

AFRY

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# NG ESO: Review of Replacement Reserve Product and ENTSO-E CBA

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# Agenda

- Overview of the project
- Review of Replacement Reserve
- Review of previous CBA
- Considerations for new CBA
- Annex

# Overview of the project

## Overview

### The project

- NG ESO has appointed AFRY to conduct a cost-benefit analysis on a GB-only Replacement Reserve product GB can no longer fully participate in TERRE, having been excluded from the EU internal market for energy.
- To understand the impact of introducing a RR product we propose creating a model of what would have happened in GB if there had been a RR product in 2021. To do this we will create a merit order based on the actions that have been taken within the BM (plus some adjustments). Based on this merit order we will assume a dispatch for two Scenarios - a 'GB only RR product' and a 'GB + France RR product'.
- Our modelling will provide an update to the 2016 ENTSO-E CBA which identified a benefit for Great Britain of ~€17 million (2013 money base) as a result of access to 'lower priced' reserve from France over the interconnector. This analysis also identified limited benefits from a GB only product.

### This document

- This document provides a critical review of the 'Replacement Reserve' product and the initial CBA undertaken by ENTSO-E in 2016.
- We have presented the review in three sections:
  - review of the Replacement Reserve (RR) product;
  - review of the CBA (e.g. process, assumptions etc.); and
  - considerations for the updated CBA (e.g. what learnings should we take forward from the reviews).

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# Introduction to Replacement Reserve

## Introduction

### What is it?

- The aim of the Replacement Reserve product is to create a harmonised playing field for market participants which would facilitate greater competition by increasing the transparency of prices paid for the service.
- The Replacement Reserve product would introduce a new 'pay as clear' pricing approach that would work in parallel with 'pay as bid' BM arrangements.
- The Replacement Reserve product would be based on scheduled activation by NGESO, with a 30 minute full activation time, based around 15 minutes blocks - There would be a single auction per hour, in which four blocks would be cleared.
- It is understood that RR would be paid solely for activation, not availability/holding.

### Opportunity for NGESO

- The Replacement Reserve Product would provide a new balancing auction (with similarities to the Day-Ahead arrangements), taking place after gate closure.
- It could allow access to additional flexibility such as non-BM units, and potentially across borders for energy balancing.
- It could provide an additional tool to conduct coarse energy balancing actions, e.g. for demand forecast error trends, energy for constraint action and if the market is continually long/short.
- It could allow STOR (or similar product) to be stood down earlier (on the day) as the Replacement Reserve takes over.

### Opportunity for market participants

- For market participants Replacement Reserve could increase the liquidity and opportunities to offer flexibility, by allowing competition in two parallel markets. It also has the potential to open up an international market – if trading with France can be agreed.
- Replacement Reserve could also remove barriers to entry for non-BM participants and small embedded generation sources.
- However additional costs may occur for interconnectors.

# Review of RR product: Issues identified for 'GB only Product'

|   |              | Topic area   | Rationale /open issues  |
|---|--------------|--|---|
| 1 | Design Phase | <ul style="list-style-type: none"> <li>How complete are the design phases</li> </ul>   | <ul style="list-style-type: none"> <li>The design phase started at the end of 2013 and has been organized into six Technical Working Packages, plus one Legal and Governance Working Package. Each Technical Working Package is being led by one or two participating TSOs. The Governance issues have been dealt with by the Legal and Governance Working Group.</li> <li>We need to understand how complete these are. How would the TERRE design impact on the GB plans?</li> </ul>  |
| 2 | Platform     | <ul style="list-style-type: none"> <li>Would the RR make use of existing IT</li> </ul> | <ul style="list-style-type: none"> <li>'The main objective of the TERRE project is to establish and operate a platform capable of gathering all the offers for Replacement Reserves from TSO's local balancing markets'</li> <li>NGESO would need to use a system that is compatible with the 'TERRE LIBRA platform'. Due to Brexit they would not be able to access the LIBRA platform directly and so an indirect work around would be required.</li> <li>It is understood that NGESO may have some rights to the IP of the platform however future costs are unclear, any assessment would need to understand any potential impacts on other NGESO Platforms.</li> </ul> |
| 3 | Product      | <ul style="list-style-type: none"> <li>Flexibility</li> </ul>                          | <ul style="list-style-type: none"> <li>The Replacement Reserve product was created primarily to improve the harmonisation and optimisation of providing reserve across multiple markets. It is not clear if this product is required to address a clear inefficiency in the Great Britain market. Alternatively, if the inefficiency does exist, it is not clear whether there are alternative approaches for addressing it. For example, are there other types of products, or structural changes to the market, that need to be considered (if cross-border trade of RR is not possible)?</li> </ul>  |



# Review of RR product: Issues identified for the wider 'EU Product'

|   |                | Topic area  | Rationale /open issues  |
|---|----------------|---|---|
| 1 | Constraints    | <ul style="list-style-type: none"> <li>– Could reserve provision lead to constraint problems or vice versa</li> </ul> | <ul style="list-style-type: none"> <li>– There will be instances when constraints don't allow the cheapest provider to be activated. For example, if a RR is needed in France and the cheapest provider is in Scotland.</li> <li>– It is understood that NG ESO would forecast constraints such that relevant RR bids would be tagged as unusable.</li> <li>– If this was missed then the BM would be used to unwind the position.</li> </ul> |
| 2 | Settlement     | <ul style="list-style-type: none"> <li>– Different approaches to pricing</li> </ul>                                   | <ul style="list-style-type: none"> <li>– In some markets there are differences between how the proposed RR product is priced compared to other reserve and energy services (pay-as-clear v pay-as-bid).</li> <li>– This may impact on how the participants are able to efficiently price their services into the market.</li> </ul>   |
| 3 | Interconnector | <ul style="list-style-type: none"> <li>– Efficient allocation of the interconnector</li> </ul>                        | <ul style="list-style-type: none"> <li>– How are flows impacted on the interconnector? Would interconnector trades over the interconnector solve reserve issues if the interconnector is at full capacity. How frequently is the interconnector not at capacity when the energy prices are cheaper in France?</li> </ul>  |

## Review of RR product: Issues identified for the wider 'EU Product'

|   |                   | Topic area  | Rationale/open issues  |
|---|-------------------|---|--|
| 4 | Non-participation | <ul style="list-style-type: none"> <li>– Is there an impact on non-participating markets</li> </ul>         | <ul style="list-style-type: none"> <li>– Does the RR product lead to any impact on the flows between participating and non-participating countries? Would this product be prioritised over interconnector flows between other interconnected (non-participating) markets (e.g. GB-Ireland or France–Belgium). How would loop flow and further capacity constraints be dealt with?</li> </ul>   |
| 5 | Losses            | <ul style="list-style-type: none"> <li>– RR trades across the interconnector will lead to losses</li> </ul> | <ul style="list-style-type: none"> <li>– The volume of losses is nominally included within the TERRE Algorithm for DC interconnectors, but these were to be set at zero initially. This would have led to inefficiencies (had that algorithm been implemented for GB).</li> <li>– The treatment of losses needs further review but this is a second order consideration: working assumption is that assumed losses would be set at zero in the initial implementation of the algorithm.</li> </ul> |

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# Overview of the 2016 ENTSO-E CBA

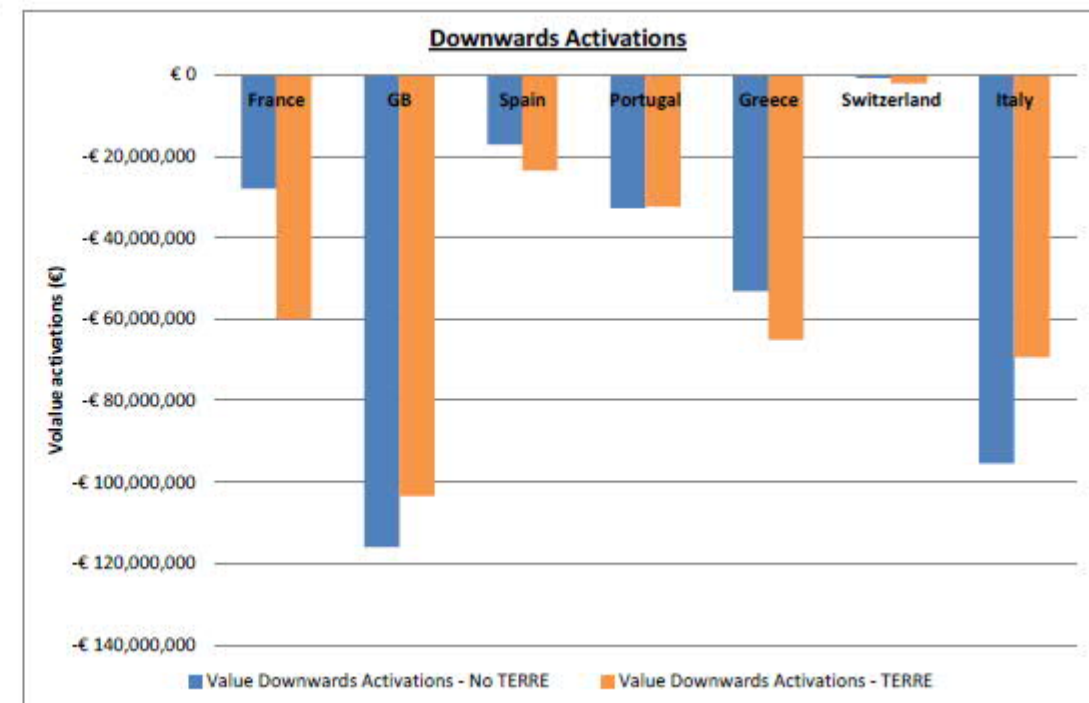
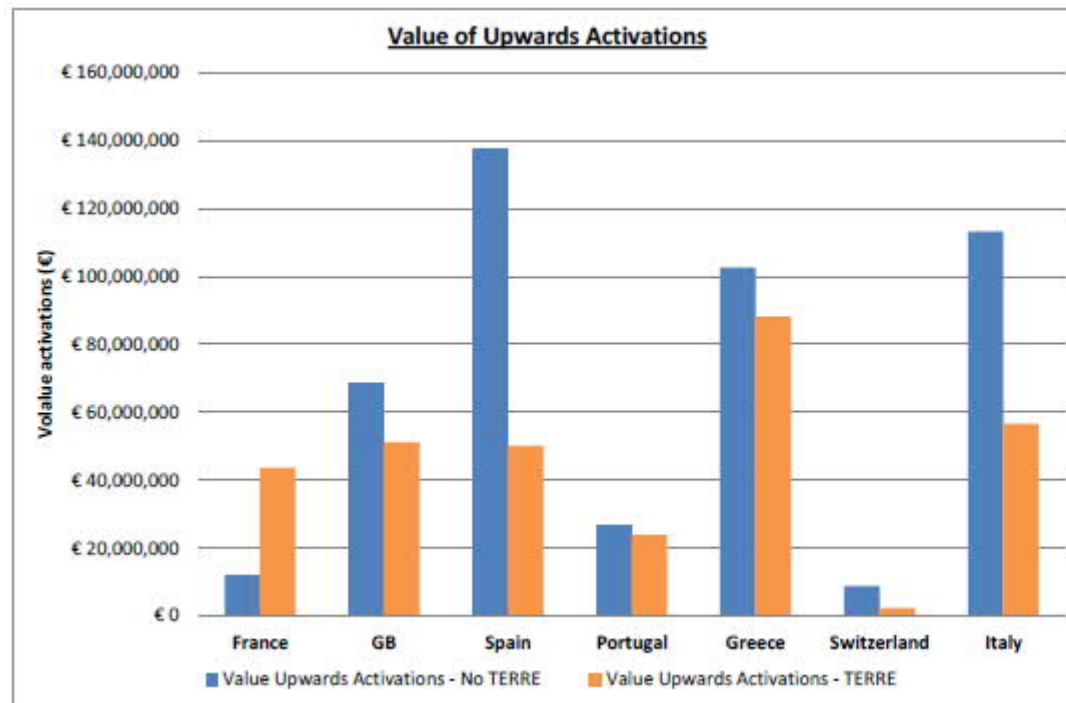
## Summary of the ENTSO-E objective

### ENTSO-E summary

- A key part of the TERRE project was the development of a methodology to assess the potential benefit of coupling the different 'Replacement Reserve' markets across the participating countries in order to perform a robust Cost Benefit Analysis.
- In order to assess the benefits of coupling different RR markets, historical data from each TSO for the 2013 calendar year was used in order to establish consistent data sets. ENTSO-E then adapted this data, based on a set of assumptions, to allow for a comparison of a 'single product' across the participating countries.
- The benefits of coupling the different RR markets were calculated using the simulation tool developed during the design phase of the project under the scope of the Balancing CMO & Algorithm Working Package. While the costs were based on the development and operation of the central platform (LIBRA), plus any local IT infrastructure costs within each region.
- The results of the CBA identified an annual cost saving for each participating country, both in absolute terms and percentage change compared to the values without TERRE. Spain was found to have the largest benefit, exceeding €60 million (2013 money base), while the benefit for Great Britain was calculated at ~€17 million (2013 money base) as a result of access to 'lower priced' reserve from France over the interconnector.

## Example results of the 2016 ENTSO-E CBA

### Example results



Source: ENTSO-E ([https://consultations.entsoe.eu/markets/terre/supporting\\_documents/20160307\\_TERRE\\_Consultation\\_FV.pdf](https://consultations.entsoe.eu/markets/terre/supporting_documents/20160307_TERRE_Consultation_FV.pdf))

## Review of previous CBA: Issues identified

|   |                    | Topic area   | Rationale  |
|---|--------------------|--|--|
| 1 | Market differences | <ul style="list-style-type: none"> <li>Differences between markets</li> </ul>                  | <ul style="list-style-type: none"> <li>There were a number of challenges in modelling different markets which led to simplified assumptions: <ul style="list-style-type: none"> <li>Differences in existing balancing market – options for pricing (pay-as bid, marginal pricing, unit-based bidding, portfolio-based bidding).</li> <li>Modelling bidder behavior – which is reflective of individual market / regulatory conditions.</li> </ul> </li> </ul>  |
| 2 | Imbalance Volume   | <ul style="list-style-type: none"> <li>Impact of imbalance volume changes over time</li> </ul> | <ul style="list-style-type: none"> <li>The analysis showed (as expected) there is a strong correlation between imbalance volume and cost in each country.</li> <li>The CBA provides a brief qualitative discussion on the impact of imbalance changes on the level of residual balancing, but it did not consider the impact of changes in the imbalance volume on the benefits of TERRE.</li> </ul>   |
| 3 | Benefit to France  | <ul style="list-style-type: none"> <li>Benefit to France is marginal</li> </ul>                | <ul style="list-style-type: none"> <li>Net benefits to France are marginal in terms of both annual reduction in BRP costs and percentage reduction in costs compared with no TERRE.</li> <li>However, France is critical to the benefits of neighbouring countries (e.g. GB and Spain). Based on the results of the CBA it appears that consumers in GB / Spain, and producers in France, are all benefitting at the expense of customers in France. It is unclear if this is sustainable in the longer term.</li> </ul> |

## Review of previous CBA: Issues identified

|   |                      | Topic area   | Rationale  |
|---|----------------------|--|--|
| 4 | Costs                | <ul style="list-style-type: none"> <li>IT costs based on estimates</li> </ul>        | <ul style="list-style-type: none"> <li>IT cost estimated where shared evenly between the participants (no evidence on the derivation of these costs has been presented) – they may lead to an over / under estimation.</li> <li>However, the cost range is relatively small in terms of the benefits and so any difference is unlikely to be material (nb. this be more of an issue for a 'GB only RR product') given the likelihood of smaller benefits.</li> </ul> |
| 5 | Data and time period | <ul style="list-style-type: none"> <li>Limited timeframe for the analysis</li> </ul> | <ul style="list-style-type: none"> <li>The original CBA only used data from a single year (2013) to assess the benefits. This can lead to bias based on the market conditions in that particular year.</li> </ul>  |
| 6 | Simplification       | <ul style="list-style-type: none"> <li>Simplification assumptions used</li> </ul>    | <ul style="list-style-type: none"> <li>There are several simplification assumptions that could improve the accuracy of the modelling, some are more minor than others. These include: <ul style="list-style-type: none"> <li>Exchange rate: use of daily rate rather than annual average</li> <li>Inclusion of 'clock-change' days</li> </ul> </li> </ul>  |

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# Summary of AFRY's approach

## Overview

### Our approach

- Our modelling will provide an update to the 2016 ENTSO-E CBA which identified a benefit for Great Britain of €17 million (2013 money base) as a result of access to 'lower priced' reserve from France over the interconnector.
- The main elements of our modelling approach will include:
  1. The RR product utilisation as currently defined, and costs based on historical bids and offers but pricing as pay-as-clear.
  2. In order to assess the benefit stemming from potential access to French plants only, we would suggest an additional comparison:
    - a) Recreating a GB bidding merit order using estimated variable costs to approximate a pay-as-clear product.
    - b) Including French plant data on the same basis, with relevant interconnector availability.
- Additional clarifications on the core modelling assumptions are provided in the following slides.

# Considerations for new CBA

|   |                    | Topic area  | Rationale   |
|---|--------------------|---|---|
| 1 | Counterfactual     | <ul style="list-style-type: none"> <li>Modelling approach</li> </ul>                        | <ul style="list-style-type: none"> <li>Our approach: We plan to model two scenarios; a 'GB only RR product' and a 'GB + France RR product'</li> <li>We will then compare the first of these against actual RR costs in GB from the BM. Secondly, we will compare the two Scenarios against each other. This allows both a validation of the modelling approach and also to highlight to what extent the benefit accrues from access to RR balancing energy from France.</li> </ul>  |
| 2 | Balancing products | <ul style="list-style-type: none"> <li>Interaction with other balancing products</li> </ul> | <ul style="list-style-type: none"> <li>Issue: A challenge will be to isolate the actual cost of the Replacement Reserve (e.g. so it doesn't include inertia, reducing largest loss, voltage etc.)</li> <li>Our approach: We will abstract the RR product utilisation from the rest of the balancing actions taken. The model will take as an input a generic half hourly utilisation of RR, rather than detailed specific balancing needs. The RR utilisation merit order will be dispatched against this need, similar to the original CBA.</li> </ul> |
| 3 | Bidding behaviour  | <ul style="list-style-type: none"> <li>Impact on bidding behavior</li> </ul>                | <ul style="list-style-type: none"> <li>Issue: Following the deployment of a RR product, we would expect bidding behavior could change (nb. this will be a bigger uncertainty for the GB – France Scenario due to the impact of different merit order stacks within and between countries)</li> <li>Our approach: Due to the complexity of modelling bidding behavior (as acknowledged by the 2016 study) we do not plan to model the different bidding behaviours quantitatively, but will discuss the impact with the qualitative analysis</li> </ul>  |

# Considerations for new CBA

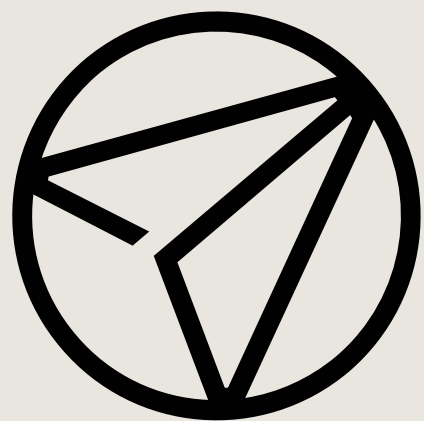
|   |                          | Topic area  | Rationale   |
|---|--------------------------|---|---|
| 4 | Costs                    | <ul style="list-style-type: none"> <li>Updated costs of IT infrastructure</li> </ul>        | <ul style="list-style-type: none"> <li>Issue: To calculate a CBA we need to estimate the cost of installing appropriate IT infrastructure. We will need to consider costs for a GB only platform and a cost which is consistent with the TERRE LIBRA platform for the GB + France scenario (if different)</li> <li>Our approach: A starting point for the estimated with be the previous CBA which assumed a 25-30 million cost split evenly between the participating countries. We will build on this based on NGESO and wider Stakeholder input</li> </ul>   |
| 5 | Impact of other products | <ul style="list-style-type: none"> <li>Unintended consequences of the new market</li> </ul> | <ul style="list-style-type: none"> <li>Issue: The introduction of the RR product may have an impact on the future behavior of participants in the BM and the interaction between RR and other reserve products.</li> <li>Our approach: For the quantitative modelling understanding is that the new RR product would be a stand-alone product, which is dispatched in parallel to the BM. What arrives in the BM is then the "TERRE bids", which are then used in imbalance pricing – so we will not model impact or interaction with the rest of the BM. However, our intention will be to discuss any potential impacts as part of the qualitative discussion.</li> </ul> |
| 6 | Assessment period        | <ul style="list-style-type: none"> <li>Over what period are we assessing RR</li> </ul>      | <ul style="list-style-type: none"> <li>Issue: Modelling historic years does not provide an indication of the impact of the RR product in the future, and its interactions with expected changes in the market.</li> <li>Our approach: Due to uncertainty of the modelling assumptions, we have agreed with NGESO that modelling future years is out of scope for the quantitative analysis. However, as part of the qualitative analysis we will discuss the impact of introducing a RR product to understand its impact under the expected future market changes</li> </ul>  |

# Considerations for new CBA

|   |                | Topic area   | Rationale   |
|---|----------------|--|---|
| 7 | Interconnector | <ul style="list-style-type: none"> <li>– Future ATC increases</li> </ul>                 | <ul style="list-style-type: none"> <li>– Issue: Increasing cross-border capacities could potentially lead to further benefit (system) by reducing the spread in marginal prices and lowering congestion rent.</li> <li>– Our approach: Although modelling future years is out of scope (due to uncertainty) we will test the impact of increase interconnector capacity within the modelled year – modelling separate cases with and without the IFA2 capacity.</li> </ul>  |
| 8 | Rules          | <ul style="list-style-type: none"> <li>– Future design in GB</li> </ul>                  | <ul style="list-style-type: none"> <li>– Issue: If the majority of benefits are coming from the GB-France scenario, NGESO will need to consider how closely the design of the RR product will need to be to the RR product developed under the EU TERRE process.</li> <li>– Our approach: Based on the results of the modelling we will provide qualitative recommendation on the design of the RR product (e.g. Does a GB RR have to follow the same rules as the EU TERRE? Or could it include additional options that might have been ruled out for the wider EU design?)</li> </ul> |
| 9 | Non-delivery   | <ul style="list-style-type: none"> <li>– Future arrangements for non-delivery</li> </ul> | <ul style="list-style-type: none"> <li>– Issue: How can NGESO mitigate against non-delivery of RR from France (assuming it is able to find an agreement post Brexit)?</li> <li>– Our approach: We will undertake a high-level review to understand what options are available to mitigate against non-delivery (nb. This will not include a formal legal review of legislation)</li> </ul>  |

## Considerations for new CBA

|    |               | Topic area   | Rationale  |
|----|---------------|--|--|
| 10 | Exchange rate | <ul style="list-style-type: none"><li>– Use of daily exchange rates</li></ul>    | <ul style="list-style-type: none"><li>– Issue: The original CBA used an annual average exchange rate for calculating the different prices across the settlement period.</li><li>– Our approach: Our modelling will use outturn daily exchange rates for the 'GB-France scenario'</li></ul> |
| 11 | Clock change  | <ul style="list-style-type: none"><li>– Inclusion of clock change days</li></ul> | <ul style="list-style-type: none"><li>– Issue: The original CBA removed clock change days due to complexity of modelling this across multiple time zones.</li><li>– Our approach: Our modelling will include all days within the year</li></ul>  |



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# Comparison of Replacement Reserve to existing GB Products

Existing Products

Planned Products

|                              | Dynamic Containment (DC)   | Firm Frequency Response (FFR)  | Short Term Operating Reserve (STOR)   | Quick Reserve (QR)  | Slow Reserve (SR)  | Replacement Reserve (RR)   |
|------------------------------|--|--|---|---|--|--|
| Overview                     | <ul style="list-style-type: none"> <li>Designed to operate post-fault, i.e. for deployment after a significant frequency deviation in order to meet the most immediate need for faster-acting frequency response.</li> </ul> | <ul style="list-style-type: none"> <li>Monthly electronically tendered service through which National Grid procures energy that can respond within 10 or 30 seconds</li> </ul>         | <ul style="list-style-type: none"> <li>STOR is procured from generation and/or demand. Procured via 3 tenders each year.</li> </ul> | <ul style="list-style-type: none"> <li>Quick Reserve is a fast-acting reserve product which is intended to bridge the gap between the new frequency response services and the slower reserve product(s).</li> </ul> | <ul style="list-style-type: none"> <li>Slow Reserve is a manually activated reserve, intended to manage short notice supply demand imbalances and transition frequency recovery into BM timescales.</li> </ul> | <ul style="list-style-type: none"> <li>RR will be procured from both BM and Non-BM participants.</li> <li>No decisions have been made on procurement etc.</li> </ul> |
| Minimum Size                 | – 1MW  | – 1MW  | – 3MW   | – TBC   | – TBC  | – 1MW  |
| Aggregation of smaller units | – TBC  | – Yes  | – Yes   | – TBC   | – TBC  | – Yes (delivery based on 15MW blocks)  |
| Response requirements        | <ul style="list-style-type: none"> <li>Response in &lt;1 second for a duration of &lt;20 minutes</li> </ul>  | <ul style="list-style-type: none"> <li>Response in &lt;10 seconds sustained delivery of 20 seconds; or</li> <li>Response in &lt;30 seconds sustained delivery of 30 minutes</li> </ul> | <ul style="list-style-type: none"> <li>Response in &lt;20 minutes sustained delivery of &gt;2 hours</li> </ul>                      | <ul style="list-style-type: none"> <li>Full delivery in 30 Seconds</li> <li>1-minute extendable full output blocks, maximum of 20 minutes, stopped at any time</li> </ul>   | <ul style="list-style-type: none"> <li>Full delivery in 15 minutes</li> <li>1-minute extendable full output blocks, up to 240 minutes</li> </ul>   | <ul style="list-style-type: none"> <li>Response in 30 minutes sustained delivery of 60 minutes</li> </ul>  |



# National Grid view on the potential benefits of Replacement Reserve (2017 analysis)

