

# Frequency Response

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Graham Hathaway

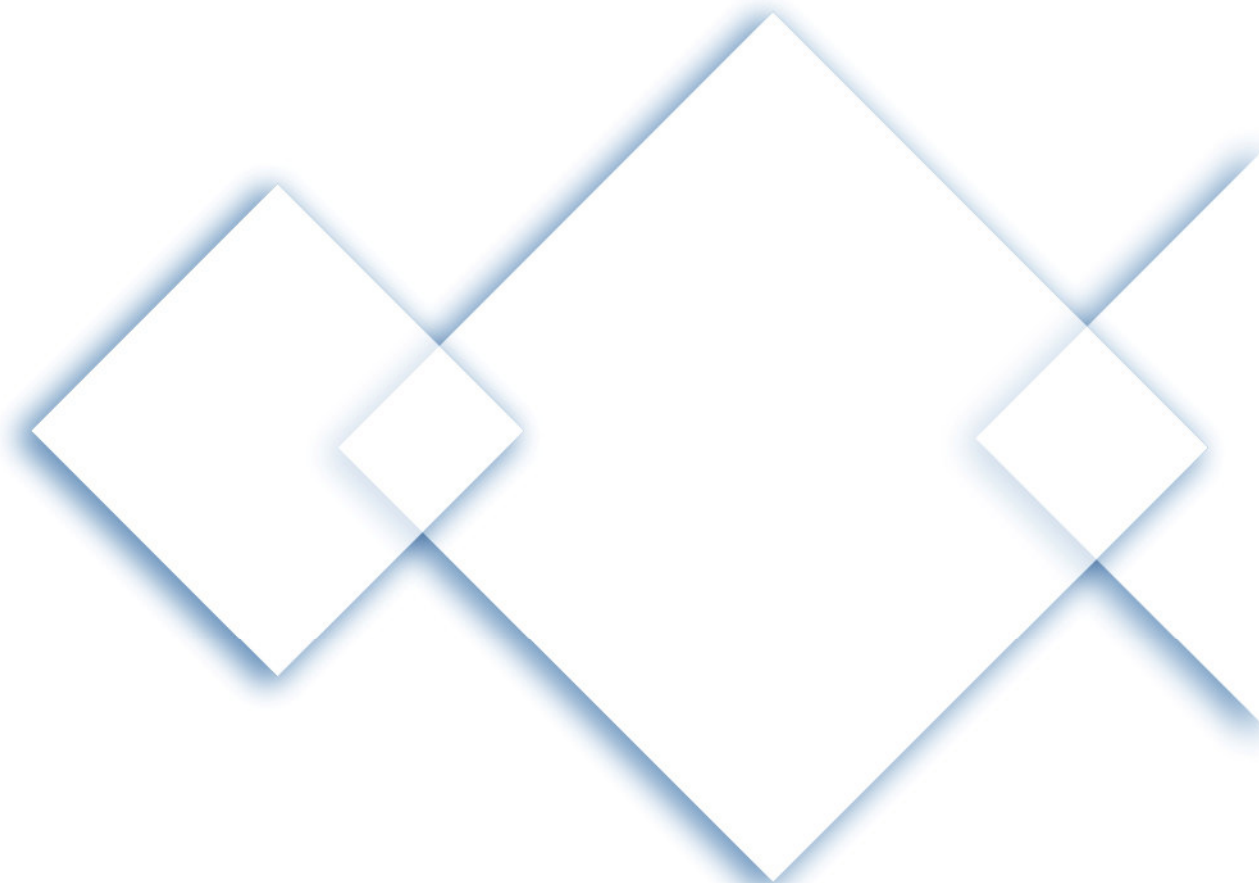
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# Contents

## The objectives of this presentation are to:

1. Give an overview of frequency response
2. Run through our current response requirements
3. Show how frequency response is despatched
4. Show how we assess and optimise frequency response services
  - *to enable tenderers to optimise their tenders to maximise chances of success*
5. Outline the drivers behind our future (2020) requirements



## 1. Overview of what is Frequency Response

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# (1) What is Frequency Response?

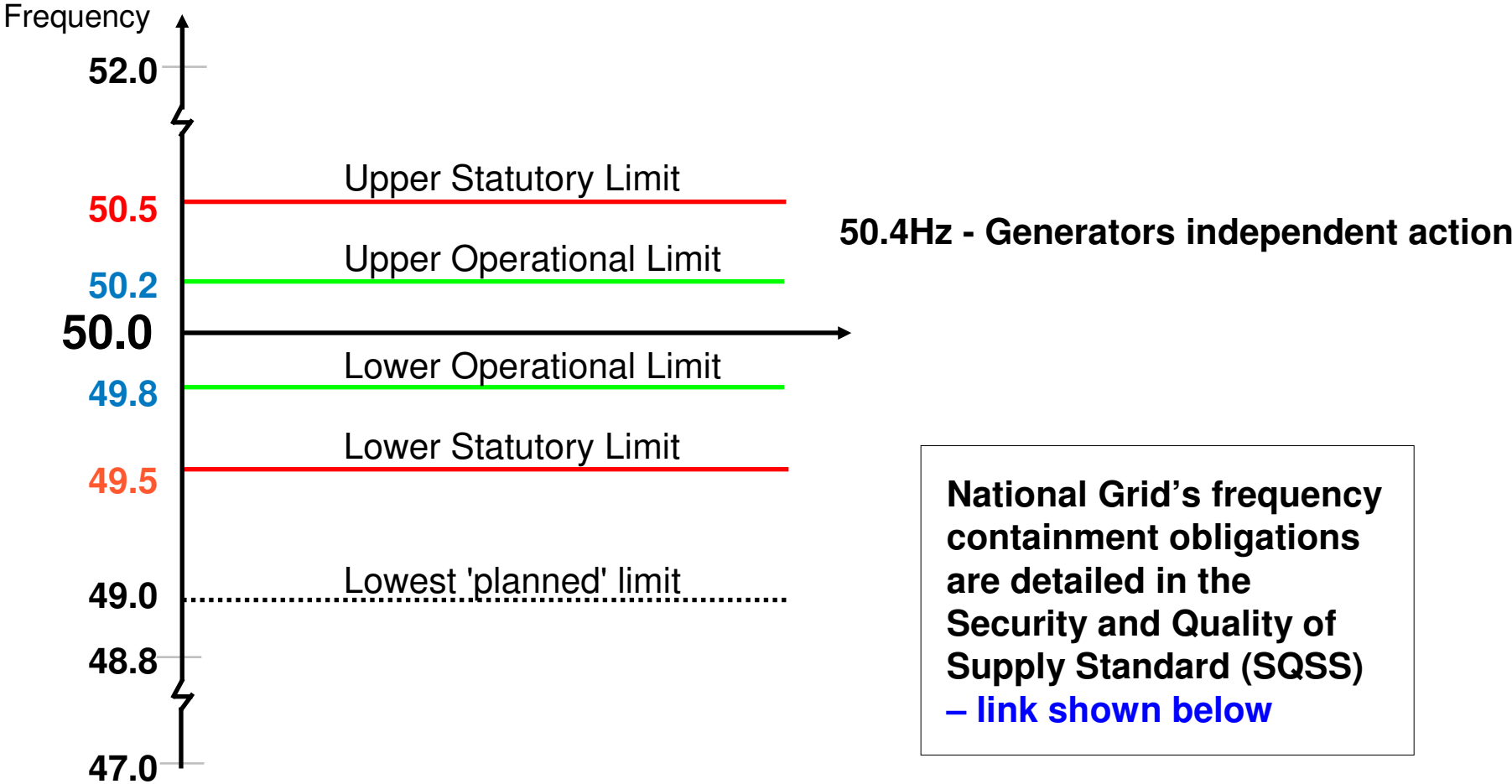
## There are two types:

- ◆ Dynamic: An *automatic* change in active power output or demand in response to a frequency change
- ◆ Non-Dynamic response: An *immediate* (usually within 2 secs) drop in demand (often called “static” response)

## Why do we need it?

- ◆ To maintain system frequency within statutory and operational limits....

# National Grid's frequency containment obligations



National Grid's frequency containment obligations are detailed in the Security and Quality of Supply Standard (SQSS) – [link shown below](#)

# How is frequency response provided?

## Mandatory response

- ◆ All directly connected generators must have response capability
- ◆ Holding prices submitted monthly under CUSC arrangements

## Firm-frequency response

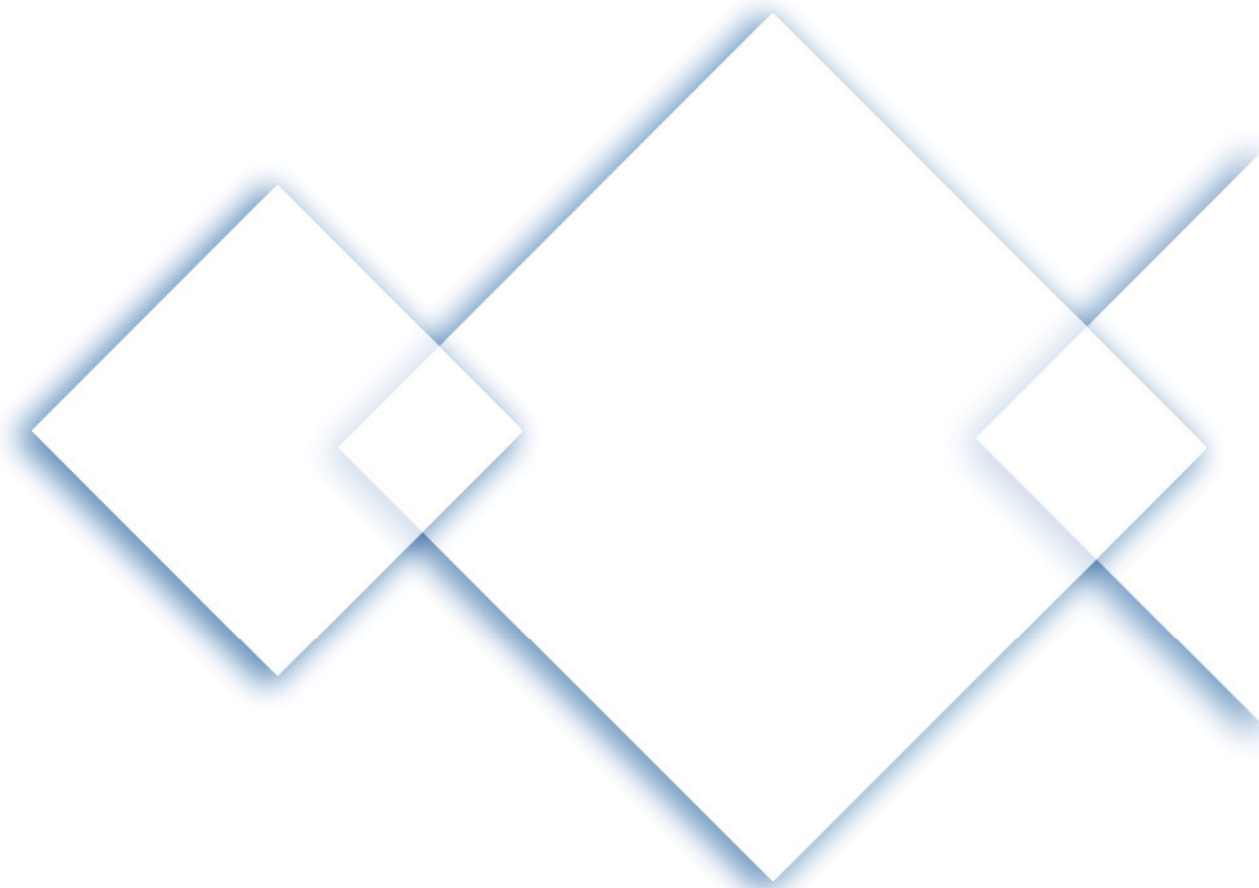
- ◆ Procured via a GB wide tender for single month, multi-month or long-term tenders
- ◆ Firm provision of response from providers with a proven delivery capability

## Commercial frequency response

- ◆ Terms negotiated on a bilateral basis where insufficient competition exists under tender frameworks

## Desired characteristics of service provision

- ◆ Easily despatchable, measurable, repeatable, reliable



## 2. Frequency Response Requirements

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## (2) Frequency Response Requirements

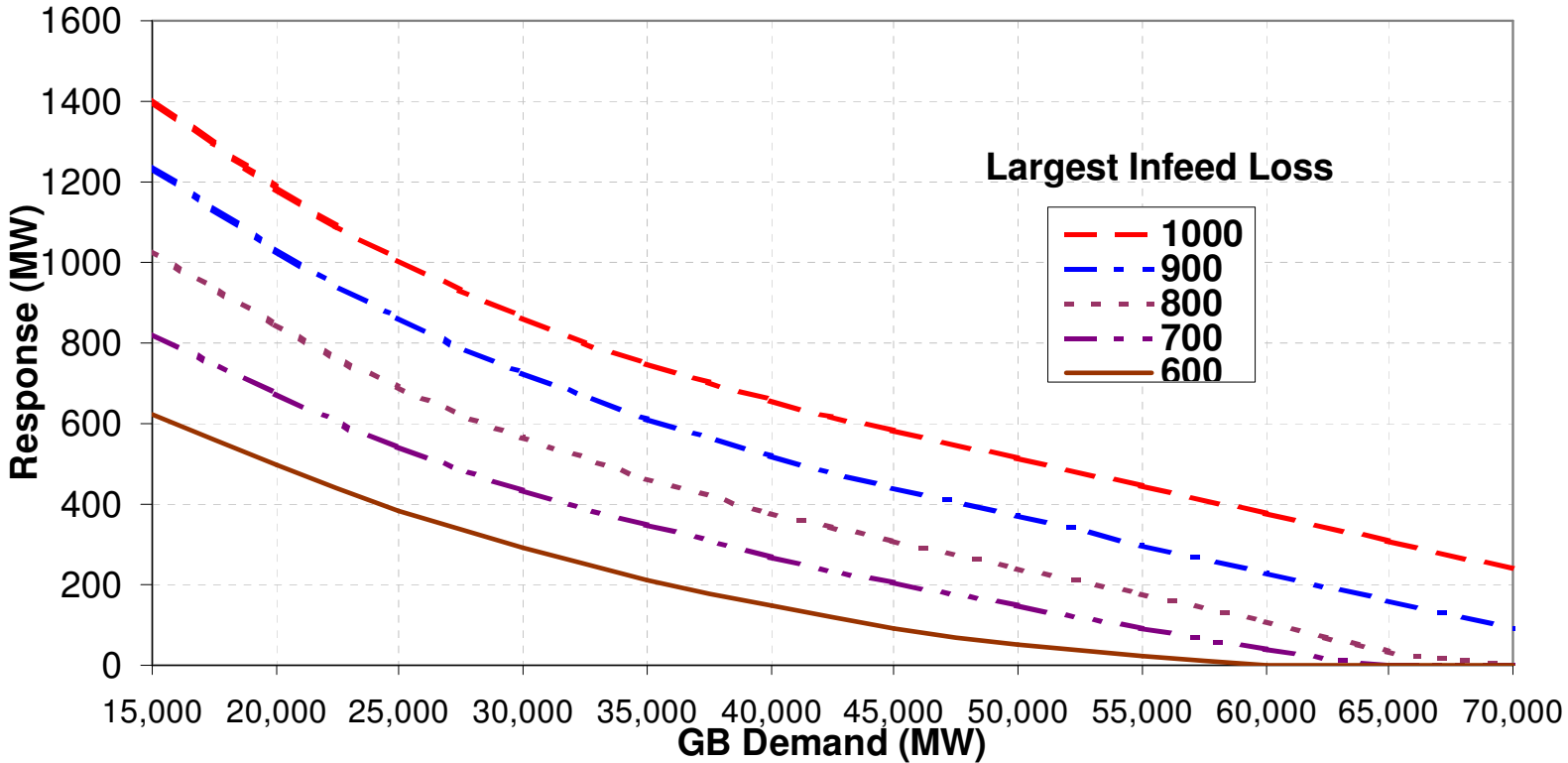
**Frequency Response Requirements are continuously changing.**

**They depend on several factors:-**

- ◆ Demand on the System
- ◆ Largest infeed currently connected on the system (demand or generation)
- ◆ Dynamic / Non Dynamic requirements
- ◆ These requirements are illustrated by a set of requirements curves....

# Frequency Response Curves (P-0.5)

## (GB) Primary Response Required to Contain Instantaneous Loss to -0.5Hz



# Dynamic / Non Dynamic Requirements

- ◆ **Minimum Dynamic requirement in the order of 400-500MW dependent on time of day as measured at 0.5Hz.**
- ◆ **This is set for stability and security of supply reasons.**
- ◆ **No minimum Non-Dynamic requirement however**
- ◆ **Maximum Non-Dynamic = Total Response Requirement - Dynamic Requirement**

# Response Requirement Summary

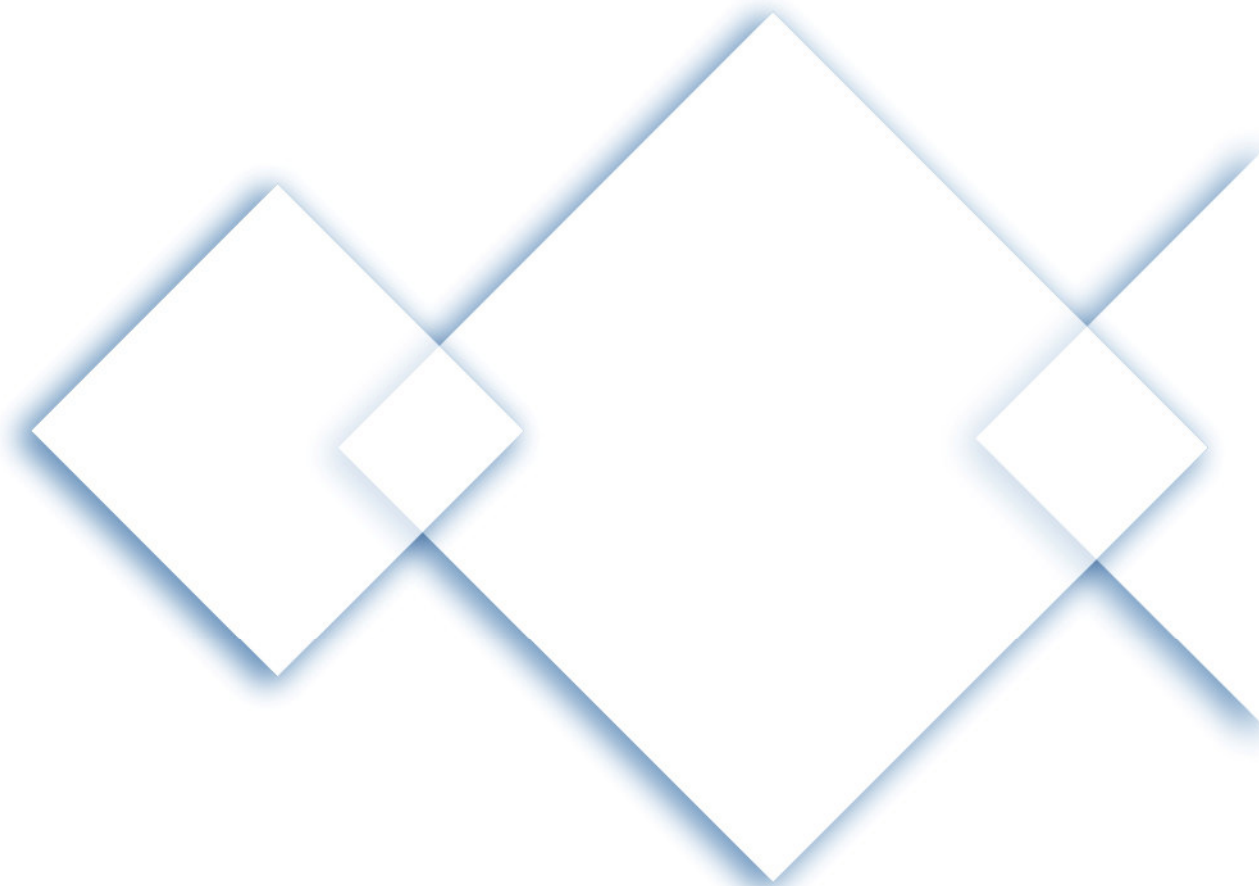
## Essentially a dual requirement....

### Largest Loss Requirement

- ◆ Continuously varying with Demand and Largest loss
- ◆ Requirement is higher overnight and in the summer
- ◆ Largest loss requirement can be met by Non-Dynamic or Dynamic Response

### Minimum Dynamic Requirement

- ◆ Set to be higher at times of volatile demand or system stress
- ◆ Held on dynamic sources only
- ◆ Also meets the largest loss requirement



### 3. How is frequency response despatched?

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## (3) How Frequency Response is despatched

### ◆ Frequency Response is considered over a number of timescales:-

- ◆ **Longer** - OC2 submissions are checked for risk days and weeks ahead of real-time
- ◆ **Day Ahead** - check to ensure sufficient frequency response plant available and ensure sufficient headroom for plant to provide response
- ◆ **18hrs, 12hrs, 4hrs** ahead plans checked to ensure viability maintained
- ◆ **Real-time** instructions issued to response providers

## (3) How Frequency Response is despatched

- ◆ A process of continuous optimisation at real-time
- ◆ Takes account of many factors:
  - ◆ Price
  - ◆ Reliability of delivery (historic reliability)
  - ◆ Speed of delivery
  - ◆ Capability
  - ◆ Efficiency ratio = pull back or lifting vs. capability
  - ◆ Location
  - ◆ Bid-Offer Prices
  - ◆ Dynamic/non-dynamic provision
  - ◆ 0.2Hz/0.5Hz/0.8Hz capabilities
  - ◆ .....



## 4. Assessment and optimisation of frequency response services?

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# Introduction

**This section will give an overview of:**

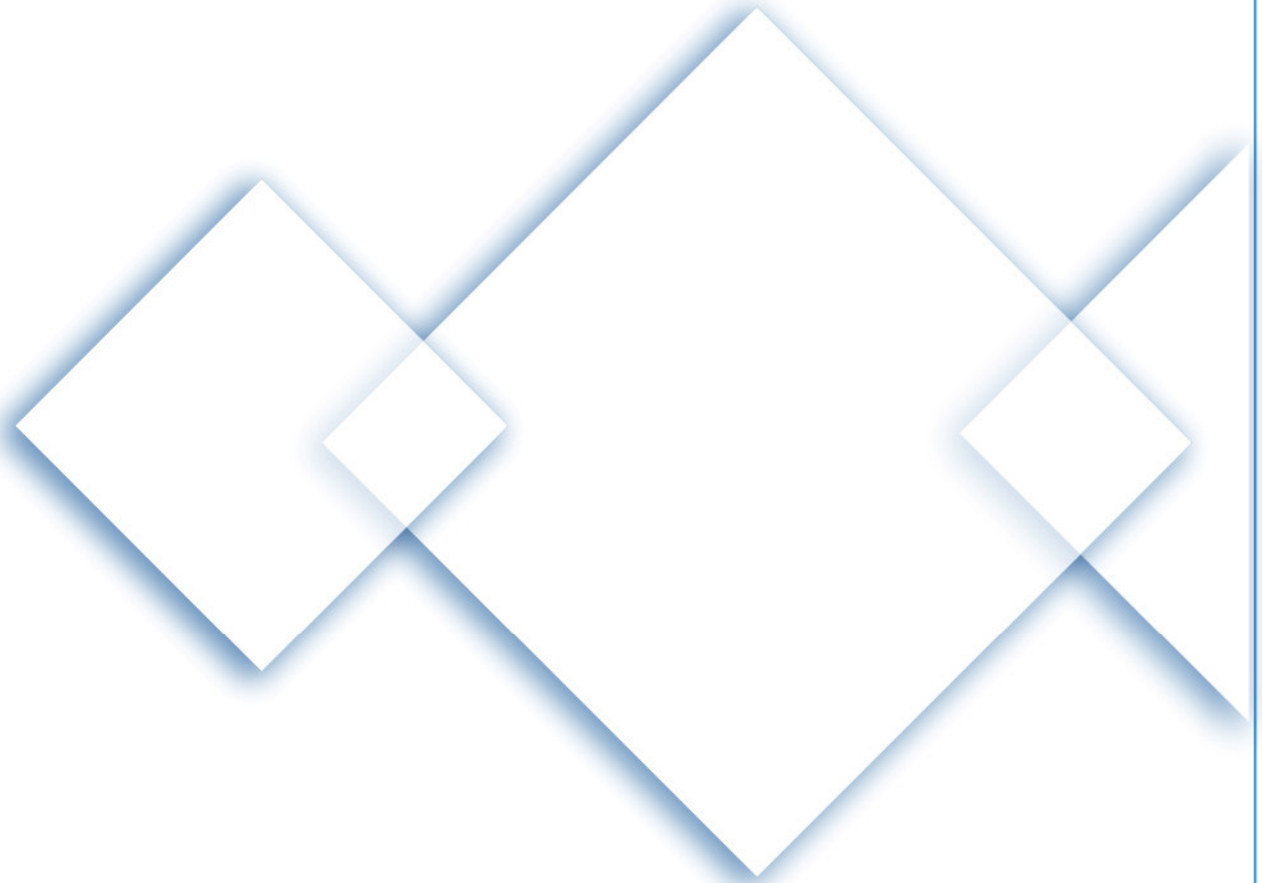
- ◆ How tenders are assessed
- ◆ How tendered services are subsequently optimised

**Detail and information that will help potential Frequency Response providers to develop services that are both**

- ◆ Profitable to the provider
- ◆ Economic to National Grid

# Assessment Sections

- 1. Assessment Principles**
- 2. Assessment Detail**
- 3. Optimisation of Assessment**
- 4. Summary**
- 5. Market Information**



# 1. Assessment Principles

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# Assessment Principles

## Requirement

- ◆ **Dual Requirement for Frequency Response to cover:**
  - ◆ Largest Loss Requirement, to a 0.8Hz or 0.5Hz deviation
  - ◆ Minimum Dynamic Requirement, covering 0.2Hz deviations
- ◆ **Largest Loss Requirement varies with System Demand and largest loss**
  - ◆ Greater requirement when demand is lower
  - ◆ Can be either Primary or Secondary driven
  - ◆ High Frequency Requirement varies with largest demand loss and system demand
- ◆ **Minimum Dynamic Requirement set through analysis/experience**
  - ◆ Higher at times of Demand/Generation volatility

# Assessment Principles

## Economic Assessment

- ◆ **Tenders are assessed on economics against the forecast alternative cost of provision.**
- ◆ **Alternative cost of provision means:**
  - ◆ Cost of Response Holding Payments
    - Mandatory payments under CUSC arrangements mainly...
  - ◆ Cost of Bids/Offers to reposition plant in the Balancing Mechanism
    - E.g. Taking a Bid to pull a unit back and, if required taking a balancing Offer
  - ◆ Cost of actions to create additional “Frequency Reserve”
    - Warming, synchronising BOAs, PGBTs, STOR for Primary and Secondary Response
    - Cost of overnight Downward Regulation actions for HF response

# Assessment Principles

## Other Assessment Drivers

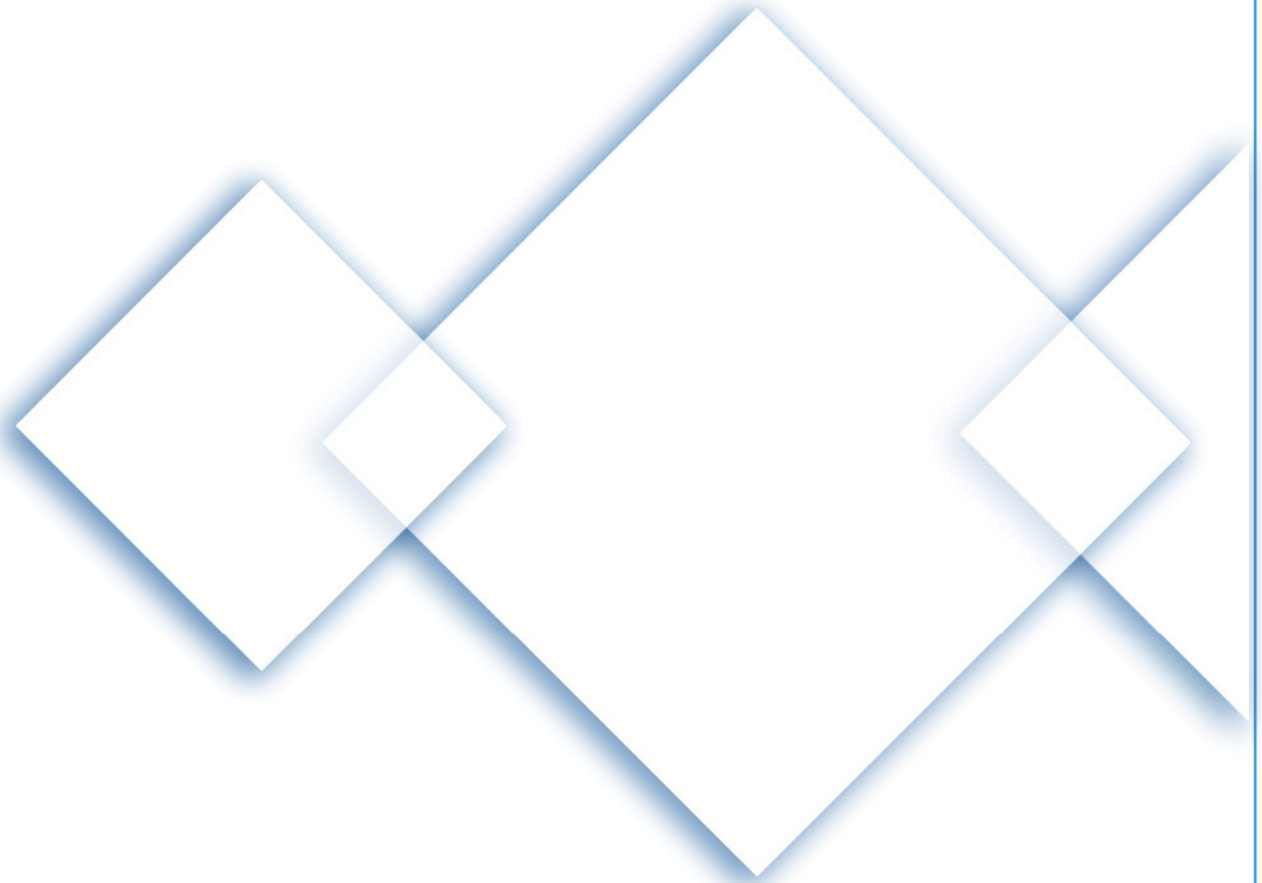
**Main driver of assessment will be pure economics. However, in addition:**

### **Quality/Reliability**

- ◆ Historic performance of provider will be taken into account during assessment.  
Preference for reliable provision.

### **Location**

- ◆ Potential for a locational element if system is forecast to be constrained.
- ◆ Still assessed on economics but against economics within the constrained area.



## 2. Assessment Detail

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# Assessment Detail

## - Economics of Response Despatch

Now each of the alternatives used in the assessment in detail.....

# Assessment Detail

## - Economics of Response Despatch

### 1. Instruction of mandatory Frequency Response services on part loaded plant available in the BM and optional services

◆ Volumes and costs of Response are published through procurement guidelines reporting

◆ For example:

◆ The June 2009 Monthly Balancing Services Summary (MBSS\*) gives average prices for Mandatory holding as follows:

◆ Primary	£3.12/MW/h
◆ Secondary	£2.09/MW/h
◆ High	£7.18/MW/h

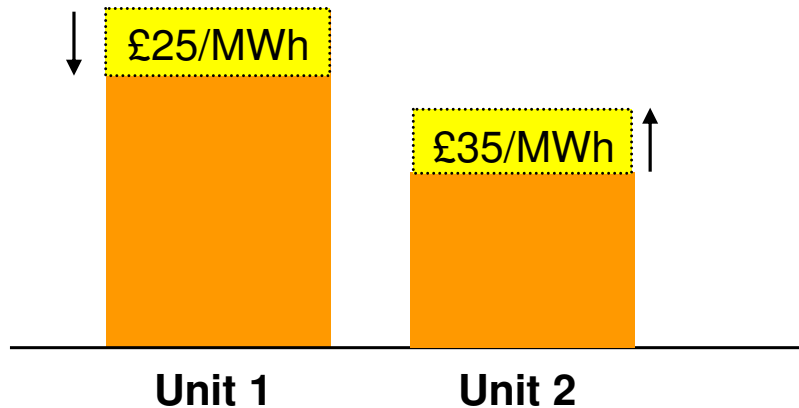
\*Note: The MBSS is available at  
<http://www.nationalgrid.com/uk/Electricity/Balancing/Summary/>

# Assessment Detail

## - Economics of Response Despatch

2. Optimisation of Response delivery may involve some repositioning (Bids and/or Offers) of Units to achieve best delivery of response for the headroom and Bid/Offer prices available

◆ Some example bid-offer costs:



Reposition Units to create 10MW of additional response:

Accept 10MWh of matching Bids and Offers at £10/MWh spread

Cost of BOAs:  $\text{£}10/\text{MWh} \times 10\text{MWh} = \text{£}100$

Cost of Response Creation:

$$\text{£}100 / 10 \text{ MW}_{\text{response}} = \text{£}10/\text{MW}_{\text{response}}$$

# Assessment Detail

## - Economics of Response Despatch

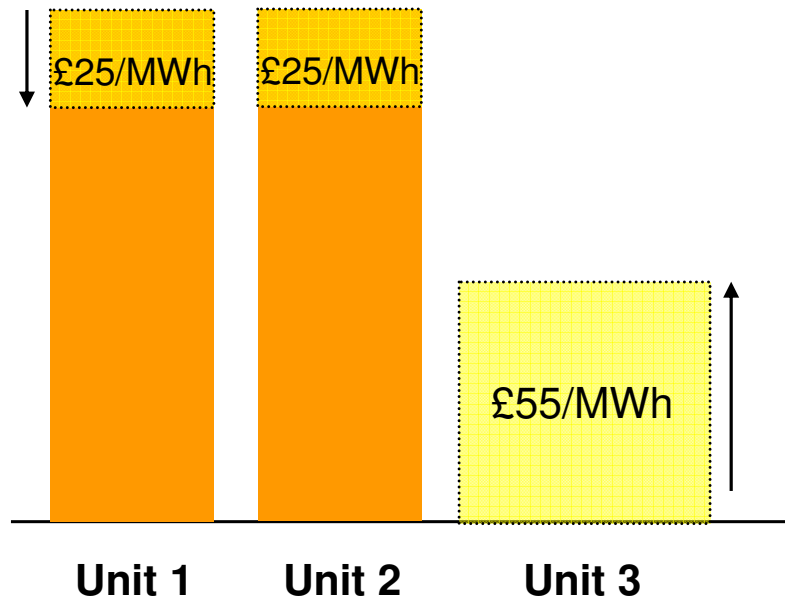
**3. Further response provision delivered through BM Startup and/or synchronising actions, PGBTs, running of STOR etc.**

◆ For example.....

# Assessment Detail

## - Economics of Response Despatch

For example...



Synchronise additional Unit to provide Headroom to create 100MW of additional response:

Synchronise Unit 100 MWh at £55/MWh

Balancing Bids at £25/MWh

Bid-Offer Spread = £30/MWh spread

Cost of BOAs: £30/MWh x 100MWh = £3000

Cost of Response Creation:

$£3,000 / 100 \text{ MW}_{\text{response}} = £30/\text{MW}_{\text{response}}$

# Assessment Detail

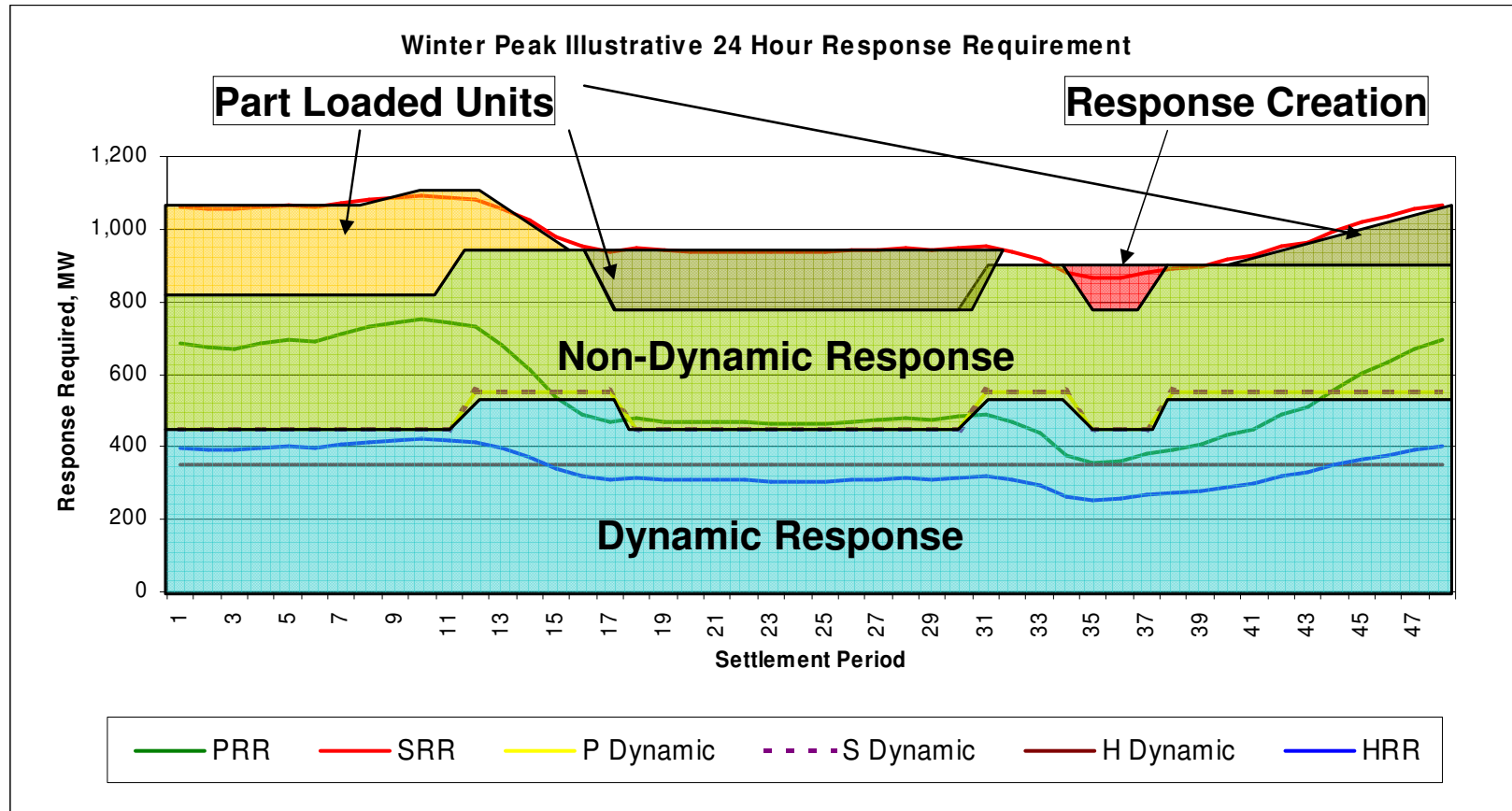
## - Economics of Response Despatch

### A note on Frequency Reserve

- ◆ For a Generating Unit to deliver Response there must be sufficient Headroom and/or Footroom on the unit to allow it regulate up and down
- ◆ Across the GB fleet, the average response delivered for every 1MW of Headroom or Footroom is assumed to be 0.55MW. i.e. For 1 MW of Headroom you get ~ 0.55 MW of Primary and Secondary.
- ◆ For HF response we have recently updated our assumptions to 0.7 from 0.55.
- ◆ If insufficient Response is available then it is necessary to create additional Headroom or Footroom in order to deliver additional Response
- ◆ Once created, Response may be dispatched on the same Unit as the created Headroom, or further repositioning may occur to optimise Response holding

# Assessment Detail

## - Economics of Response Despatch



# Assessment Detail

## - Non-Dynamic Response

### Non-Dynamic Services

- ◆ **Can be used to make up any residual Frequency Response Requirement above the MDR**
- ◆ **May therefore displace either**
  - ◆ other non-dynamic provision or
  - ◆ Dynamic Response, dependent on economics and availability of alternative providers
- ◆ **This means that for assessment and optimisation purposes Non-Dynamic provision can be competing against either alternative Non-Dynamic provision or Dynamic provision**

# Assessment Detail

## - Meeting the requirement

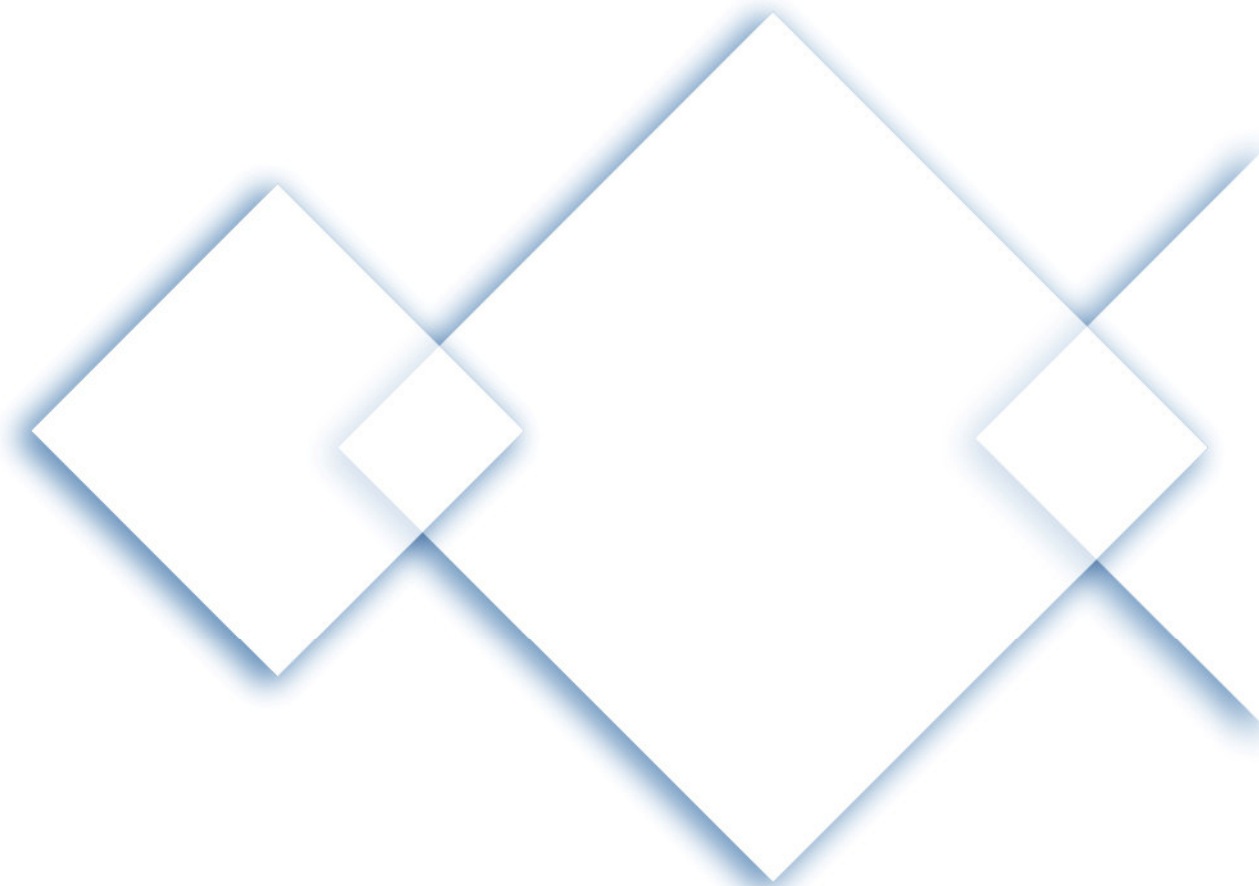
**Is the highest Response requirement always the biting requirement?**

◆ **No, the biting requirement will depend on the availability of each type of response.**

- ◆ For example, it may be possible to satisfy a higher secondary response requirement on already part-loaded plant but then need to reposition additional plant to meet a lower Primary Response Requirement

**The optimal solution will be the one that most efficiently and economically meets all Response Requirements. Using the example above:**

- ◆ If a more expensive provider delivers both Primary and Secondary Response and is required to meet the Primary Response Requirement then this may create an excess of Secondary Response.
- ◆ If this delivers the lowest overall cost solution, it may be selected in preference to a cheaper provider only delivering Secondary Response.



## 3. Optimisation of Assessment

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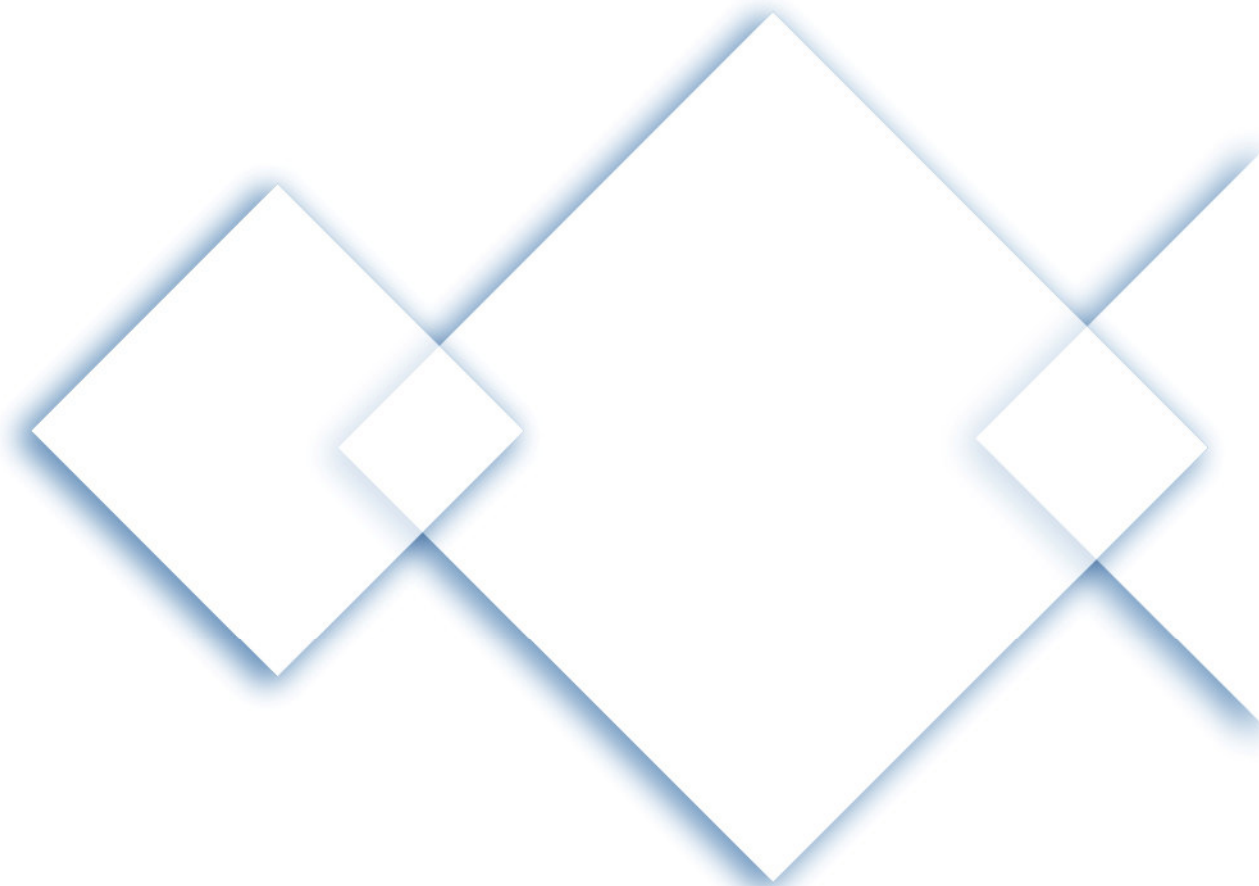
# Optimisation of Tenders

- ◆ **During and after an assessment, tenders will be optimised to maximise economic value they deliver to National Grid.**
- ◆ **Tenders are optimised by selecting the ‘best fit’ of window nominations, balancing cost of nomination and forecast value**
- ◆ **Nominated windows for FFR contracts will be finalised after the completion of an assessment and confirmed to providers on Business Day 14 every month of the contract**

# Optimisation of Tenders

We also place a value on flexibility:

- ◆ For example for FFR - increasing the proportion of tender cost within window initiation and hourly nomination fees, and reducing availability fees
- ◆ This facilitates flexibility in tender optimisation and can help to increase possibility of procurement for the same overall tender income.
- ◆ In addition, value may be placed on the option to re-nominate windows, as this increases flexibility and the chance to manage risk closer to real time.



## 4. Summary

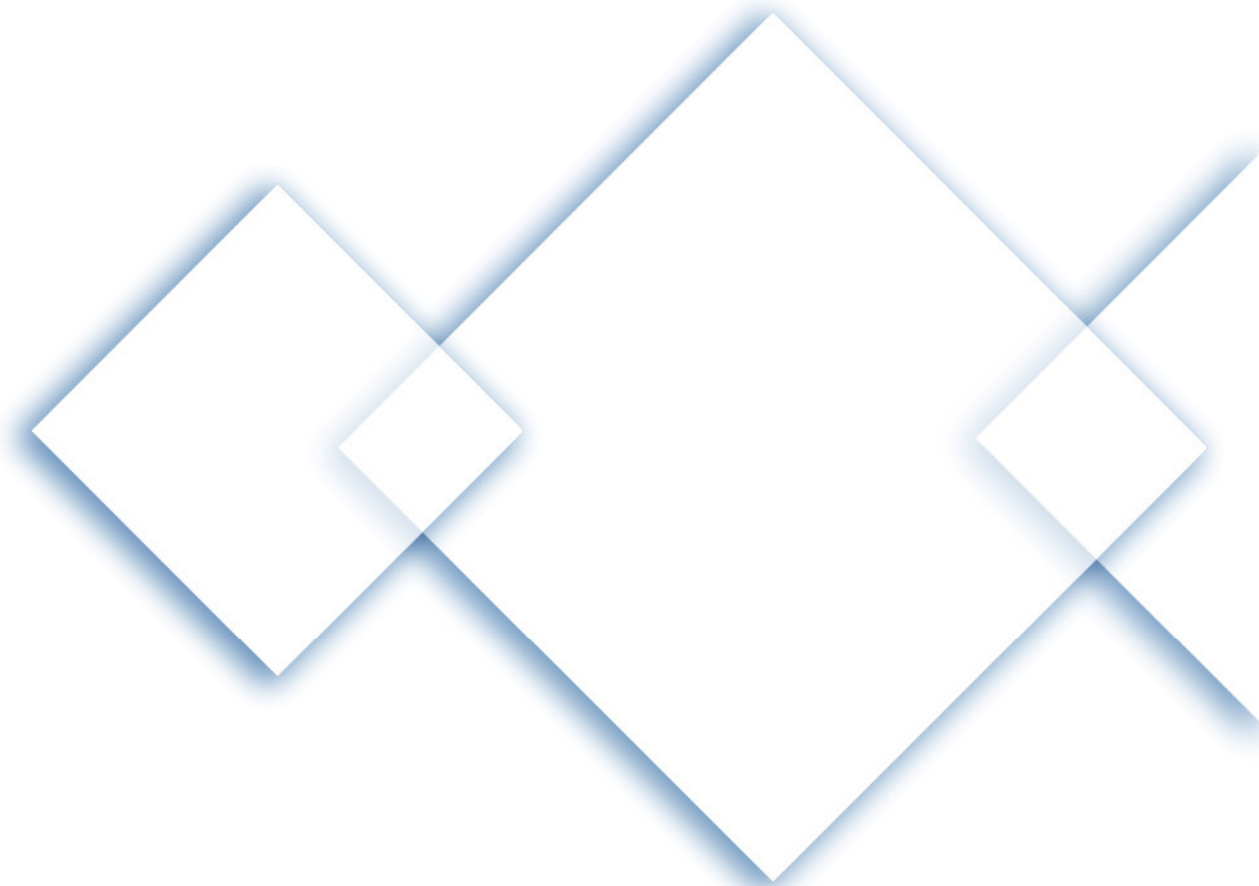
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# Overall Assessment Summary

- ◆ **Majority of the assessment against economics of provision on a non-locational basis. Avoided costs are:**
  - ◆ Response Holding costs
  - ◆ Response creation balancing action costs
- ◆ **Consideration of historic reliability and performance**
- ◆ **Flexibility adds value**
  - ◆ Flexibility of tender pricing and hence window nomination increases possibility of optimisation and therefore procurement
  - ◆ Re-nomination of windows adds flexibility, facilitating risk management
- ◆ **Further assessment criteria in line with other tenders**



## 5. Market Information

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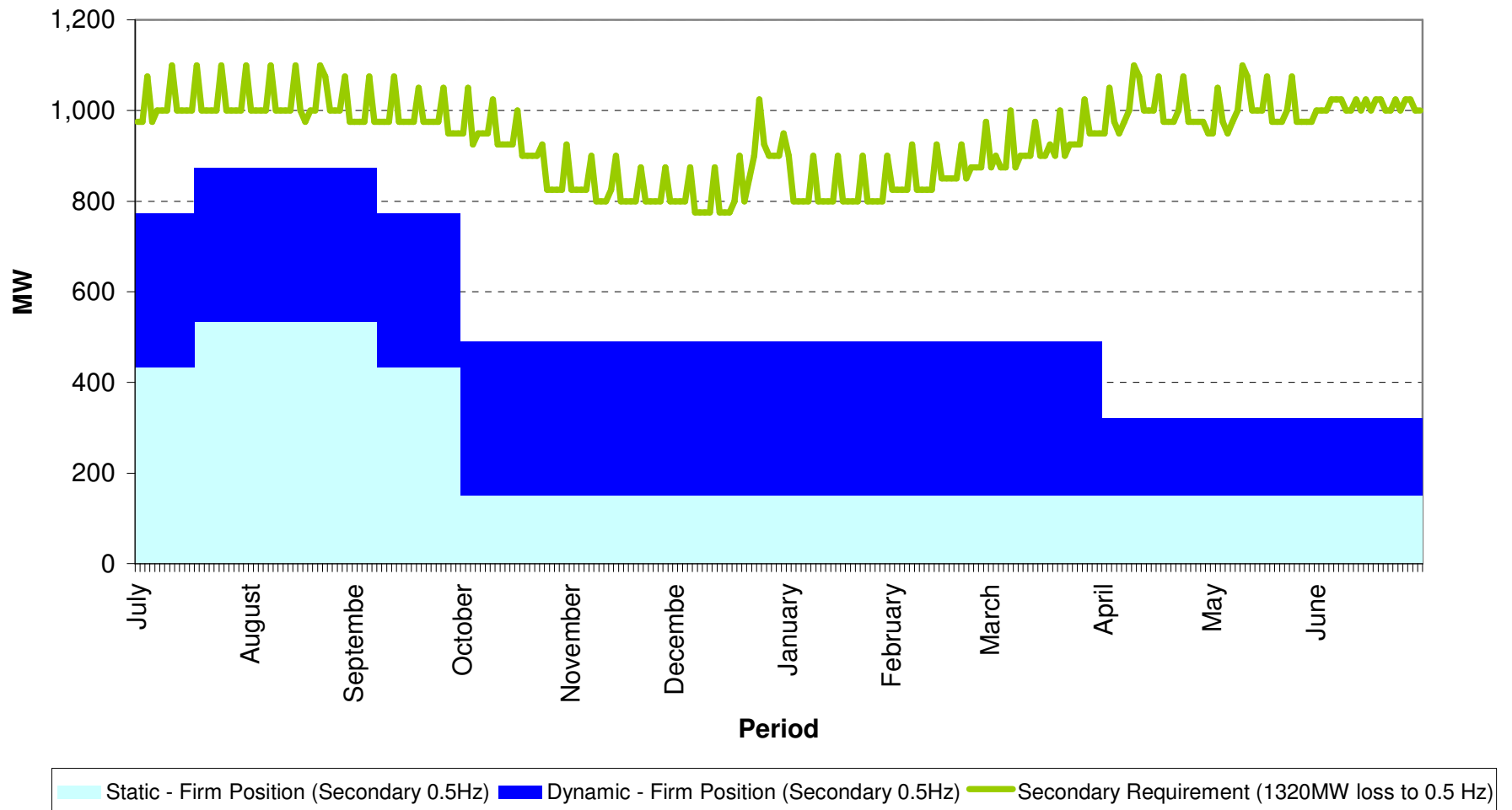
# Market Information

- ◆ We publish Market Information report on Business Day 18 pre-tender for FFR detailing:
  - ◆ Forecast Response Requirements at Settlement Period resolution
  - ◆ 1 year ahead graphs of Frequency Response contracts/requirements
  - ◆ Historic Frequency Response holding volumes, costs and prices
- ◆ Example of 1 year ahead requirements . . . . .
- ◆ Full FFR tender process timescale follows . . . . .

# LF response requirement

1 year ahead contracts

*Current 12 month forward contracted outlook - Weekday*



# Market Information

◆ In addition to tender round information, further details of National Grid balancing activity, actions and costs can be found on the following

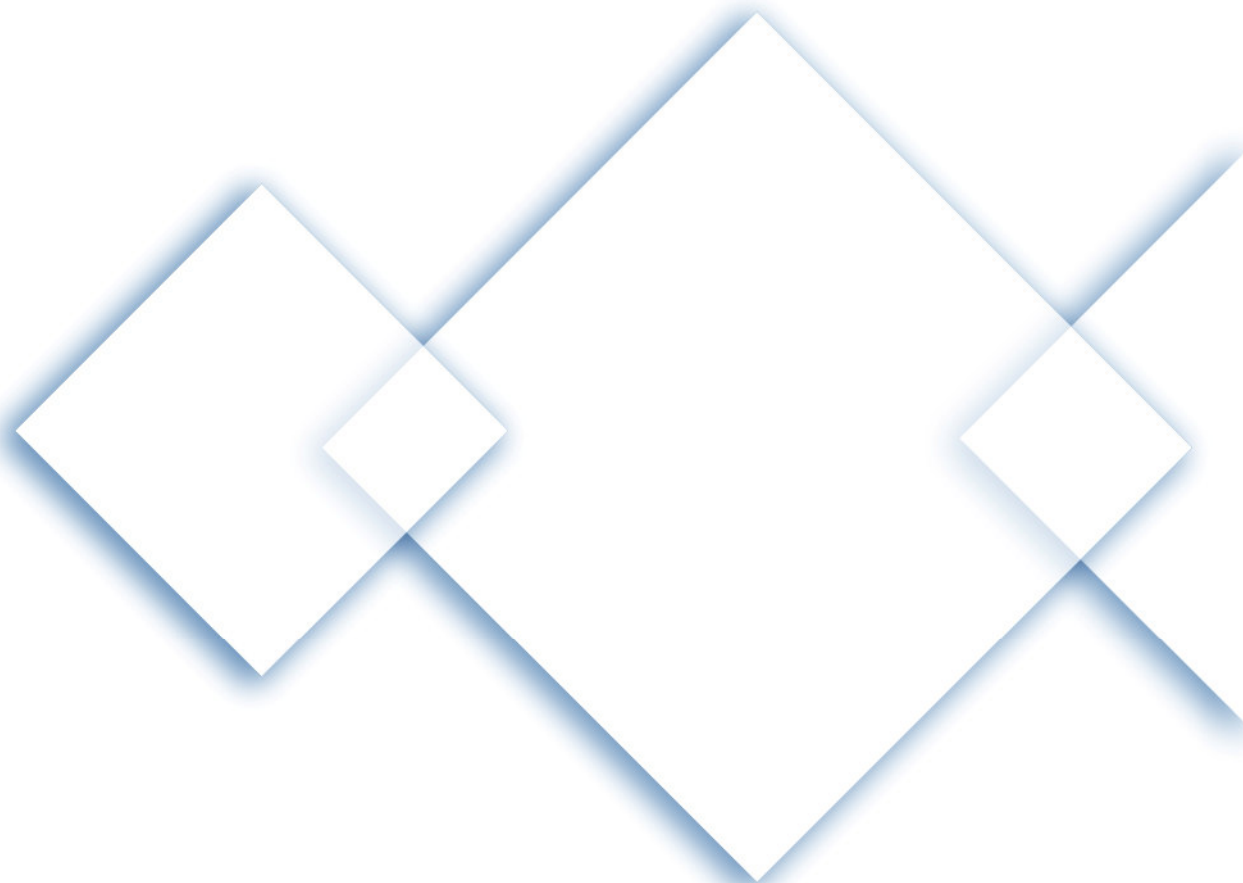
sites:

- ◆ Balancing Mechanism

[www.bmreports.com](http://www.bmreports.com)

- ◆ National Grid's full range of Balancing Services

<http://www.nationalgrid.com/uk/Electricity/Balancing/>



## 5. Future Requirements (2020 and beyond)

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## (5) Future Requirements

- ◆ **Largest infeed loss will increase from 1320MW to 1800MW**

- ◆ This raises Primary and Secondary Response Requirements by ~480MW
- ◆ Detailed analysis is available as part of the SQSS review:  
<http://www.nationalgrid.com/uk/Electricity/Codes/gbsqsscode/reviews/>  
(under the section headed "GB SQSS review GSR007")

- ◆ **Increase in Wind Capacity**

- ◆ Wind Turbines provide limited system inertia
- ◆ Therefore, when wind is generating our response requirements for Primary and High increase
- ◆ Additionally in 2020 and beyond, Primary and High requirements are more volatile one day to the next.

- ◆ **More Interconnection with Europe**

- ◆ Therefore more likely to have a credible 1000MW demand loss (at the moment, we usually plan for a 560MW demand loss).
- ◆ HF requirement is increased at those times.

# Any questions?

- ◆ **Frequency Response Contact:**

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- ◆ Email: [andy.walden@uk.ngrid.com](mailto:andy.walden@uk.ngrid.com)