advance. Whilst there is only a small group of available FSPs for each DNO Flexibility Service need, services can be procured from these FSPs in advance. Conversely, the ESO issues are typically non-locational but unpredictable.
    - Better coordination of procurement timeframes could aid coordination of services avoiding locking parties out of certain services due to the interaction between procurement timescales. A flexibility procurement platform which can be used by multiple procurers and multiple providers of flexibility may be beneficial in this respect, with the potential to enable co-ordinated procurement and delivery of flexibility across the system as a whole.
    - However, to facilitate this there is also a need to develop a set of clear principles and primacy rules for addressing flexibility service conflicts between the transmission and distribution networks. These will need to balance the technical requirements / risks for the whole system with the needs of a flexibility procurement platform, value for FSPs and ultimately the end consumer.

8 Implementation

Table 14 sets out a series of recommendations and options that have been taken from this paper by the WS1A group. For clarity, these have also been tagged to the six steps for delivering flexibility services, committed to by the 6 DNOs and GTC in June 2019:

1. Champion a level playing field
2. Ensure visibility and accessibility
3. Conduct procurement in an open and transparent manner
4. Provide clarity on the dispatch of services
5. Provide regular, consistent and transparent reporting
6. Work together towards whole energy system outcomes

The Flexibility Consultation in Summer 2020 will also seek views from our wider stakeholder group on these options and their prioritisation within further scheduled work.

Table 14: Implementation Recommendations and Proposed Options

Report Recommendation	Implementation Option	Complexity / Effort	Lead Party	FSP input to inform?	Flexibility Commit-ment [12]
DNOs to implement an accurate and common baselining methodology for Flexibility Services	WS1A P7 to take forward potential options for baselining approaches (July 2020 consultation)	Medium / Medium	Open Networks 2020 WS1A P7 Dec 2020	Yes	1 3 4 5
Alignment of DSO service non-delivery penalties	Seek stakeholder feedback on convergence and timescales for implementing common non-delivery penalties	Medium / Medium	DNOs	Yes	2 3 4 5
Alignment of exclusivity and information sharing position between ESO contracts and to DNO/ON Common Contract	Open Networks to enable a level playing field between flexibility services by aligning to exclusivity and information sharing terms	Medium / Medium	Open Networks 2020 WS1A P4 Apr 2021	Yes	1 2 3
ESO and DNO to provide better visibility of contracted positions	ESO and DNO to review asset and contracts visibility provided by the DNO System Wide Resource Registers (SWRRs) alongside the ESO approach; share findings with FSPs to agree best practice and seek alignment across the whole system	Low / Medium	ESO / DNO Potential Future ONP activity	Yes	2 3

12 https://www.energynetworks.org/assets/files/ENA%20Flexibility%20Commitment%20Our%20Six%20Steps%20for%20Delivering%20Flexibility%20Services.pdf

	Flexibility service data will be published in line with EDTF principles. Where it cannot be published open, ESO and DNO will clarify the data exchanged bilaterally for operational purposes, recognising the impact the CLASS determination might have.				
DNO to provide better visibility of flexibility actions	ESO and DNO to review flexibility reporting arrangements; share findings with FSPs to agree best practice and seek alignment across the whole system	Low / Medium	ESO / DNO Potential Future ONP WS1A activity	Yes	1 2 5
Flexibility Service coordination issues between DNO and ESO to be resolved	Building on the work identified in DSO Services – Conflict Management & Co-optimisation (2019 WS1A P5 delivered March 2020); develop a set of principles and primacy rules for addressing flexibility services conflicts (T-D). Needs to balance technical requirements / risks for the whole system and value for FSPs / end consumer.	Medium / Medium	Open Networks 2019 WS1A P5 Complete Potential future ONP WS1A activity	Yes	1 2 3 4
	ESO Pathfinders' reports to provide more visibility on service design and options considered to optimise flexibility alongside DSO Flexibility Services	Medium / Medium	ESO		1 2 3
Address potential for supplier imbalance and CM penalties due to FSPs participating in DSO services	Option 1: Transmission Licence C16 to be amended to include requirement for ESO to coordinate with DNOs on ABSVD data. DNOs to report data on flexibility usage to ESO (HH to 2 day window). BSC Section Q changes required	High / High	ESO Ofgem		1 2 3
	Option 2: Distribution Licence to mirror requirements for ABSVD methodology. DNOs to report on flexibility usage to Settlement Administration Agent. BSC Section Q changes required	High / Medium	DNOs Ofgem		1 2 3

Address potential conflicts with the CM	Amend the CM rules to include DSO services specifically under the exclusions for Relevant Balancing Services	Low / Medium	BEIS	Yes	1 2 3
Visibility on the timetable of procurement actions across the ESO and DSO services	Provide a co-ordinated view of the flexibility service calendar across ESO and DSO services. (Incl. recommendations from 2019 WS1A P2)	Low / Medium	Open Networks WS1A P2 Dec 2020		2 3 4
Alignment on Flexibility Service tendering timescales	WS1A P2 to report on good practice for alignment of tendering process and make recommendations on convergence and timescales. This will include implementation plans to achieve alignment.	Medium / Medium	Open Networks 2020 WS1A P2 Dec 2020		1 2 3
Flexibility Procurement Timescales	Initiatives developing the procurement of flexibility services closer to real-time will be reviewed by Open Networks for future implementation. Closer to real time procurement removes barriers for FSPs who cannot accurately forecast their availability over longer time horizons but may become available closer to delivery timescales. E.g. Flexible Connections (ANM); wind and solar generation.	Medium / Medium	Open Networks 2019 WS1A P5 Complete Potential future ONP WS1A activity	Yes	1 2 3

Appendix 1: Glossary

The following terms are used throughout this document:

Name	Acronym	Description
Applicable Balancing Service Volume Data	ABSVD	Used to account for volumes dispatched by the ESO for balancing services
Balancing and Settlement Code	BSC	Electricity industry code covering the rules for the Balancing Mechanism and the settlement of imbalance charges in GB
Balancing Mechanism	BM	A mechanism that enables the ESO to instruct generators and suppliers to vary electricity production or consumption close to, or in, real time in order to maintain safe operation of the system
Balancing Mechanism Bid Offer Acceptance	BOA	Instruction issued by the ESO when accepting a Bid or Offer submitted by a BSC Party
Balancing Mechanism Unit	BMU	The units used under the BSC to account for all energy that flows on or off the Total System (the Transmission System and each Distribution System combined)
Bilateral Embedded Generation Agreement	BEGA	An agreement between the ESO and a generator connected to the distribution network, setting out the terms under which that generator may access the transmission system
Capacity Market	CM	The government's flagship energy security scheme
Capacity Market Notice		The ESO publishes a Capacity Market Notice when either: (i) the ESO gives a Demand Reduction Instruction and/or an Emergency Manual Disconnection Instruction to one or more DNOs; (ii) an Inadequate System Margin is anticipated to occur in a Settlement Period falling at least 4 hours after the expiry of the current Settlement Period; or (iii) an Automatic Low Frequency Demand Disconnection takes place
Capacity Market Volume Reallocation		A notification of Traded Capacity Market Volume in relation to one or more Settlement Periods
Capacity Provider		A generator or demand side response provider that holds a Capacity Market Agreement
Demand Side Response	DSR	Allows businesses and consumers to turn up, turn down, or shut demand in response to signals from the wider system
Distribution Network Operator	DNO	Companies licensed to distribute electricity in GB by Ofgem
DNO Flexibility Services		One of the four active power services procured by DNOs: Sustain, Restore, Secure and Dynamic
Energy Contract Volume Aggregation Agent	ECVAA	The organisation that BSC parties submit their contract positions to
Energy Forward Agreement Block	EFA Block	A four hour period, identified by its start time, weekday/weekend and season

Name	Acronym	Description
Energy Imbalance Volumes		The difference between the amount of electricity that a company has contracted to generate or consume and the amount of electricity which the company generated or consumed
Fast Reserve	FR	A Balancing Service procured by National Grid ESO
Final Physical Notification	FPN	The level of Import or Export that the Party expects to Import or Export from a given BMU in a given Settlement Period, in the absence of any BOA from the ESO
Firm Frequency Response	FFR	A Balancing Service procured by National Grid ESO
Flexibility Service Provider	FSP	A provider of flexibility services, including BSPs and parties that are not BSPs, but not including BRPs
Gate Closure		For each Settlement Period, the spot time 1 hour before the spot time at the start of that Settlement Period
Grid Code		A technical specification which defines the parameters a facility connected to a public electricity network must meet to ensure safe, secure and economic functioning of the electricity system
National Grid Electricity System Operator	ESO	Licensed operator of the GB Transmission system
Net Imbalance Volume	NIV	The volume of overall System energy imbalance, as a net of all System and energy balancing actions taken by the ESO for the Settlement Period
Power Purchase Agreement	PPA	A contract between two parties, one of which generates electricity (the seller) and one which is looking to purchase electricity (the buyer)
Replacement Reserve	RR	A harmonised reserve product for European Transmission System Operators introduced by project TERRE
Satisfactory Performance Days		A Capacity Provider in the CM must demonstrate capacity at a level equal to or greater than its Capacity Obligation for at least one Settlement Period on three separate days, each of which is a "Satisfactory Performance Day", during the Winter of the relevant year
Settlement Period		A period of 30 minutes beginning on the hour or the half-hour
Short Term Operating Reserve	STOR	A Balancing Service procured by National Grid ESO
System Stress Event		A Settlement Period in which an ESO Instigated Demand Control Event occurs where such event lasts at least 15 continuous minutes (whether the event falls within one Settlement Period or across more than one consecutive Settlement Periods, and where the event falls across multiple consecutive Settlement Periods, each of those Settlement Periods)

Name	Acronym	Description
Trans European Replacement Reserve Exchange	TERRE	A balancing product implementation project, developed by a group of European Transmission System Operators, including National Grid
Virtual Lead Parties	VLP	An aggregator of SVA-registered generating units which can participate in the BM and provide RR