

# Firm Frequency Response Seminar

Edgar Goddard

Electricity Balancing and Energy Trading Manager

# Agenda

## Morning session

- Welcome and Overview Edgar Goddard
- System Requirements and Using Firm Frequency Response Rachel Morfill
- Service Description and Procurement Process James Soundraraju

**1150 Break for 2 minute silence**

**1210 LUNCH**

## Afternoon session

- Assessment Process Duncan Burt
- Q & A

# Firm Frequency Response Service (FFR)

The seminar objectives are to :

- introduce Firm Frequency Response
- present an overview of generic Standard Contract Terms (SCTs) and agreements
- communicate tender rules and timescales
- identify any potential barriers to participation
- allow NGT to address any barriers to participation and if required, amend the SCTs of the service to encourage greater participation

# Firm Frequency Response Service (FFR)

(Why have the service?)

- The provision of FFR is open to BM and Non-BM providers thereby increasing the number of potential providers and improving liquidity
- Creating a route to market for providers whose services may otherwise be inaccessible
- Replacing bespoke bilateral firm services with the introduction of a competitive tender
- Providing a mechanism to secure firm income, allowing providers an element of certainty in financial planning
- A degree of stability against price uncertainty under CAP047

# Firm Frequency Response Service (FFR)

## At a glance

- Firm provision of Dynamic and Non-Dynamic Frequency Response from providers with a proven delivery capability and procured via a GB wide tender
- Transparent and timely discovery (prices, volumes, providers)
- Desired characteristics of service provision:-
  - Easily despatchable
  - Measurable
  - Repeatable
  - Reliable

# System Requirements and Using Firm Frequency Response

Rachel Morfill

Operational Policy and Market Information Manager

# Contents

1.0 What is Frequency Response

2.0 Frequency Response Requirement

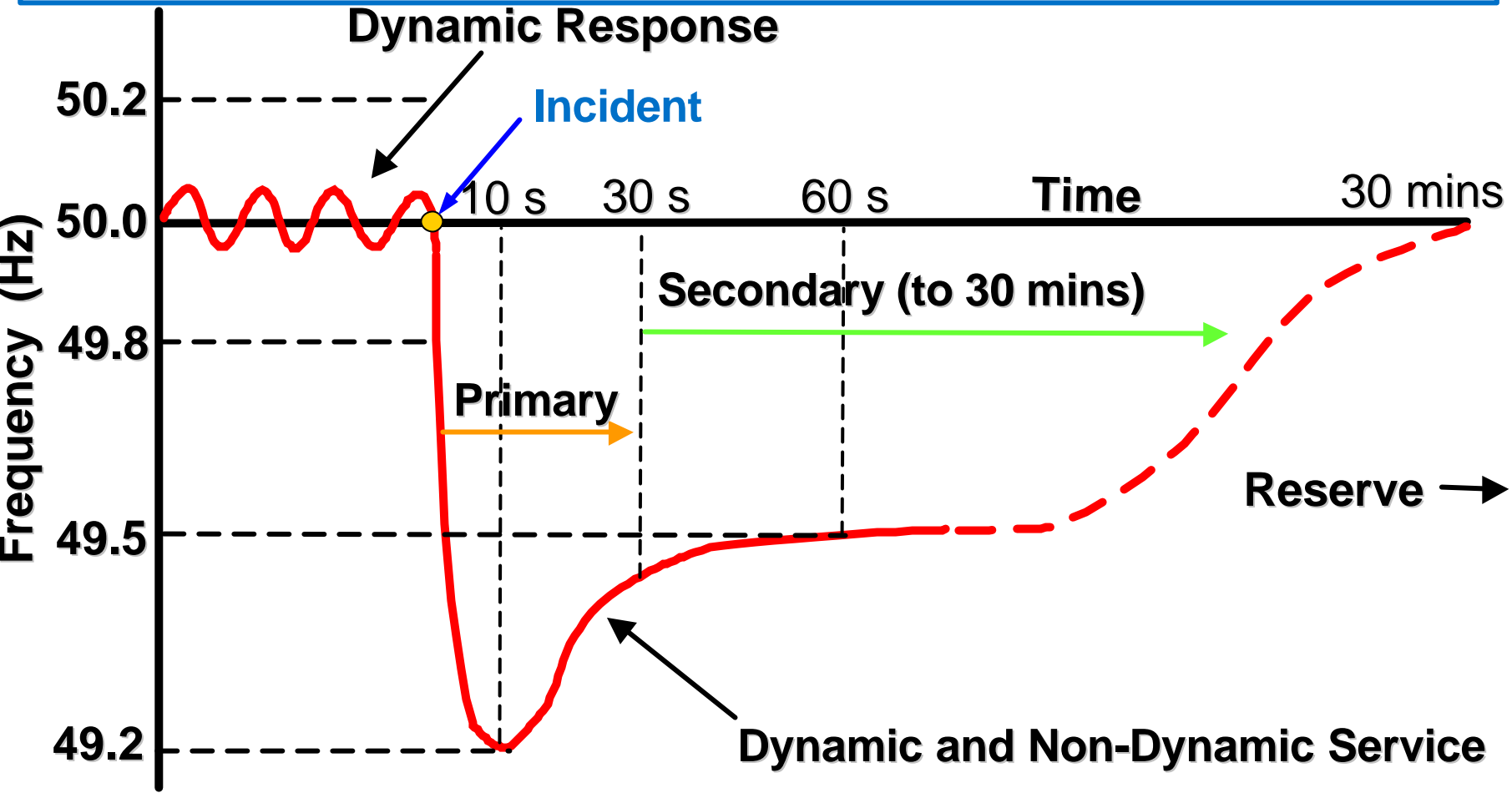
3.0 How Frequency Response Is Despatched

4.0 Firm Frequency Response Utilisation

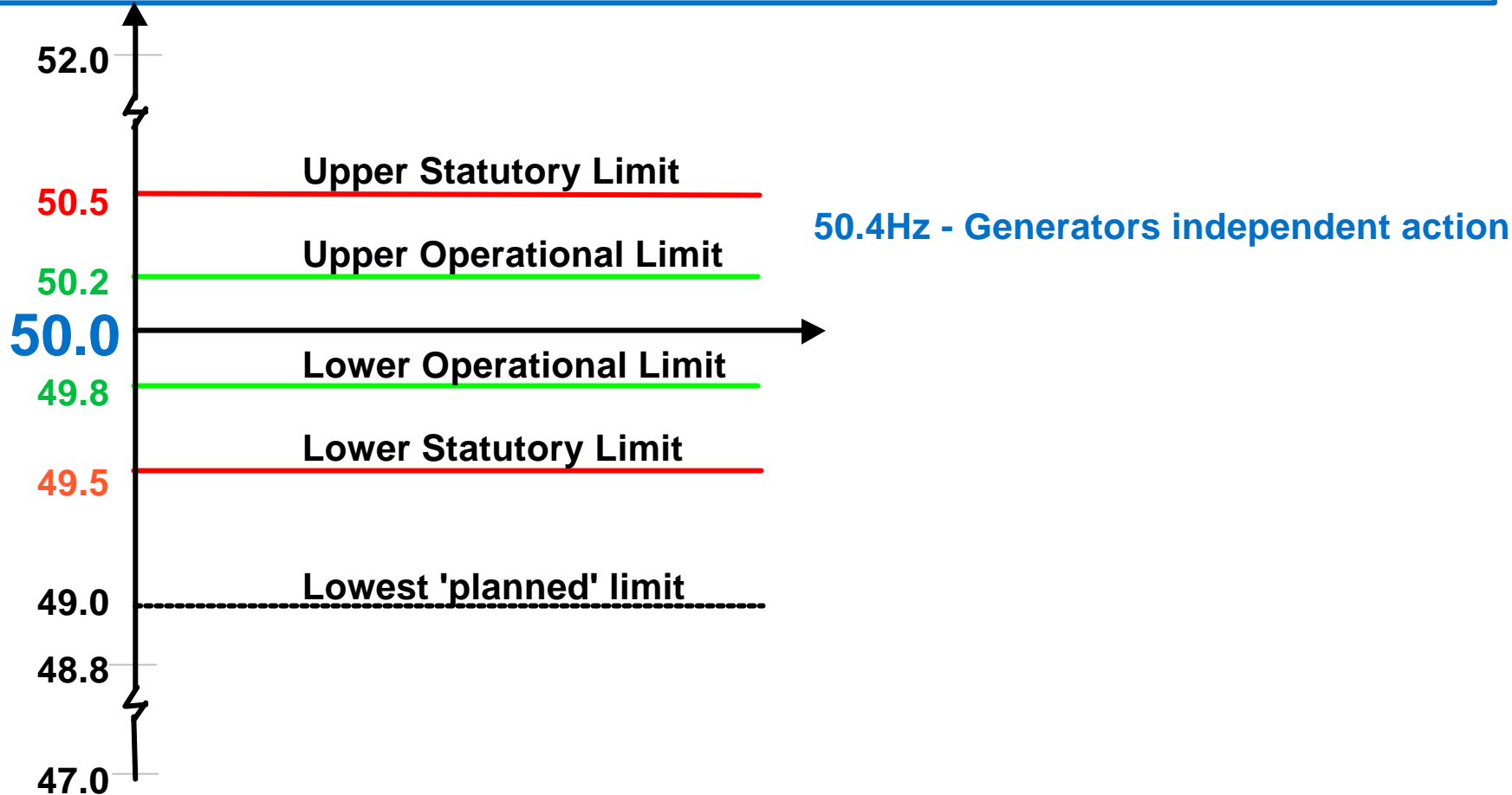
# 1.0 Frequency Response

- What is it?
  - An *automatic* change in active power output or demand in response to a frequency change
- Why do we need it?
  - To maintain system frequency within statutory and operational limits

# Frequency Control Phases



# National Grid has an obligation to maintain System Frequency within statutory limits



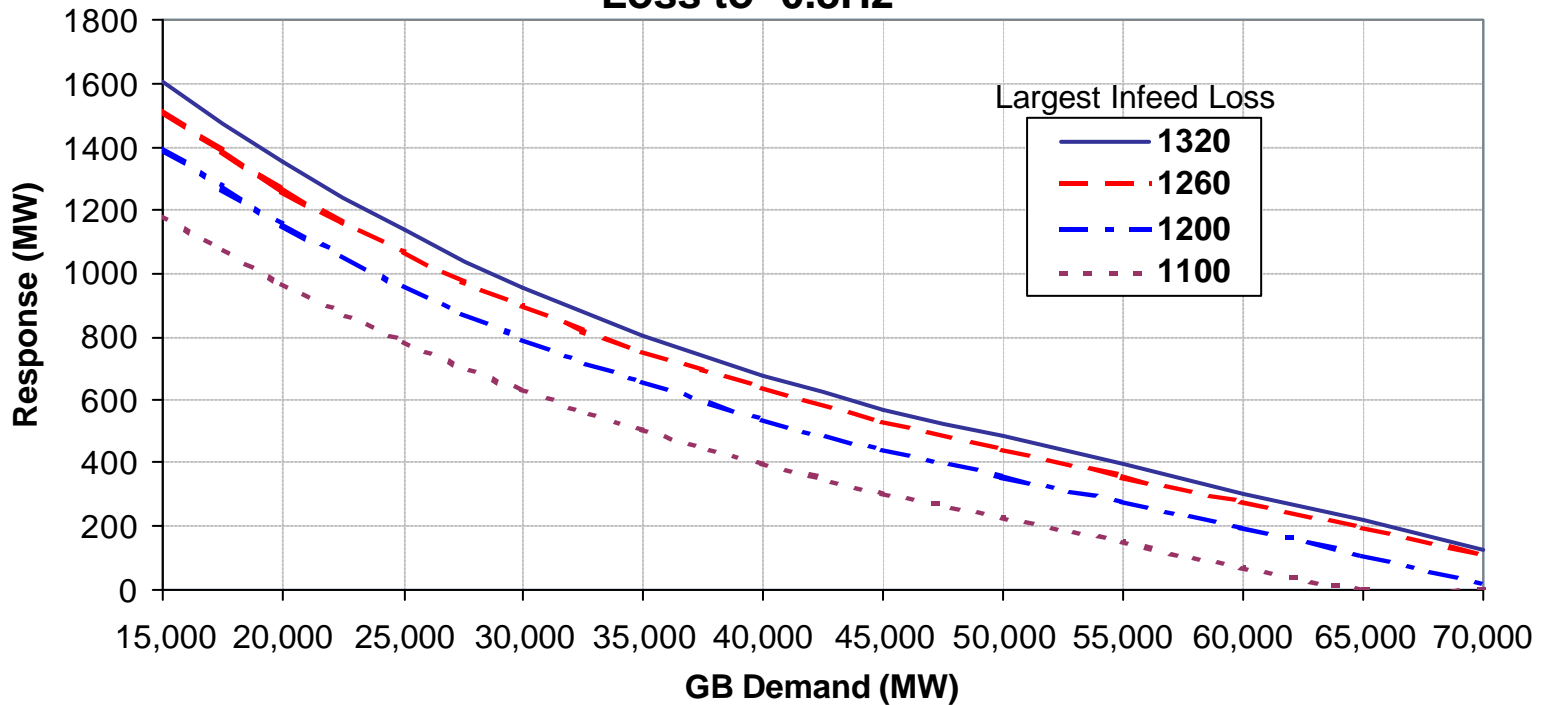
## 2.0 Frequency Response Requirements

Frequency Response Requirements are continuously changing. They depend on several factors:-

- Demand on the System
- Largest infeed currently connected on the system
- Dynamic / Non Dynamic requirements

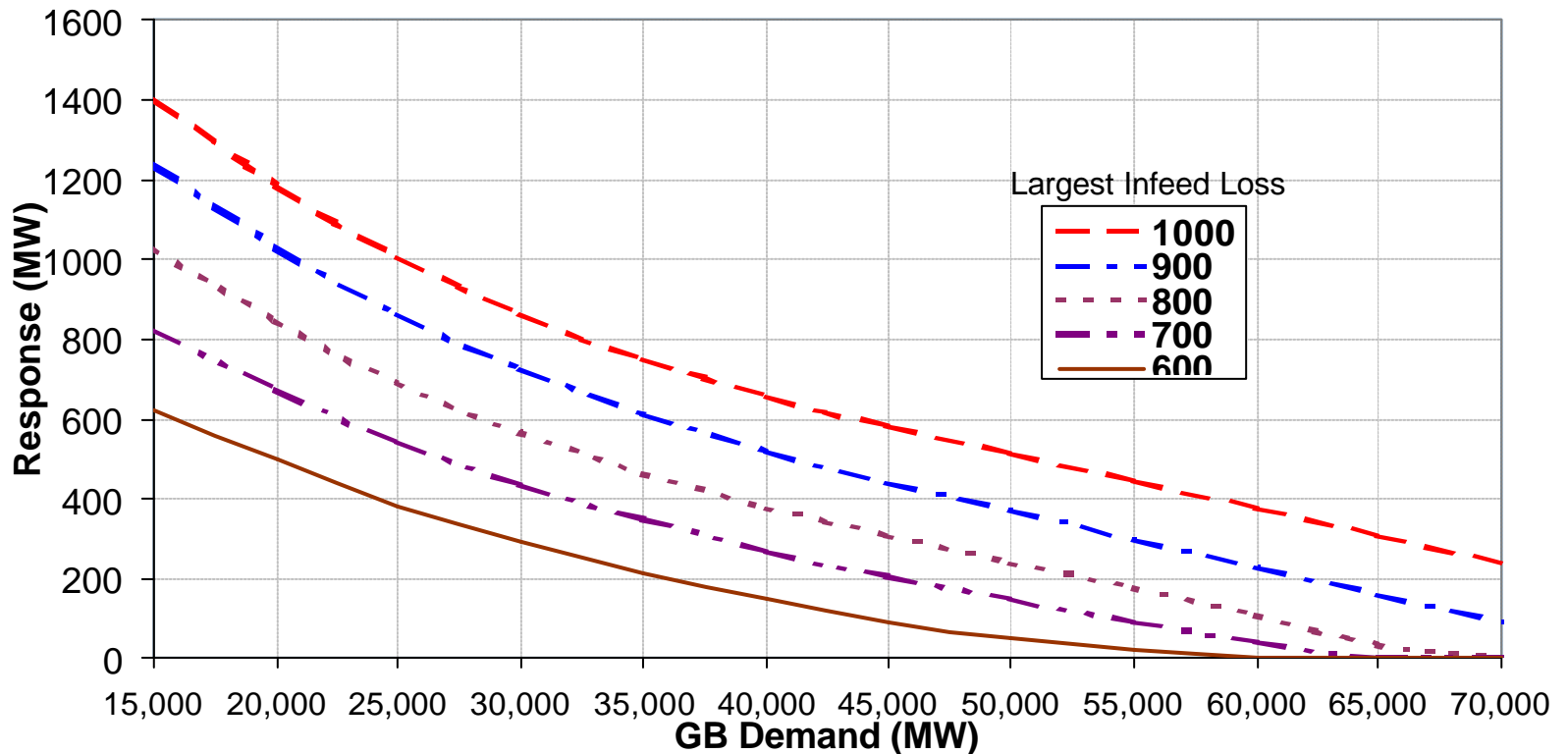
# Frequency Response Curves

**(GB) Primary Response Required to Contain Instantaneous Loss to -0.8Hz**



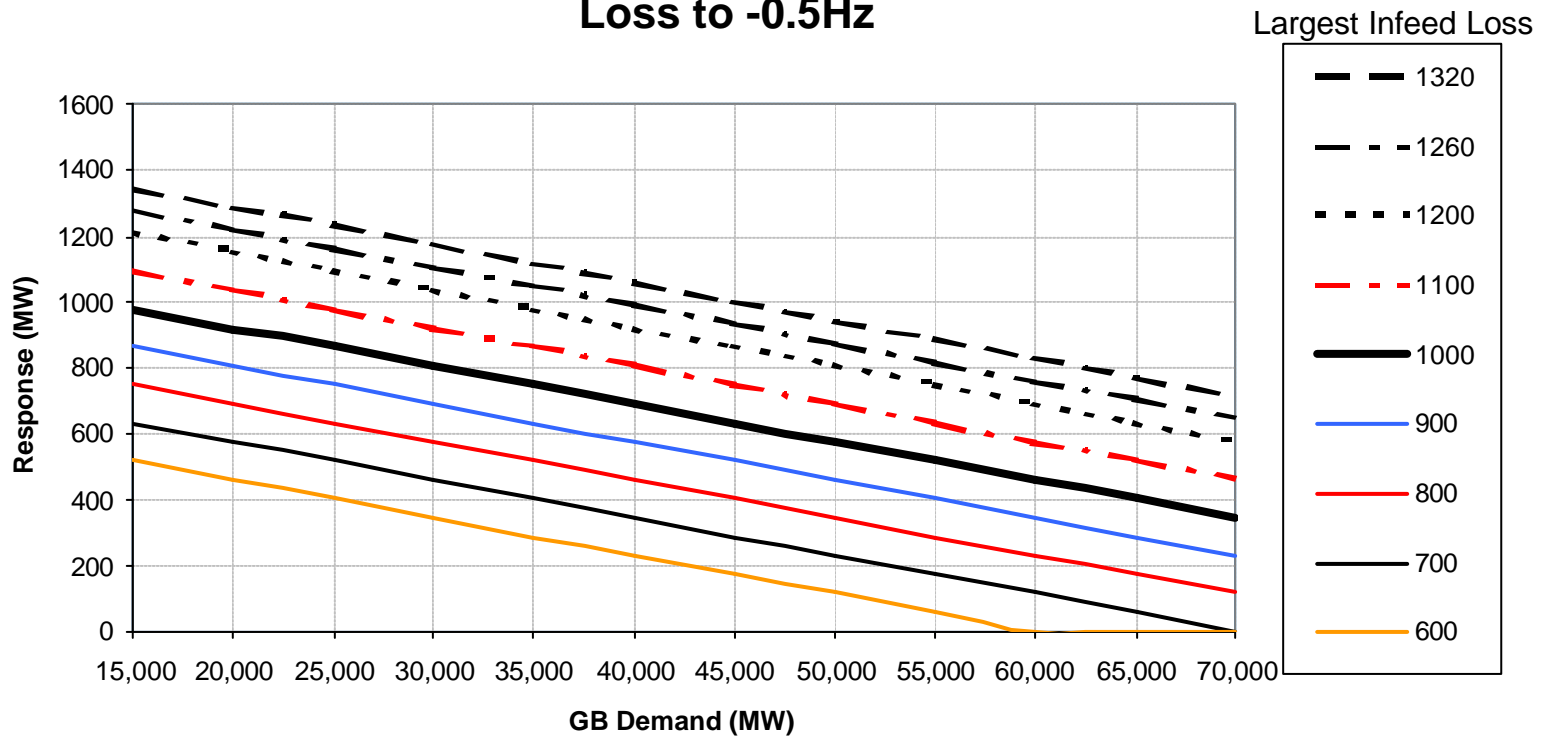
# Frequency Response Curves

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



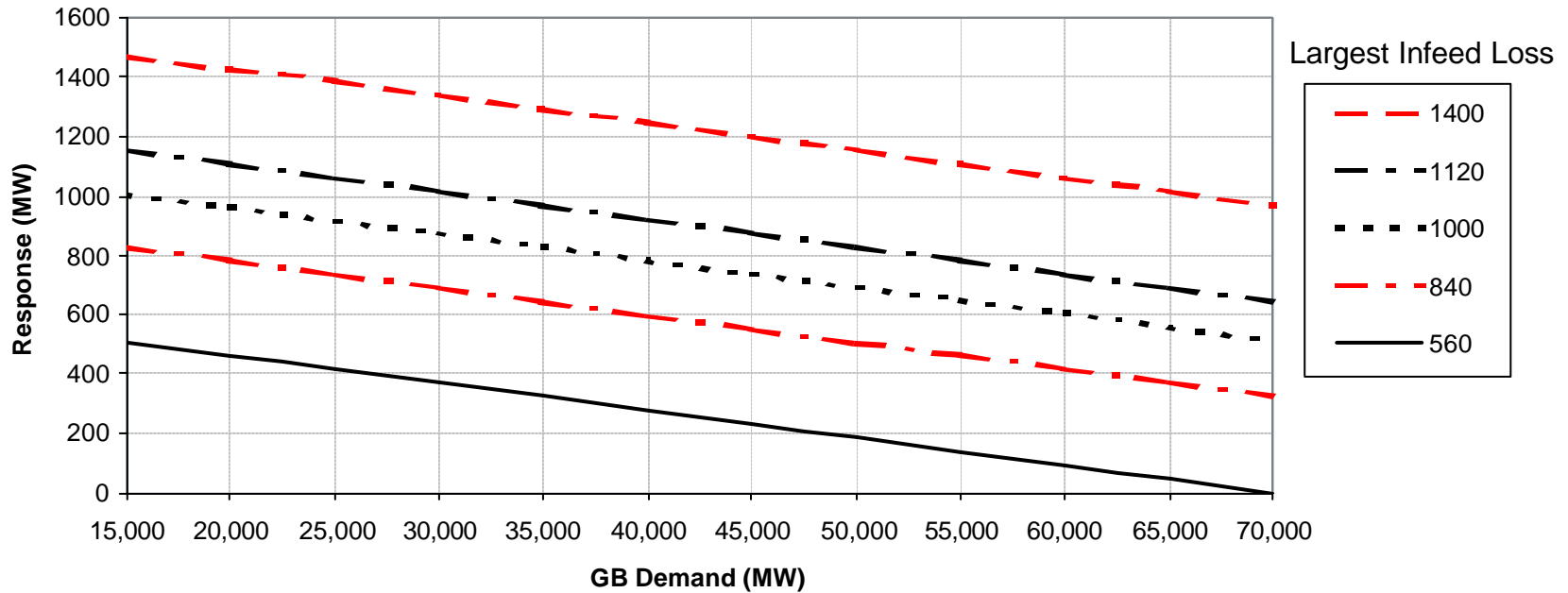
# Frequency Response Curves

## (GB) Secondary Response Required to Recover Instantaneous Loss to -0.5Hz



# Frequency Response Curves

(GB) High Frequency Response Required to Contain Instantaneous Demand Loss to +0.4Hz



# Dynamic / Non Dynamic Response

- Dynamic Response is a continuously provided service used to manage the normal second by second changes on the system.
  - Usually provided on a continuous basis through generator governor control
  - Usually based on the 0.2Hz frequency deviation (approx. 300MW change to the generation / demand balance)
- Non - Dynamic Response is usually a discrete service triggered at a defined frequency deviation
  - Usually provided on an instantaneous basis such as LF relay triggered demand

# Dynamic / Non Dynamic Requirements

- There is a minimum Dynamic requirement in the order of 300-500MW of response dependent on time of day as measured at 0.5Hz.
- No specific Non-Dynamic requirement however
  - Maximum Non-Dynamic useable = Total Response Requirement - Dynamic Requirement

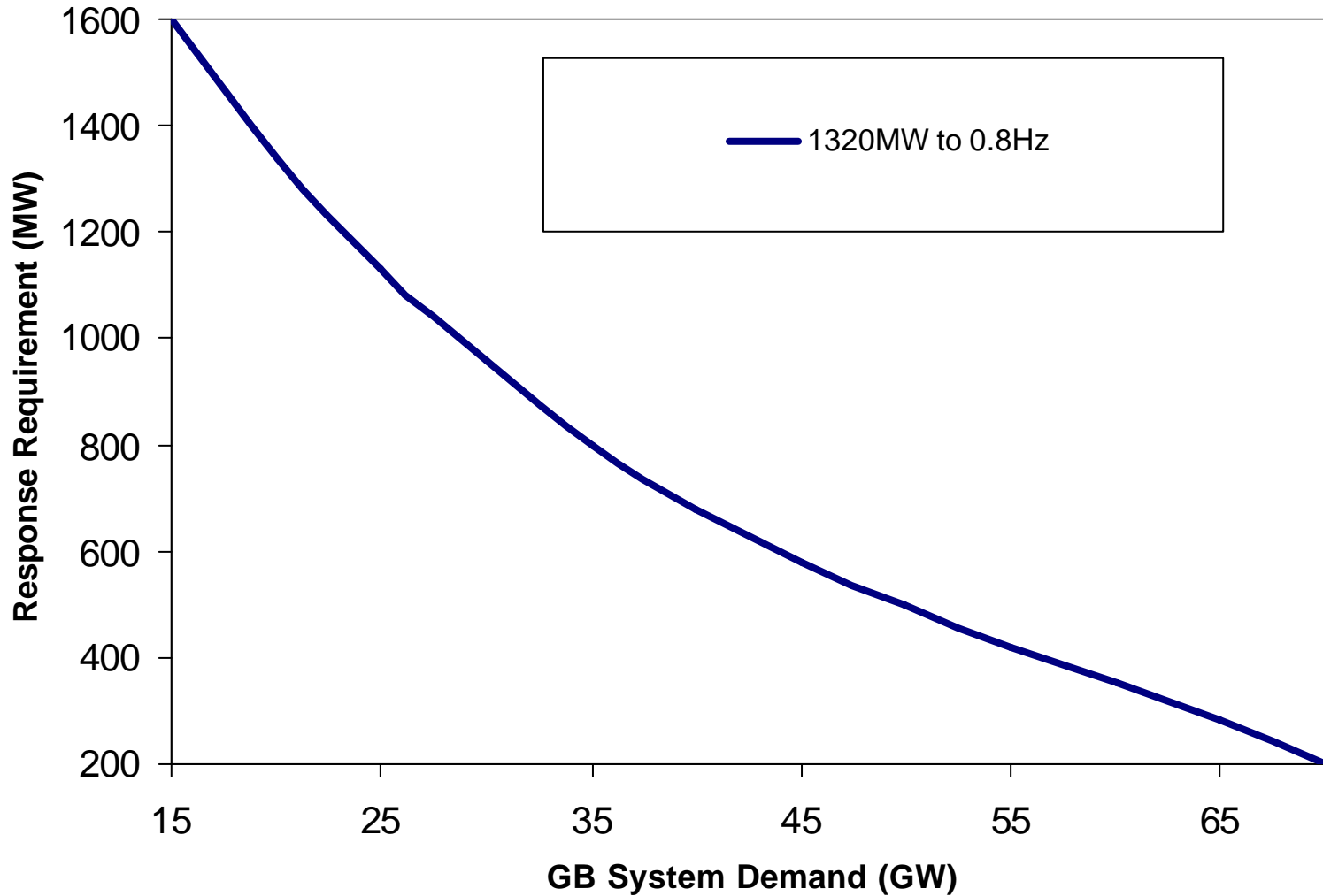
# Response Selection Illustration

## *Illustrative response Requirement*

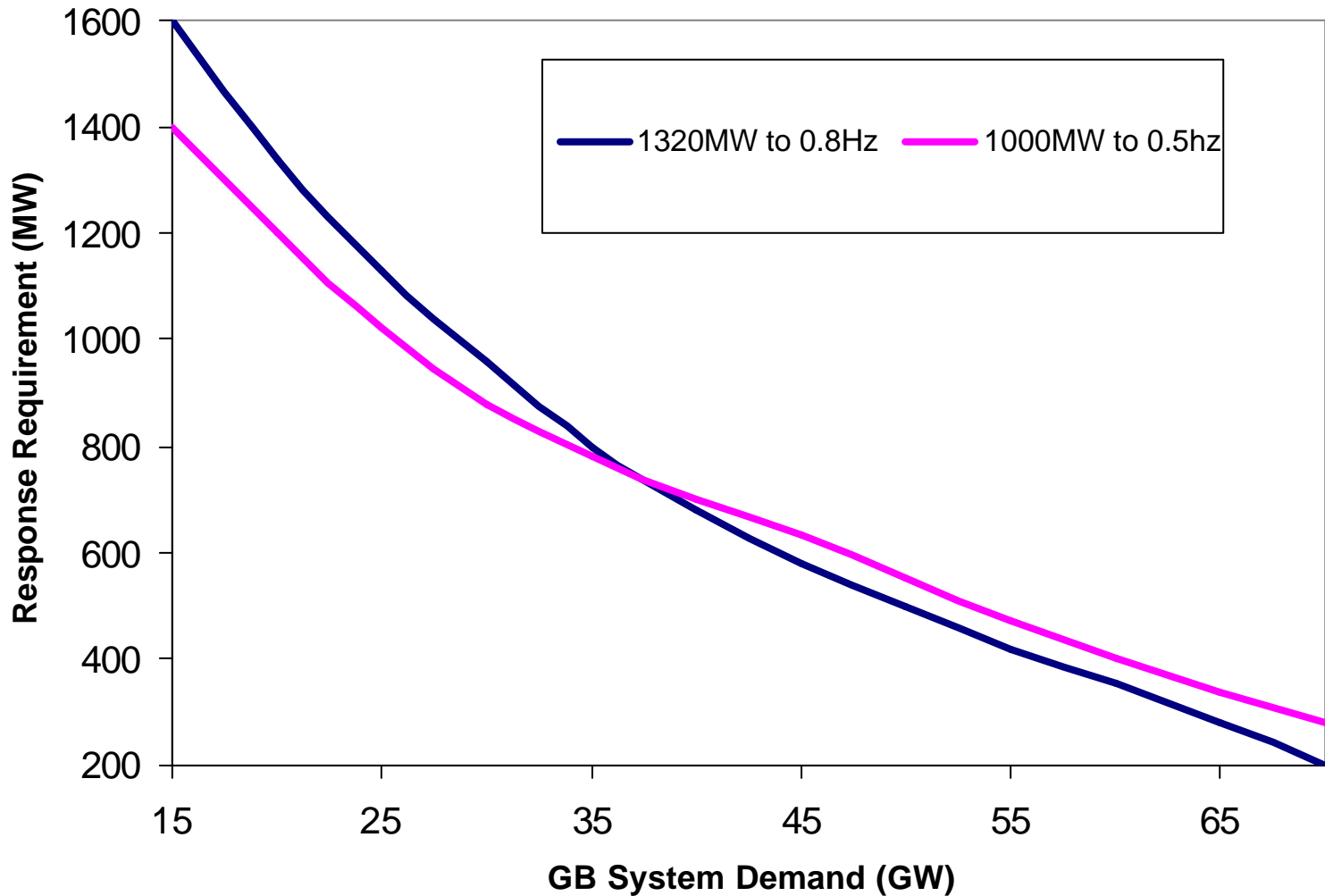
<b>Response (MW)</b>	<b>Primary</b>	<b>Secondary</b>	<b>High</b>
Overall GB Requirement	600	600	600
Minimum Dynamic requirement	350	350	0

- For simple illustration we assume a common required volume (Primary, Secondary and High) of 600MW
- Minimum Dynamic volume must equal or exceed 350MW
  - ie can accept up to 250 MW of non dynamic if it is a cost effective option

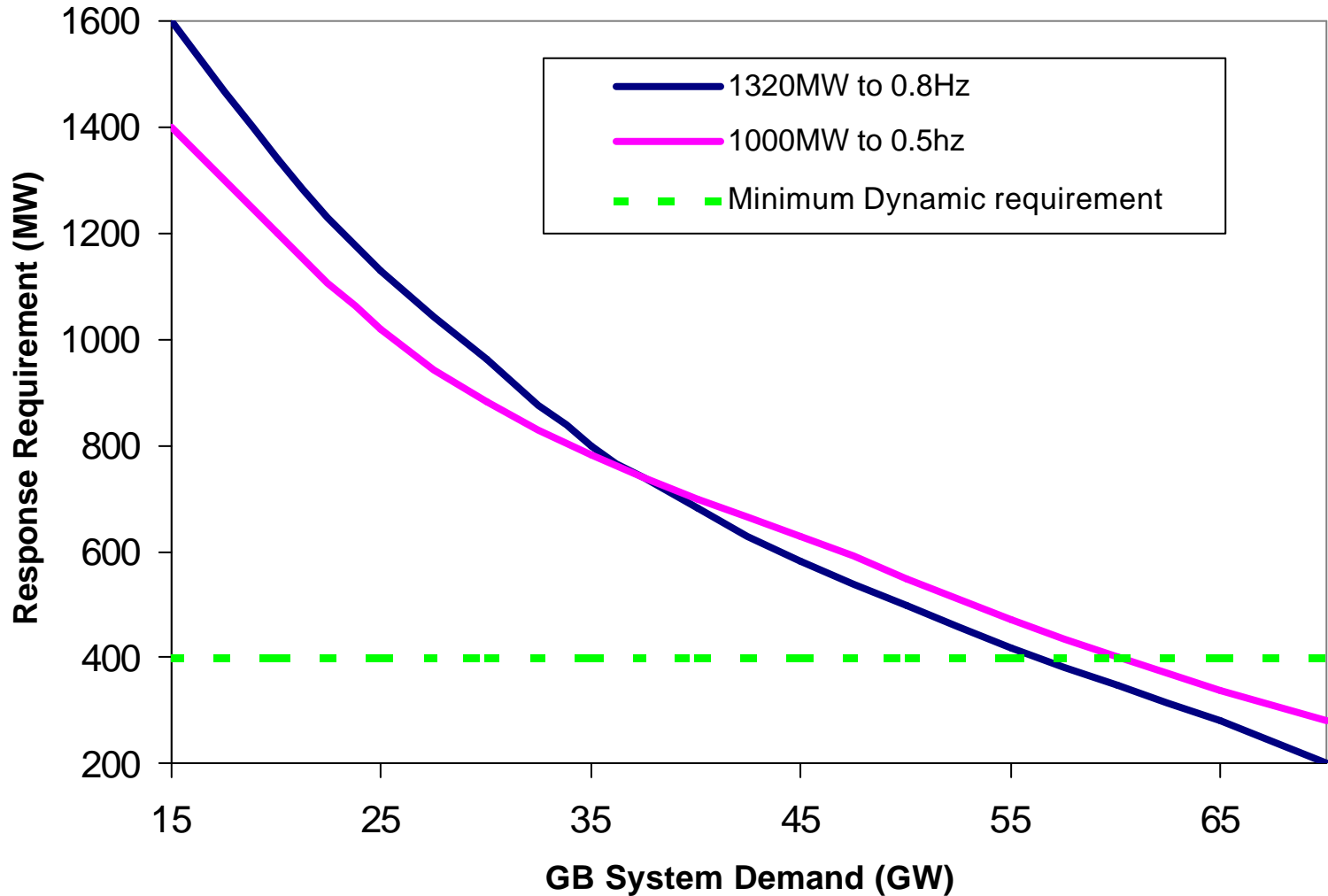
# Illustrative Primary Response Requirements



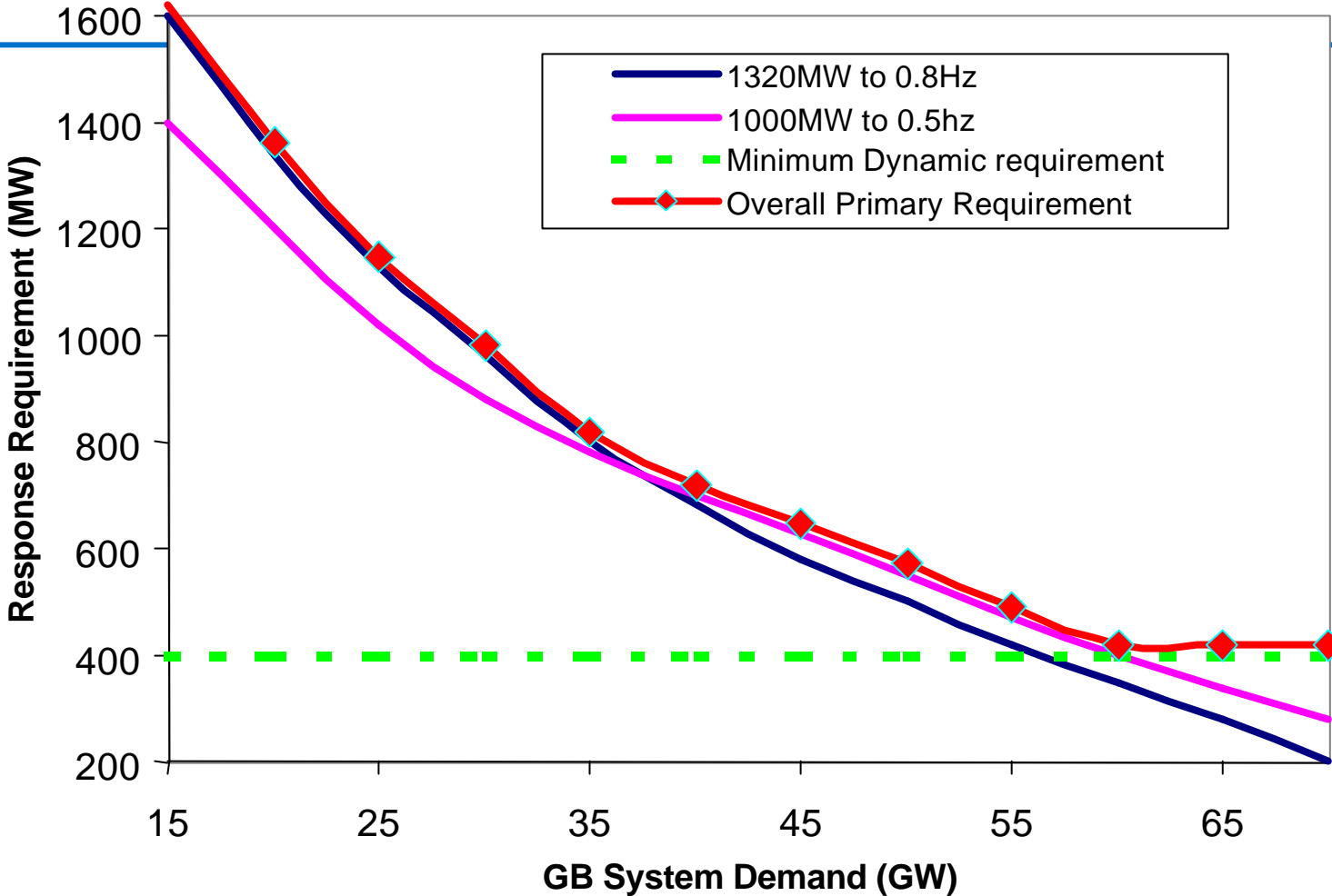
# Illustrative Primary Response Requirements



# Illustrative Primary Response Requirements



# Illustrative Primary Response Requirements



# Response Requirement Summary

## Largest Loss Requirement

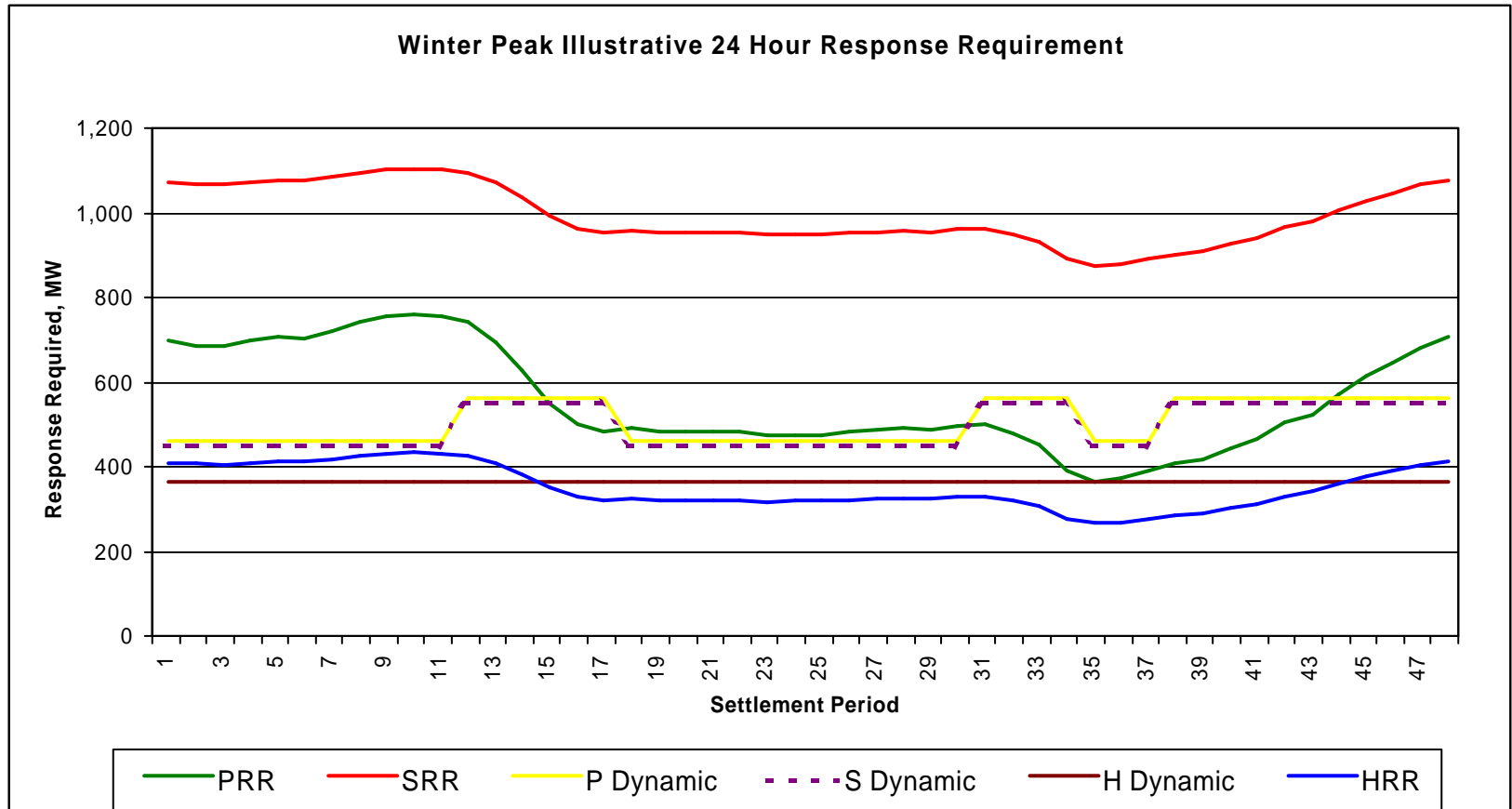
- Continuously varying with Demand and Largest loss
- Response Requirement, based on the same largest loss, is higher in overnight and/or in the summer
- The largest loss requirement can be met by Non-Dynamic or Dynamic Response

## Minimum Dynamic Requirement

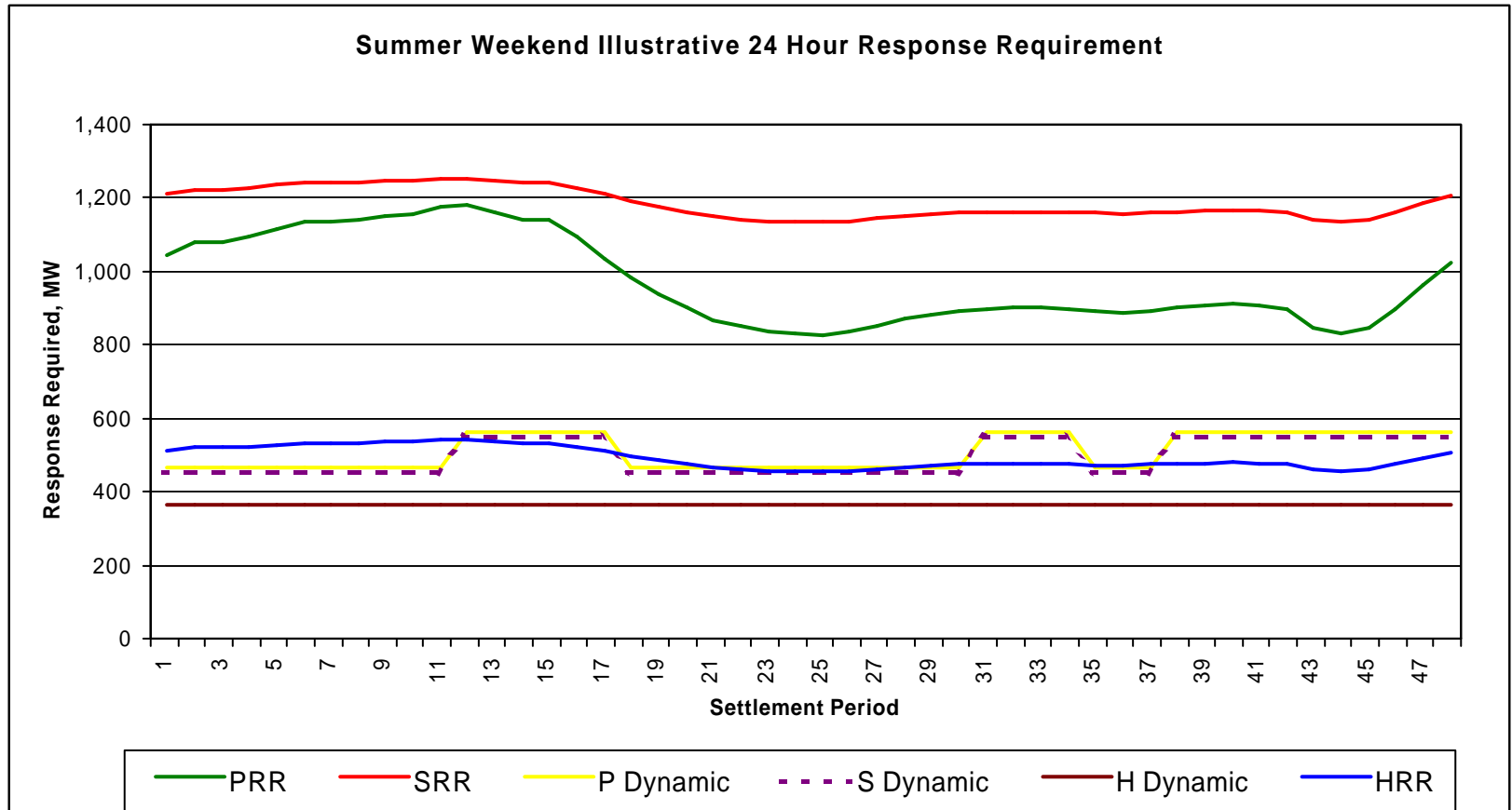
- Set to be higher at times of volatile demand
- Held on Dynamic plant only
- Also meets the largest loss requirement

Typical Daily Profiles are as follows.....

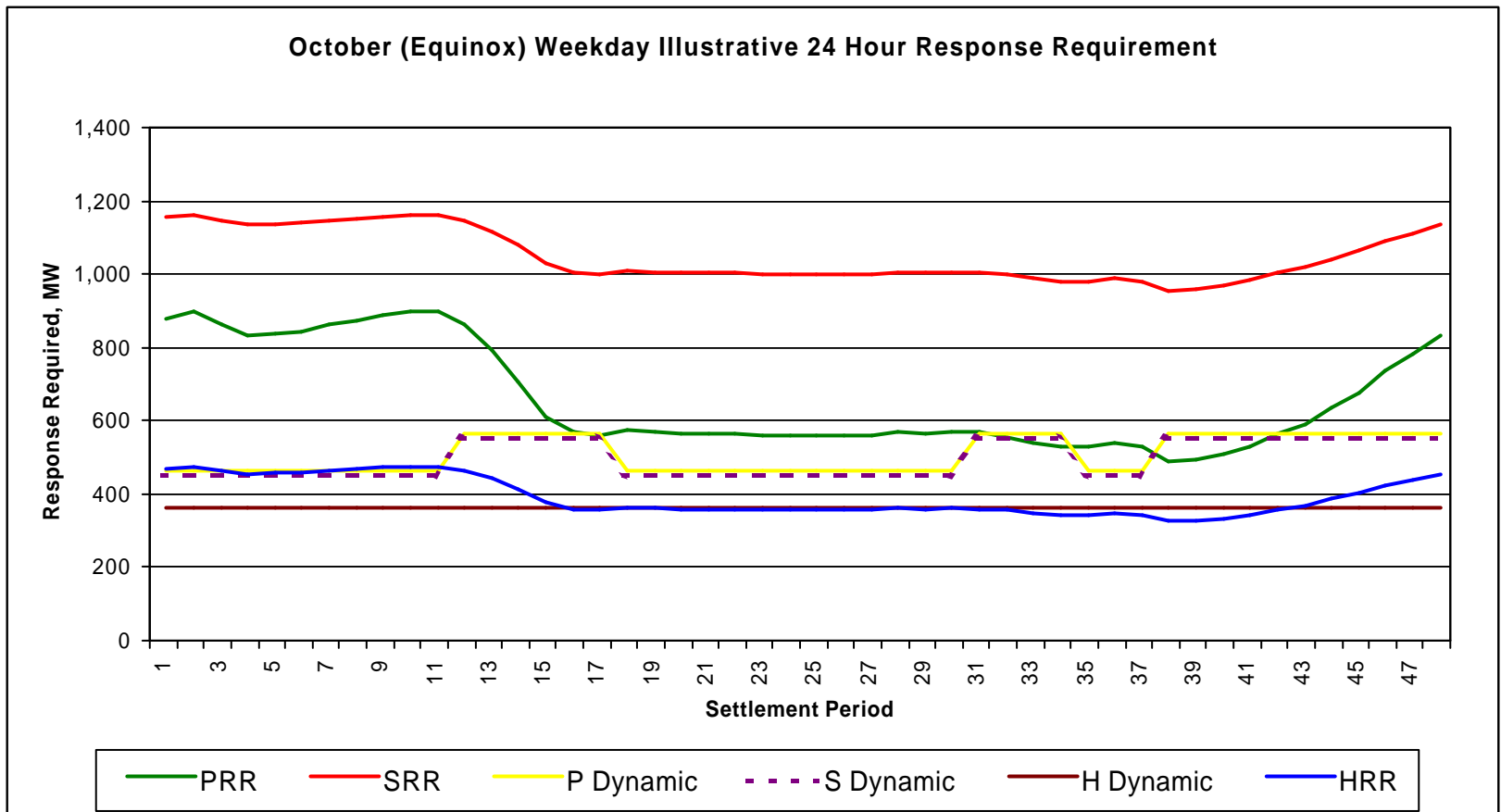
# Illustrative Daily Requirement Winter Peak



# Illustrative Daily Requirement Summer Weekend



# Illustrative Daily Requirement Equinox Weekday



## 3.0 How Frequency Response is Despatched

Frequency Response is consider over a number of timescales:-

- Longer timescales - check OC2 submission totals for NRAPM risk as appropriate
- 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 those providers required to provide response

# Real Time Despatch

- Frequency response advice provided, advising which generators should be instructed to provide response for approx. 4 hrs ahead on an optimal economic basis.
- Control Room will issue MF(Primary, Secondary and High) or MP (Primary and High) instructions to generators.
- Advice is provided based on the response matrices within the MSA / CSA with each different service allocate a different mode.

# FFR Real Time Despatch

- Generator Firm Frequency Response Providers will be allocated a Mode for the service
  - If allocated Mode D instructions will be **MFD** or **MPD** as per current Mandatory Response instructions
  - Instructions will be issued for response provision at the beginning of each window
  - Instructions to cease provisions will be issued at the end of each window
  - If incorrect mode is issued the instruction contact should be made with NG control to make modification.
  - Desynchronisation through a BOA will be treated as a Frequency Response cease instruction (as with Mandatory service)
- Demand Services will be instructed by phone via one Control Point

## 4.0 Frequency Response Utilisation

- Frequency response will be despatched in cost order until the minimum dynamic requirement is met
- Review and if required further actions will be taken on an economic basis through either Dynamic or Non Dynamic providers
- Optimisation is based upon limiting factor - depending on circumstances this can be Primary, Secondary, High or Minimum Dynamic requirement

# Response Utilisation Illustration

Remainder of Providers at price  $>£6/\text{MW}/\text{h}$

Dynamic Providers  $> 5 \text{ £}/\text{MW}/\text{h}$

Non Dynamic Providers  $3 \text{ £}/\text{MW}/\text{h}$

Dynamic Providers  $3-5 \text{ £}/\text{MW}/\text{h}$

800MW Primary  
Response Requirement

500MW Minimum  
Dynamic Requirement

# Firm Frequency Response

## *Service Description and Procurement Process*

James Soundraraju

Contracts and Trading

# Contents

- Definition of Firm Frequency Response
- Contractual Framework
- Tender Rules and Timescales
- Tendered Parameters
- Instructing Firm Frequency Response
- Procurement Process
- Pre-qualification Process

# Firm Frequency Response (Service Description)

Firm Frequency Response is the firm provision of Dynamic or Non-Dynamic Response

- Procured via a GB-wide tender
- Open to BM and Non-BM providers
- Minimum requirements :
  - Measurable - Operational metering or equivalent
  - Reliable - Proven delivery capability
  - Minimum 10MW Response Energy
- Open to all existing Frequency Response providers and new providers

# Firm Frequency Response (Service Description) *continued*

- New providers would be subject to a pre-qualification assessment
- Electronic despatch (as now) or recorded phone instruction
- Dynamic providers are obliged to be at contracted part load point during Firm Frequency Response Windows (Frequency Responsive mode only when instructed by National Grid)
- Non-Dynamic providers are obliged to be at contracted part load point, with relays armed, during Firm Frequency Response Windows
- Delivery capability to be tendered parameter

# Firm Tendered Frequency Response Service (FFR)

## (Considerations)

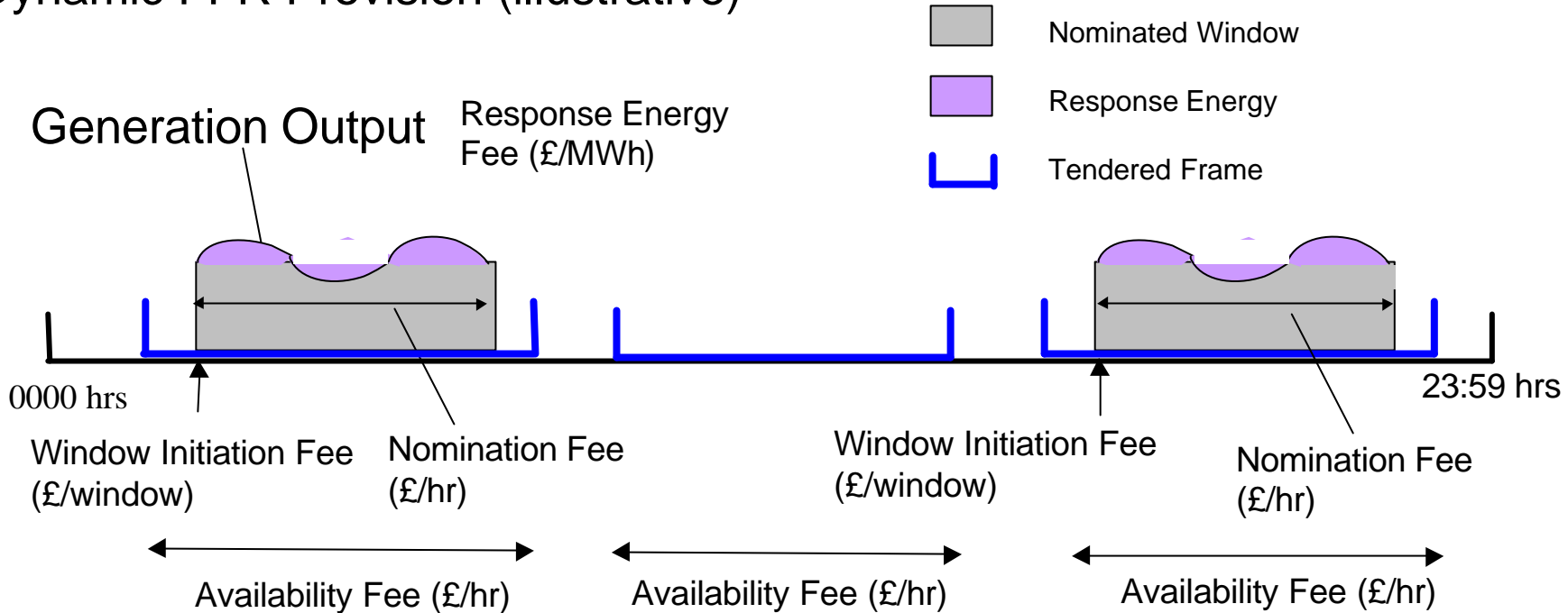
### Who can participate?

- Tender is open to BM and Non-BM providers
- Service caters for Dynamic (e.g. MW output regulated by automatic governor control) and Non-Dynamic (e.g. relay triggered demand reduction) service provision across Primary, Secondary and High Frequency Response
- Agents for Non-BM providers are allowed to participate in the service
- Typically we expect tenders to be provided by thermal plant, hydro and demand side providers

# Firm Tendered Frequency Response Service (FFR)

## (Structure of the Service)

### Dynamic FFR Provision (illustrative)



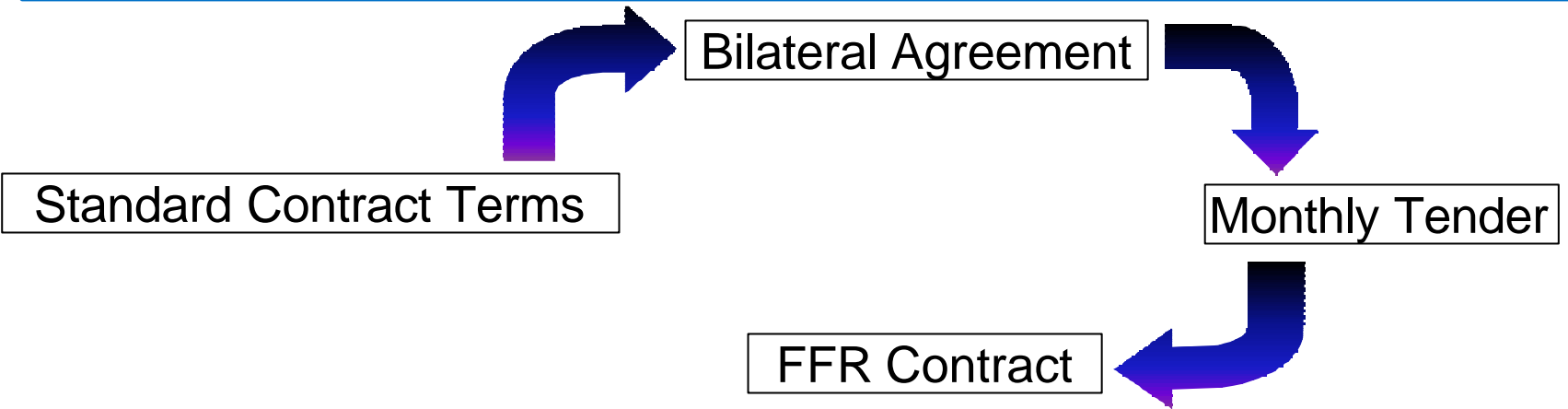
# Firm Tendered Frequency Response Service (FFR)

## (Structure of the Service)

- Monthly tender for month ahead or multiple consecutive months
- 4-part payment structure :
  - Availability Fee £/hour (tendered)
  - Window Initiation Fee (tendered) - £/window
  - Nomination Fee (tendered) - £/hour
  - Response Energy Fee (£/MWh)
    - as per CUSC for BM Providers (Dynamic)
    - tendered parameter for Non-BM Providers (Non-Dynamic)
  - Window Revisions fee £/hour, if applicable
    - (applies to gross number of hours involved)
- NGT nominates windows in advance of the service month

# Firm Frequency Response

## Contractual Framework



- Standard Contract Terms - consistent terms for all providers
- Bilateral Agreements - signs providers up to SCTs and allows tender submissions; response matrices, relay settings, etc.
- Tenders - for month ahead or multiple consecutive months and becomes contractually binding upon acceptance

# Tendered Parameters

## BM (Dynamic) Providers

- Tendered Unit (Unit ID)
- Part-Load Point (MW)
- Droop Setting (%)
- Tendered Period (month/year)
- Tendered Frames (hrs)
- Window Revision Allowed (Y/N)
- Tendered Prices
  - Availability Fee (£/hr)
  - Window Initiation Fee (£/window)
  - Nomination Fee (£/hr)
  - Window Revisions Fee (£/hr) (if applicable)
- Delivery mode : Primary, Secondary and/or High
- Utilisation Restrictions

# Tendered Parameters

## BM (Dynamic) Providers *continued*

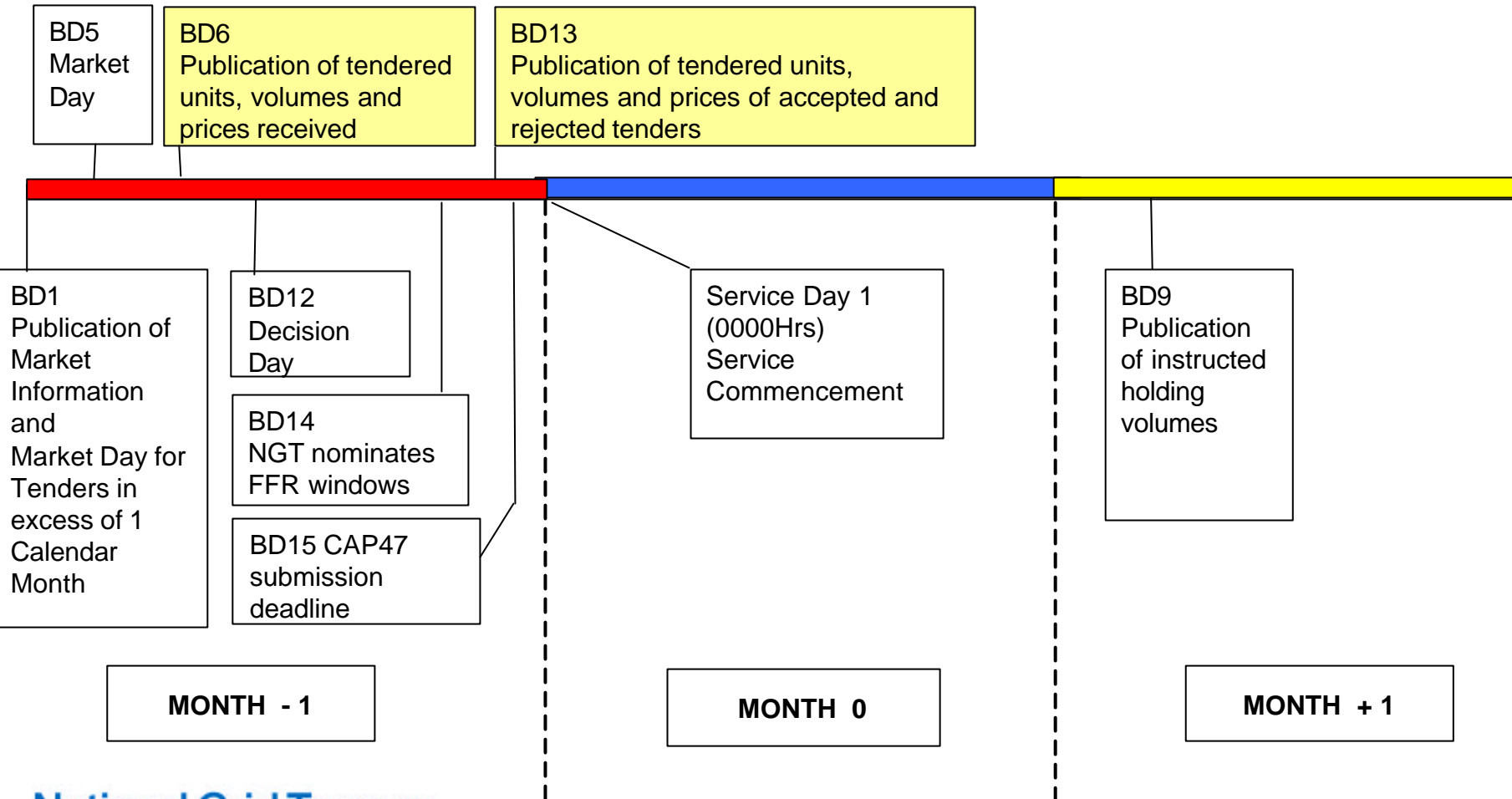
- Minimum MEL (MW)
- Maximum SEL (MW)
- Maximum Energy Response Energy Deliverable (MW)
  - Primary Response @ 0.2 Hz deviation
  - Primary Response @ 0.5 Hz deviation
  - Primary Response @ 0.8 Hz deviation
  - Secondary Response @ 0.2/0.2 Hz deviation
  - Secondary Response @ 0.5/0.5 Hz deviation
  - High Response @ 0.2 Hz deviation
  - High Response @ 0.5 Hz deviation

# Tendered Parameters

## Non-BM (Non-Dynamic) Providers

- Tendered Unit (Unit ID)
- Pre-set Trigger Level
  - LF : Setting must be between 49.8Hz - 49.65Hz
  - HF : Setting must be at 50.35Hz
- Tendered Period (month/year)
- Tendered Frames (hrs)
- Window Revision Allowed (Y/N)
- Tendered Prices
  - Availability Fee (£/hr)
  - Window Fee (£/window)
  - Nomination Fee (£/hr)
  - Window Revisions Fee (£/hr) (if applicable)
  - Response Energy (£/MWh)
  - Utilisation Restrictions

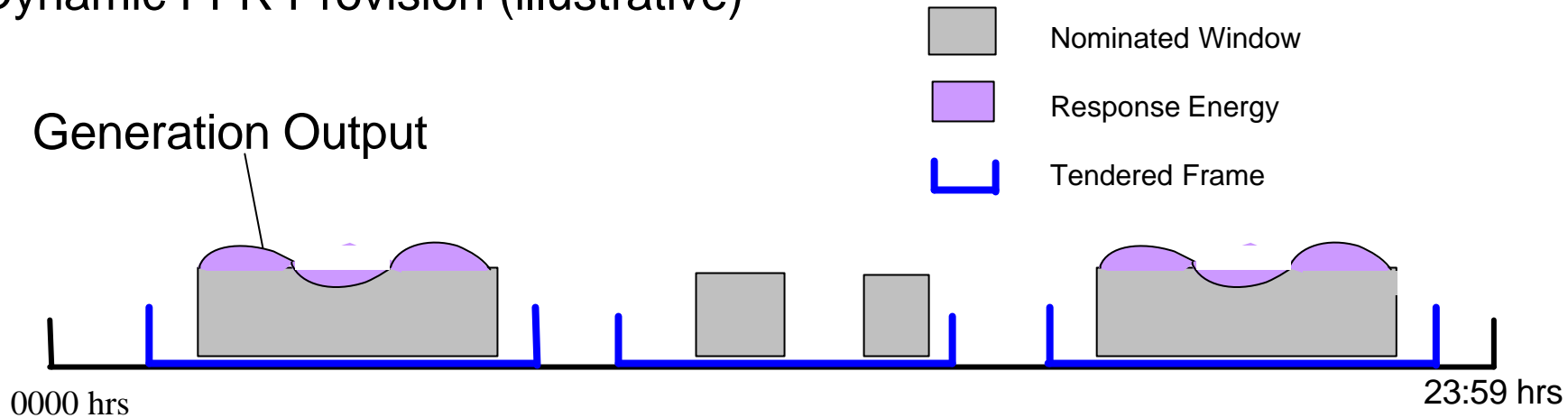
# Tender Rules and Timescales for a Service Month



# Firm Tendered Frequency Response Service (FFR)

(Instructing the Service)

## Dynamic FFR Provision (illustrative)

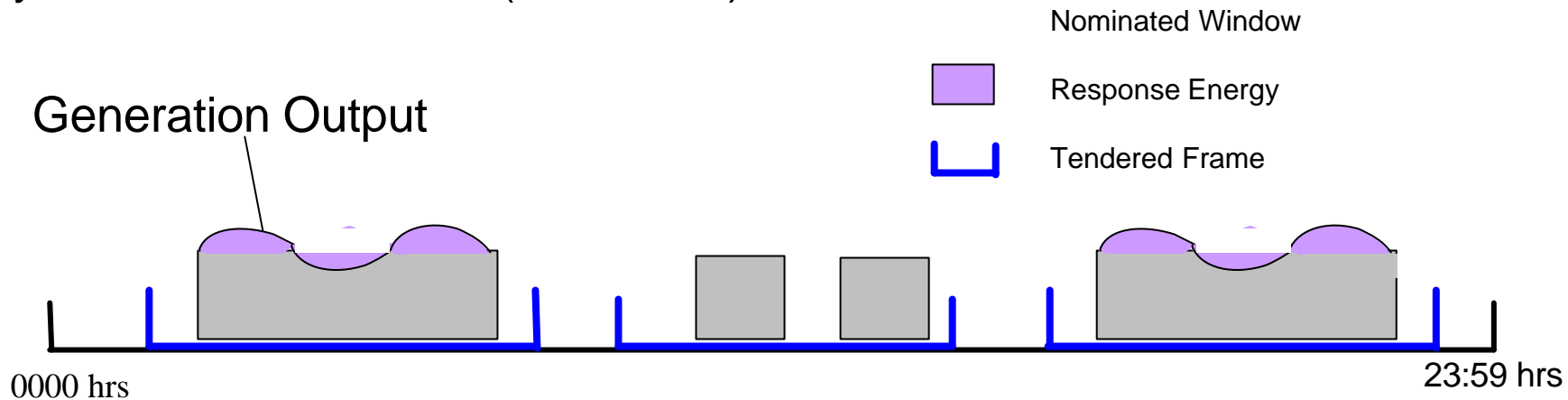


- Providers are contractually obliged to be at the contracted part load point (PN) (or armed)
- Providers must wait for instruction from NGT before going into Frequency Responsive mode
- NGT may delay issuing a FFR instruction to any point within the window in all cases such that the delayed instruction will not result in the window being extended.

# Firm Tendered Frequency Response Service (FFR)

(Instructing the Service)

## Dynamic FFR Provision (illustrative)

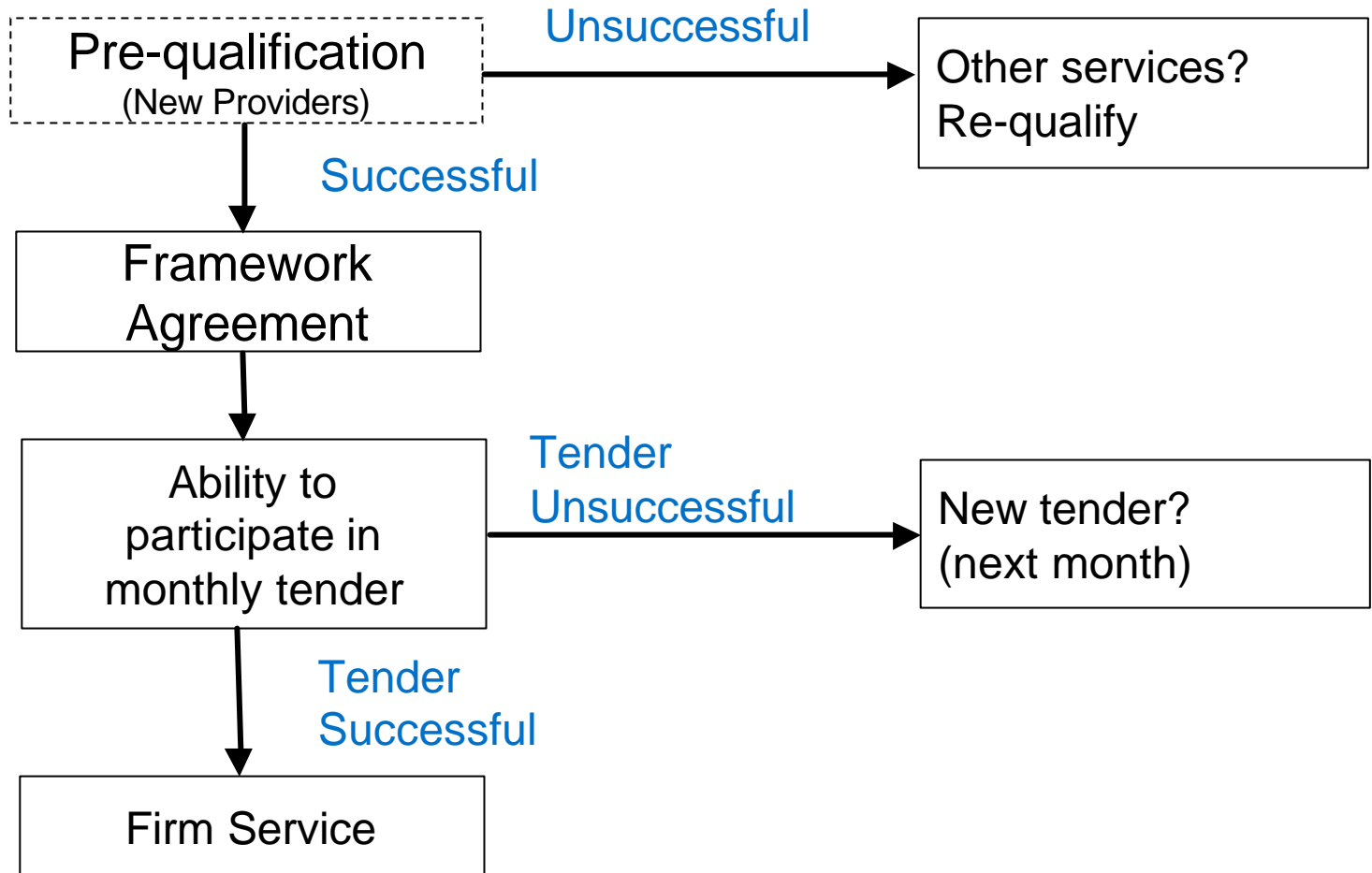


- National Grid may nominate more than 1 window within a tendered frame unless there are utilisation restrictions in the tender
- By 1000hrs Operational Day Ahead National Grid may issue window revisions by fax (only in relation to providers who have agreed to window revisions in their tender)

# Pre-qualification Assessment

- New providers (or Providers who have seriously defaulted on terms of service provision) would have to undertake a pre-qualification process before participating in the provision of Firm Frequency Response
- Pre-qualification involves 2 steps :
  - **Step 1** : Agreeing a test programme with National Grid
    - Dynamic : Published guidance notes for generators (under GC, Associated Documents - Industry Information Website)
    - Non-Dynamic : Published illustrative tests in Standard Contract Terms
  - **Step 2** : Allow National Grid technical experts to witness the tests

# Firm Frequency Response Procurement Process



# Proposed Timescales

- Seminar 14 July 2005
- Provider Feedback End July 2005
- ITT Pack Development End July 2005
- Contract Signing Commences August 2005
- Market Day (1st Tender) 05 September 2005
- Service Go-Live 01 October 2005

# FFR Assessment Process

Duncan Burt

Strategy & Assessment Manager

# Introduction

Aim of this presentation is to give an overview of:

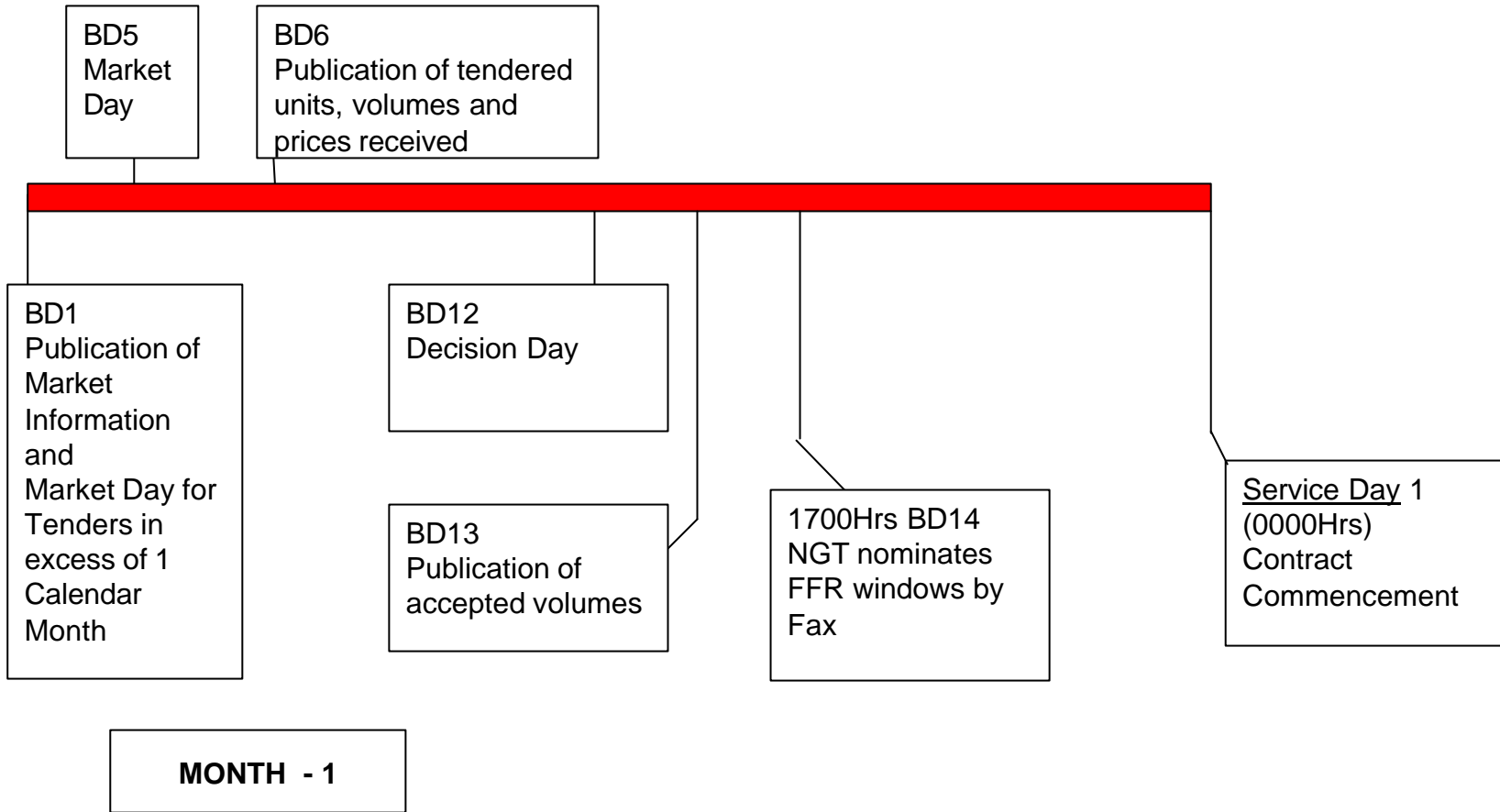
- How tenders will be assessed
- How tenders will be optimised

In general, detail and information that will help you develop tenders.....

# Contents

1. Recap Timescales
2. Assessment Principles
3. Assessment Detail
4. Optimisation of Assessment
5. Summary
6. Market Information

# Tender Timescales



# Assessment Principles

# Assessment Principles

## Response Requirement

- Dual Requirement for Frequency Response to cover:
  - Largest Loss Requirement, 0.8Hz or 0.5Hz deviation
  - Minimum Dynamic Requirement, 0.2Hz deviation
- 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 will be assessed on economics against the forecast alternative cost of provision. Alternative cost of provision means:
  - Cost of Response Holding Payments
    - Cost of mandatory payments under CUSC arrangements and optional sources of provision
  - Cost of Bids/Offers to reposition plant in the Balancing Mechanism
    - E.g. Accepting 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, Non-BM Standing Reserve 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, for example:
- Quality/Reliability
  - Historic performance of provider will be taken into account during assessment. Preference for reliable provision.
- Locational
  - Potential for a small locational element if system is forecast to be constrained. Still assessed on economics but against economics within the constrained area.

# Assessment Detail

# Assessment Detail

## - Economics of Response Despatch

Optimal provision of Response in Real time delivered via three stages:

1. Instruction of mandatory Frequency Response and optional services on part loaded plant available in the BM and elsewhere
2. Repositioning (Bids and/or Offers) of Units to achieve best delivery of response for the Headroom and Bid/Offer prices available
3. Further response provision delivered through the creation of additional headroom or footroom for Response provision through Warming and/or synchronising actions, PGBTs, running of Standing Reserve etc.

Now each of the above 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 published through procurement guidelines reporting (see info slides later).
  - For example:
    - The April 2005 Monthly Balancing Services Summary gives average prices for Mandatory holding as follows:

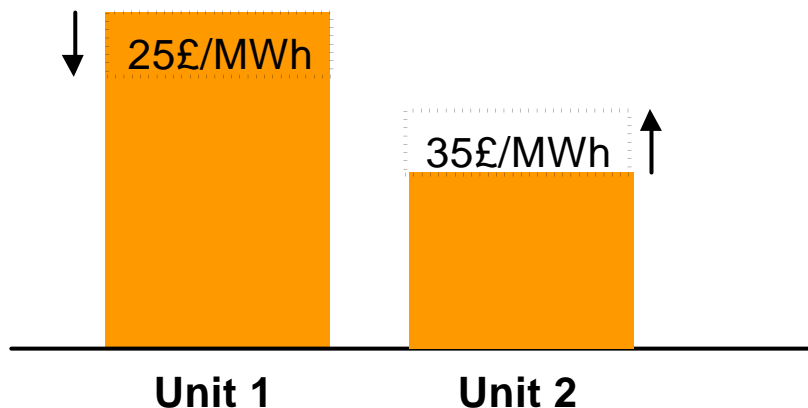
• Primary	£2.68/MW/h
• Secondary	£2.80/MW/h
• High	£0.59/MW/h

# Assessment Detail

## - Economics of Response Despatch

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

- Additional Frequency Response delivered through repositioning of synchronised units and associated Bid/Offer costs.
- For example:



Reposition Units to create 10MW of additional response:

- Accept 10MWh of matching Bids and Offers at 10£/MWh spread
- Cost of BOAs: 10£/MWh x 10MWh = £100
- Cost of Response Creation:

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

# Assessment Detail

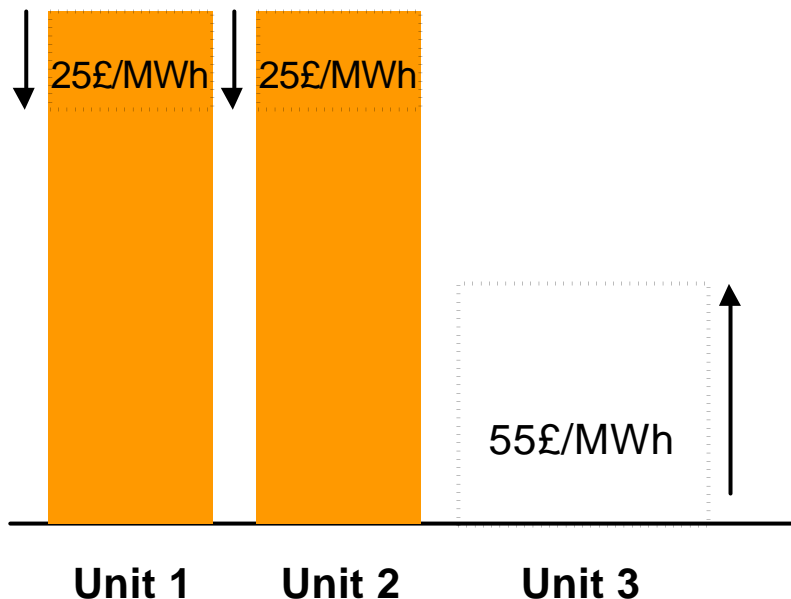
## - Economics of Response Despatch

3. Further response provision delivered through the creation of additional headroom for Response provision through Warming and/or synchronising actions, PGBTs, running of Standing Reserve etc.
- Any Residual Frequency Response Requirement delivered through Reserve creation actions. These create headroom that can be used either to deliver response directly or to allow repositioning of other units.
  - 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:

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

- However, Synchronised Unit may deliver additional value through Reserve provision so £30/MW<sub>response</sub> is a maximum

# Assessment Detail

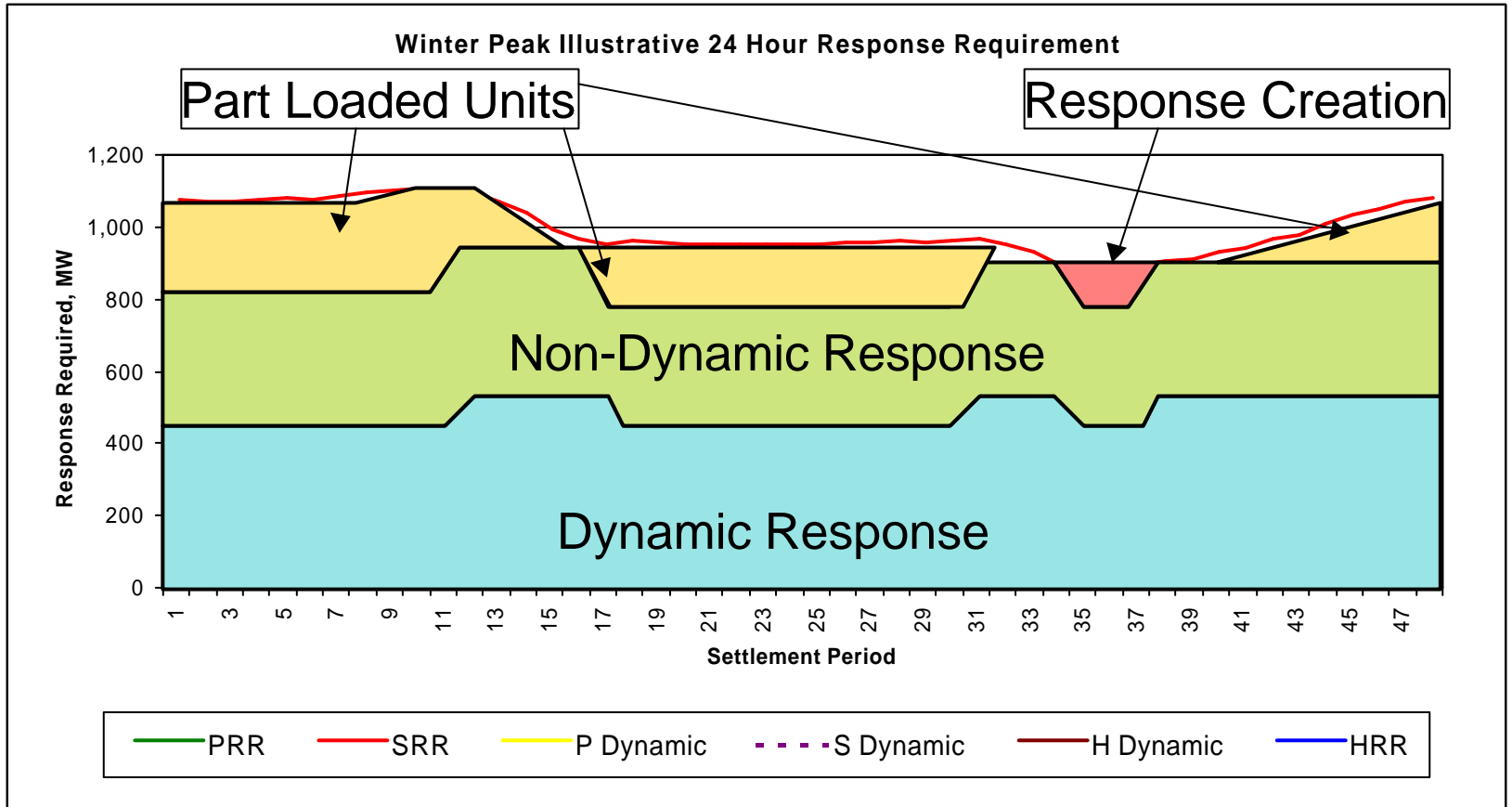
## - Economics of Response Despatch

### Frequency Reserve

- For a Generating Unit to deliver Response there must be sufficient Headroom and/or Footroom on the unit to allow the Unit to regulate up and down
- Across the GB fleet, the average response delivered for every 1MW of Headroom or Footroom is ~ 0.55MW. I.e. For 1 MW of Headroom you get ~ 0.55 MW of Primary and Secondary or High Response
- 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

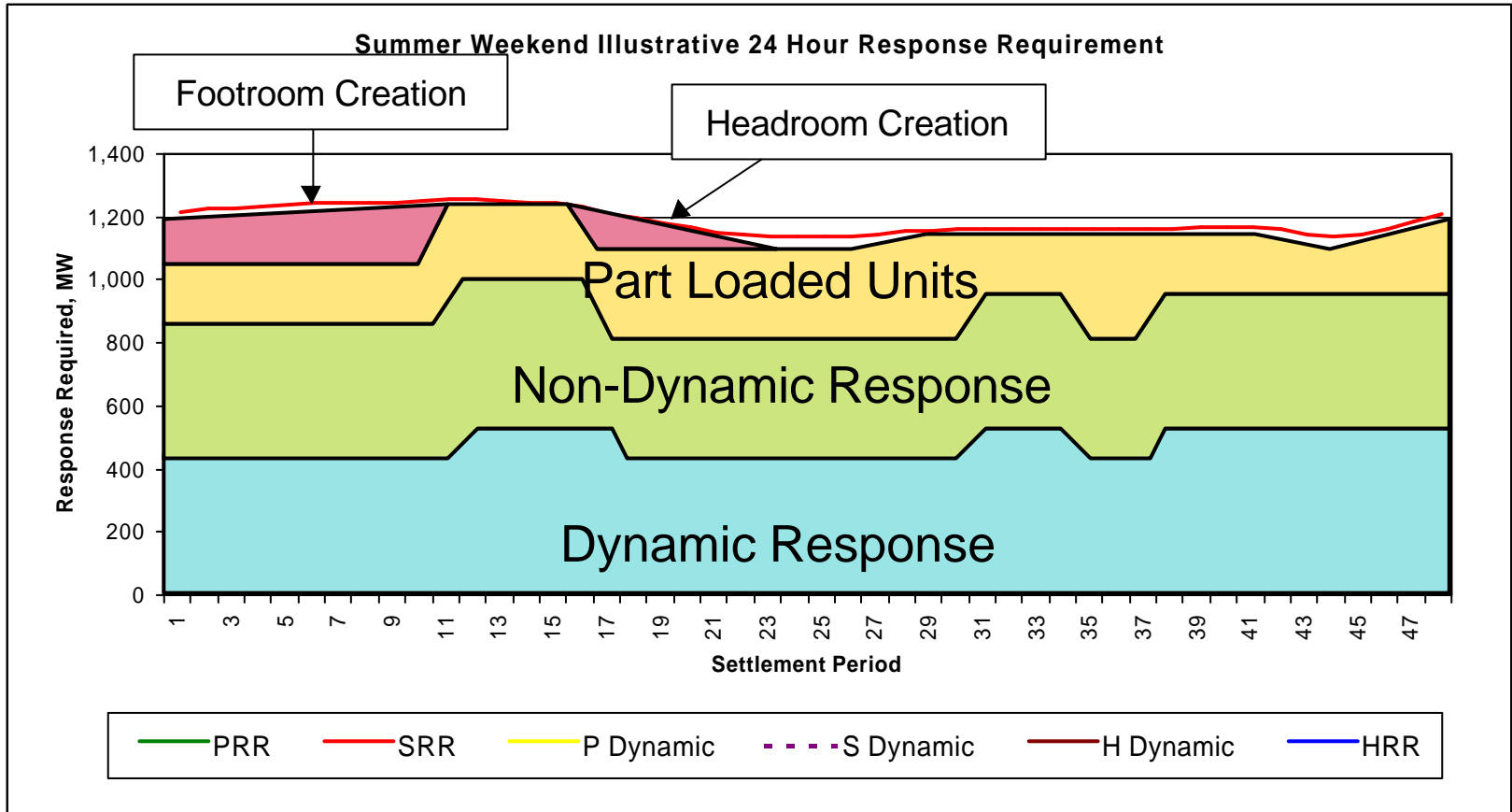
# Assessment Detail

## - Economics of Response Despatch



# Assessment Detail

## - Economics of Response Dispatch



# Assessment Detail

## - Non-Dynamic Response

- Non-Dynamic Response may be used to make up any residual Frequency Response Requirement above the Minimum Dynamic Requirement
- Procurement of Non-Dynamic may therefore displace either other non-dynamic provision or may displace Dynamic Response, dependent on economics and availability of alternative providers
- This means that 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.

# Assessment Detail

## - Forecasting Costs

- So, given the above, within the assessment NGT must forecast the mean expectation and uncertainty of the following:
- Response Requirement
- Availability and price of Mandatory and commercial Dynamic response on part-loaded plant
- Availability and price of non-Dynamic response providers
- Price and volumes of balancing actions required to optimise response provision
- Price and volumes of Reserve creation actions required to create additional Headroom or Footroom for provision of Frequency Response

# Assessment Detail

## - Further Criteria

### Reliability

- The assessment will consider historic reliability and performance of a tendering service in the provision of Frequency Response. This may include historic provision by the unit provision outside the Firm Tender.

### Dynamic Response Droop setting

- The assessment of Dynamic Response will consider the total volume of Response delivered and the level of Response delivered at 0.2Hz deviation, 0.5 HZ deviation and, for Primary, 0.8Hz deviation. No explicit value will be placed on enhanced droop settings other than the, if appropriate, an increased proportion of total Response delivered at 0.2Hz

# Assessment Detail

## - Further Criteria

### Location

- As with other Tenders, such as Standing Reserve, where appropriate consideration will be given to the location of the provider.
- However, in the majority of circumstances it is expected that the assessment will be non-locational

### Further Information

- Other assessment criteria will be detailed in the tender guidance. These will be broadly similar to other tendered service such as Standing Reserve and Firm Fast Reserve

# Optimisation of Assessment

# Optimisation of Tenders

- During the Assessment tenders will be optimised to maximise the economic value they deliver.
- Tenders are optimised by selecting the 'best fit' of window nominations, balancing cost of nomination and forecast value
- Nominated windows will be finalised after the completion of the assessment and confirmed to providers on Business Day 14

# Optimisation of Tenders

Place a value on flexibility:

- Increasing the proportion of tender cost within Window Initiation and hourly Nomination fees, and reducing Availability fees, 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.

# Summary

# 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 Firm tenders

# Market Information

# Tender Market Information

## - NGT Proposal

- Pre-tender Market Information, similar in format to Firm Fast Reserve. Detailing:
  - Forecast Response Requirements at Settlement Period resolution
  - Historic Frequency Response holding volumes, costs and prices
- Tender Details Publication
  - Tendered prices, Response volumes and tenders units by BD6
  - Accept/Reject results for individual tenders by BD13
- Further publication of full Market Report post assessment
- Intention that tender information should 'dovetail' with CAP047 timescales and data publications
- SCTs provide further information on the above

# Other Market Information

- In addition to tender round information, further details of NGT balancing activity, actions and costs can be found on the following sites:
- Balancing Mechanism  
[www.bmreports.com](http://www.bmreports.com)
- Other balancing services  
[www.nationalgrid.com/uk/indinfo/balancing](http://www.nationalgrid.com/uk/indinfo/balancing)

# Summary

# Firm Frequency Response Service (FFR)

## Summary

- The provision of FFR is open to BM and Non-BM providers thereby increasing the number of potential providers and improving liquidity
- Creating a route to market for providers whose services may otherwise be inaccessible
- Replacing bespoke bilateral firm services with the introduction of a competitive tender
- Providing a mechanism to secure firm income, allowing providers an element of certainty in financial planning
- A degree of stability against price uncertainty under CAP047

# Firm Frequency Response Service (FFR)

## Summary

- Firm provision of Dynamic and Non-Dynamic Frequency Response from providers with a proven delivery capability and procured via a GB wide tender
- Transparent and timely discovery (prices, volumes, providers)
- Desired characteristics of service provision:-
  - Easily despatchable
  - Measurable
  - Repeatable
  - Reliable

# Firm Frequency Response Service (FFR)

The seminar objectives were to :

- introduce Firm Frequency Response
- present an overview of generic Standard Contract Terms (SCTs) and agreements
- identify any potential barriers to participation
- allow NGT to address any barriers to participation and if required, amend the SCTs of the service to encourage greater participation
- communicate tender rules and timescales

# Proposed Timescales

- Seminar 14 July 2005
- Provider Feedback End July 2005
- ITT Pack Development End July 2005
- Contract Signing Commences August 2005
- Market Day (1st Tender) 05 September 2005
- Service Go-Live 01 October 2005



Questions?