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Enhanced Frequency Response Seminar

Birmingham ICC

2nd June 2016

Introduction

- Aims of the day:
  - Provide more detail on technical specification and ITT in general
  - Explain reasoning behind decisions and what NGET is aiming to achieve
  - Answer questions and clarifications

Agenda

- Introduction
- Background to EFR
- Technical Specification of EFR
- Assessment Process
- Lunch
- Assessment of EFR Value
- Tendering Process
- Performance Monitoring

Background to EFR

Pete Underhill

Electricity System Operator

- As the UK Electricity Transmission System operator National Grid has the statutory requirement to ensure:
  - The flow of energy around the system is within the limits of the in-service transmission equipment **(Constraint management)**
  - There is sufficient generation available to meet demand under feasible situations (**Reserve**)
  - Supplies of generation and demand are aligned in the short term (**Energy Balancing**)
  - The balance of generation and demand will remain within acceptable boundaries following unexpected changes (**Frequency Response**)

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NETS SQSS

- National Electricity Transmission System Security and Quality of Supply Standards (NETS SQSS).
  - for normal operation there must not be “Unacceptable frequency conditions” on the transmission system
- System Frequency states
  - Steady State: small perturbations in imbalance
  - Transient: caused by sudden imbalance as result of a loss
- Types of loss
  - Normal infeed loss (less than 1000) max frequency deviation of 0.5Hz
  - Infrequent infeed loss (currently 1000-1320 will increase to 1800MW in future) max frequency deviation of 0.8Hz

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Frequency Control Standards

- Steady State (Pre-fault)
  - 50Hz nominal frequency with +/- 0.2 Hz operational range
  - <1500 Excursions >60s outside of +/- 0.2Hz per year
  - St Dev of frequency deviation must be <= 0.07Hz per day
  - For imbalances <300MW frequency should not breach operational limits of +/-0.2Hz
- Transient state (Post-fault)
  - For a normal loss (300-1000MW) frequency deviation should be < 0.5Hz
  - For an infrequent loss (1000-1800) frequency deviation for be < 0.8Hz
  - For an infrequent loss frequency deviation should not be above 0.5Hz for more than 60 seconds
  - For both losses frequency should be restored to operational limits (+/- 0.2Hz) within 10 minutes

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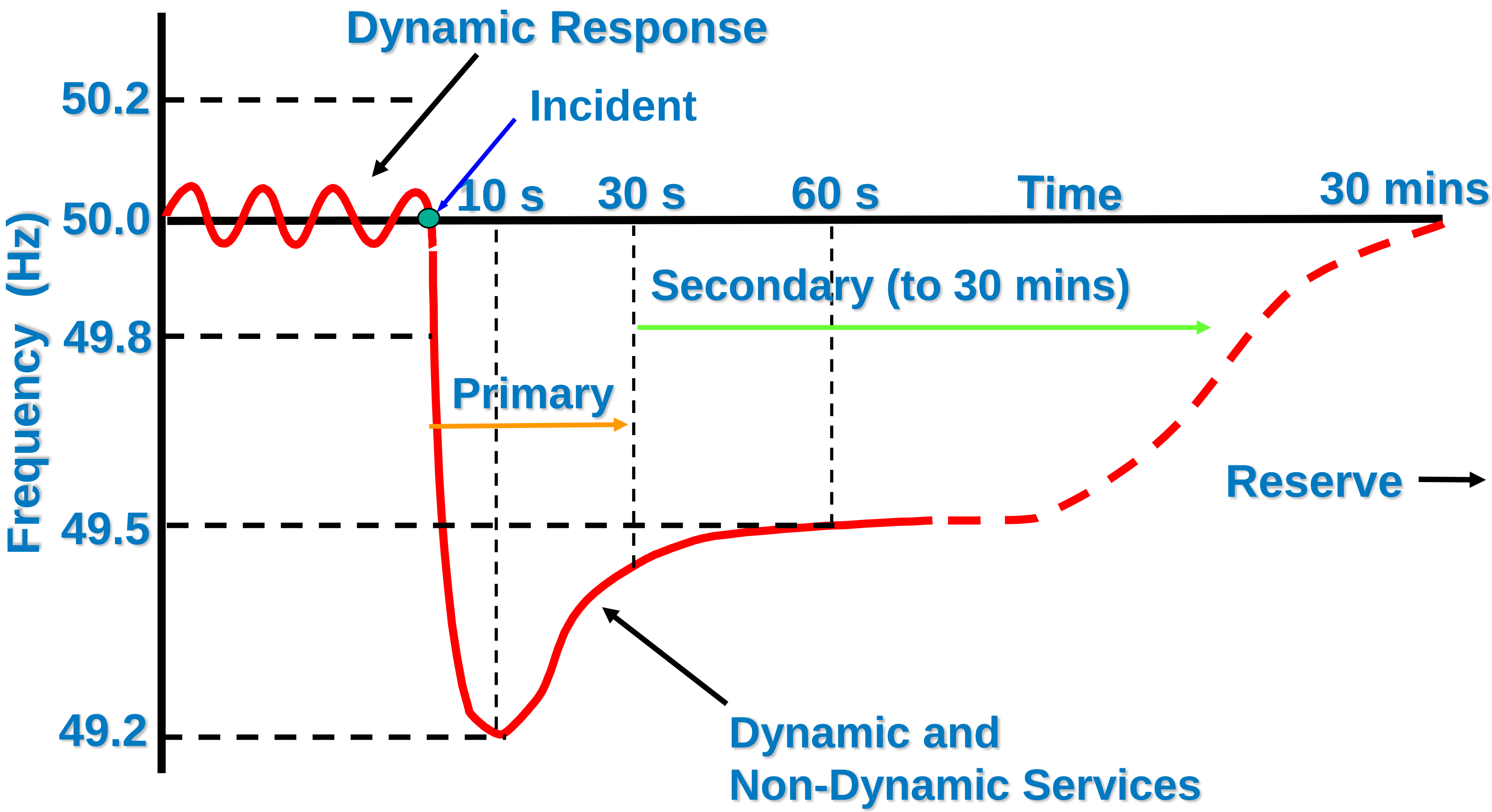
Frequency Control Services

- Full range Dynamic Frequency Response
  - Continuously provided response in proportion to frequency (small deadband)
  - Primary Response (Full delivery 10sec, sustained 30sec)
  - Secondary Response (Full delivery 30sec, sustained 30min)
  - High Response: (Full delivery 10sec, sustained indefinitely)
- Set point Triggered Response
  - Primary / Secondary / High Response
  - LF and HF Relays
  - Can be dynamic or static, different set points and with different restoration/stop points

Frequency Control Services 2

- Reserve
  - Fast Reserve
  - Regulating Reserve
  - STOR

Frequency Control - illustration



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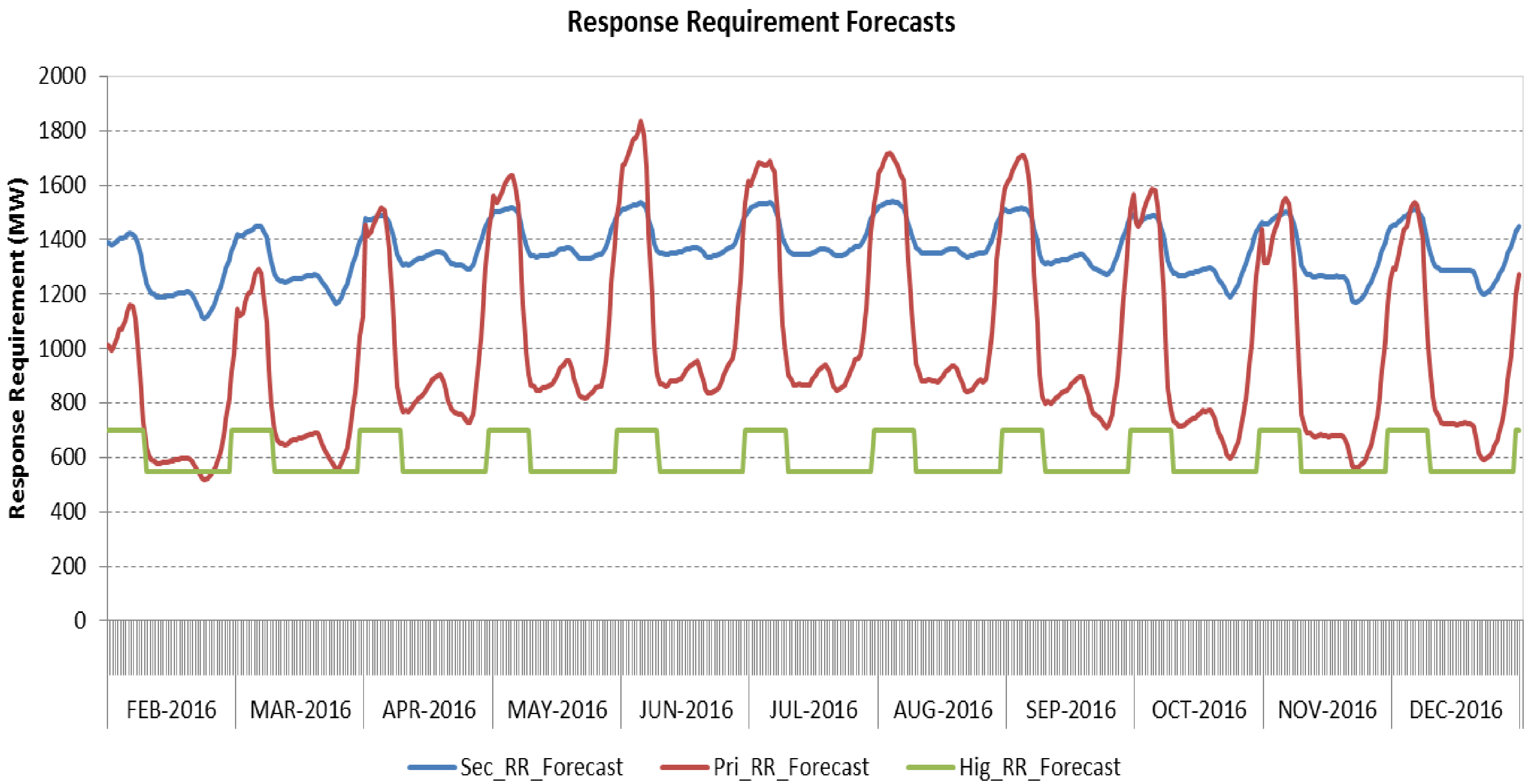
Frequency Response Requirements

- Requirements are quoted in terms of response capability at the 0.5Hz deviation for Primary Secondary and High and are modelled assuming a dynamic response service
- For Primary and High response the requirement depends on the size of the infeed loss at risk, system demand and system inertia
- For Secondary response the requirement depends on the size of the infeed loss at risk and the system demand.
- For Primary Response, the requirement is the amount of automatic power increase required to arrest the frequency fall before breaching the limit (49.5 or 49.2Hz depending on loss size)
- Secondary response require is the amount of automatic power increase required to restore frequency to operation limits

Minimum Dynamic requirement

- Only a service that operates continuously (or with very small deadband +/-0.015Hz) around 50Hz can provide the pre fault control needed
- Services with a large deadband or that trigger at a certain frequency deviation >0.1Hz can not help with pre fault control
- The minimum dynamic requirement is therefore the level of response required to meet the pre fault control standards. The level is based on historic modelling and has been "tuned" by operational experience
- The remaining requirement can be met by a full range dynamic service or a set point triggered service

Response requirements



Technical Specification

Matthew Roberts

Technical Specification: Outline

- Envelope
  - Design Principles
  - Design Tradeoffs
  - Why 2 Envelopes?
  - Illustration
- Time
  - Ramp Rate Restrictions
  - Illustration of Ramp Rates Restrictions
  - Design Tradeoff: Minimum Duration

Why Do We Need EFR

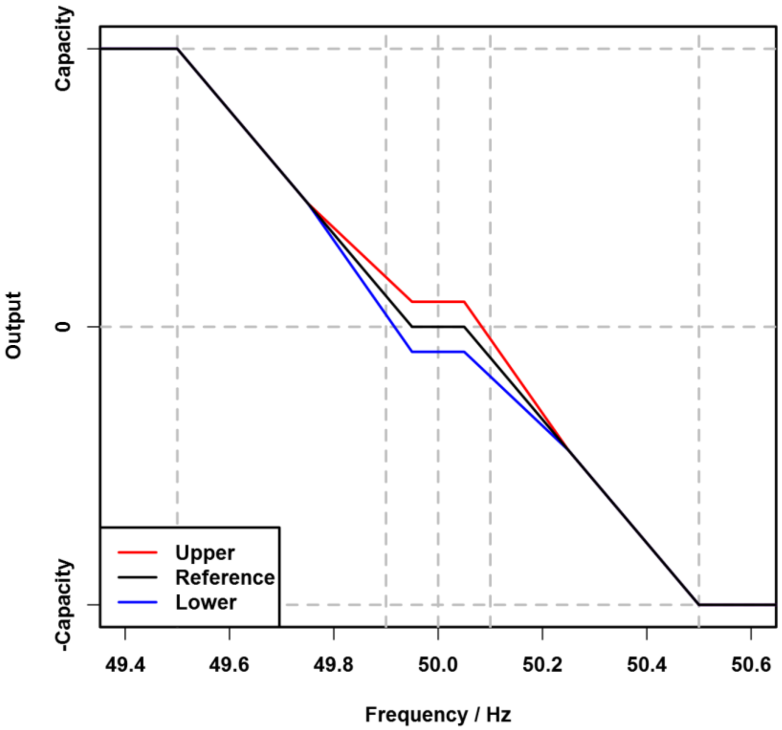
- Our multi-year-ahead forecasts (FES and SOF) forecast demand and inertia to fall
  - FES is Future Energy Scenarios
  - SOF is System Operability Framework
- As demand falls the amount of synchronised generation falls
- Inertia is the resistance of the power system to changes in frequency
  - Inertia is physically provided by the rotating mass of spinning metal in the form of turbines, compressors and generators.
- As inertia falls the speed of response delivery needs to increase

Technical Specification

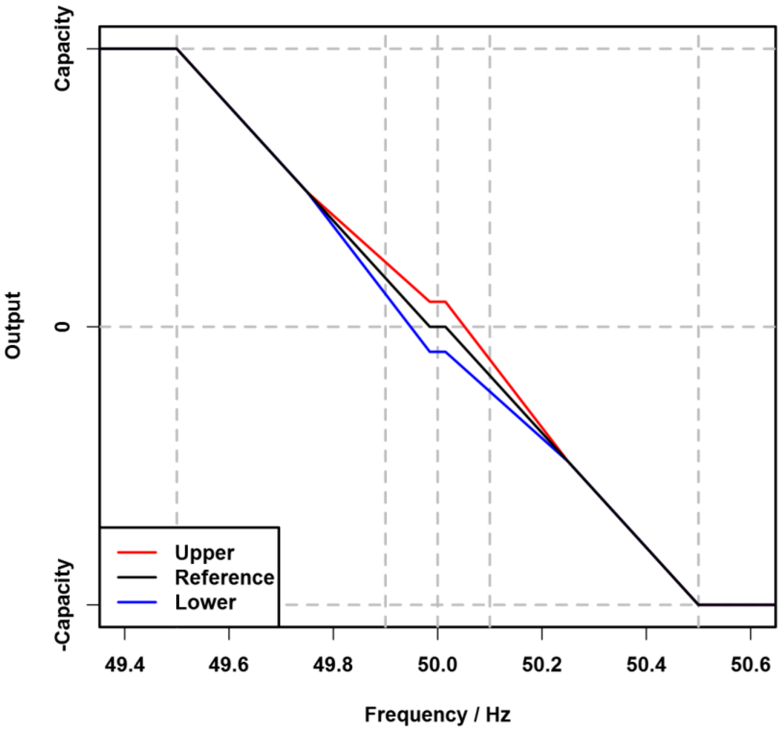
Envelopes

Technical Specification: Envelopes

Specification 1 (Wide)



Specification 2 (Narrow)



Design Principles

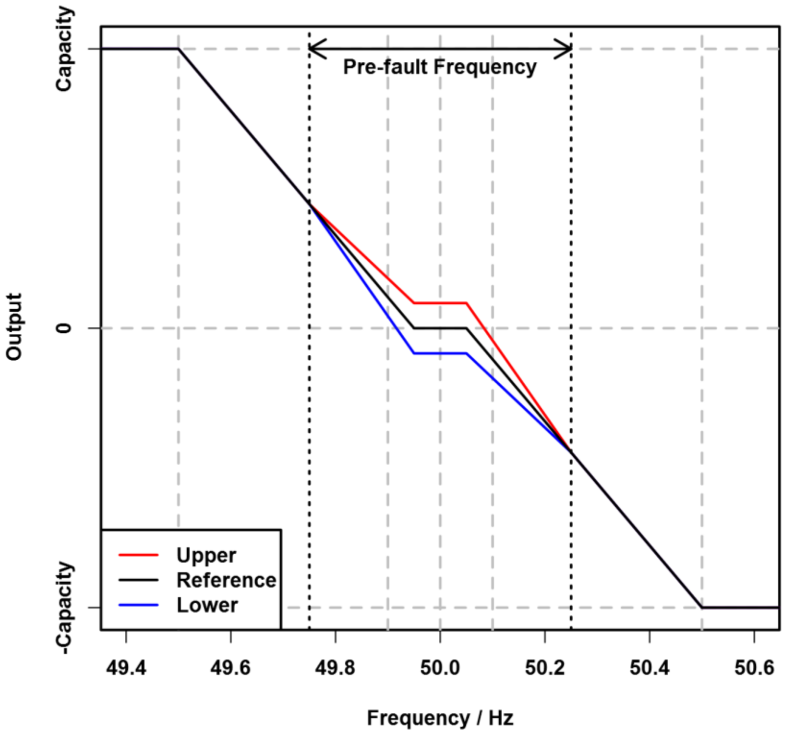
- When designing the technical specification, we used two principles to drive our decisions
  - A service that meets the technical specification must be *useful* to National Grid
    - And within the range of *useful*… valuable to National Grid
  - Meeting the technical specification should be *possible* for the provider
    - The service provision should be less onerous so long as it maintaining the usefulness of the service
      - i.e. the technical specification should be as technology neutral as possible
    - We believe that this will lower the costs of provision

Design Principles

- In addition, we have made sure that at least 1GW of EFR can be provided without causing problems to the power system
  - This means that EFR can be, in future, a standard product much like FFR is now
  - This also means that several technical parameters have been limited in order to make sure that 1GW of EFR is still *useful* and *valuable*

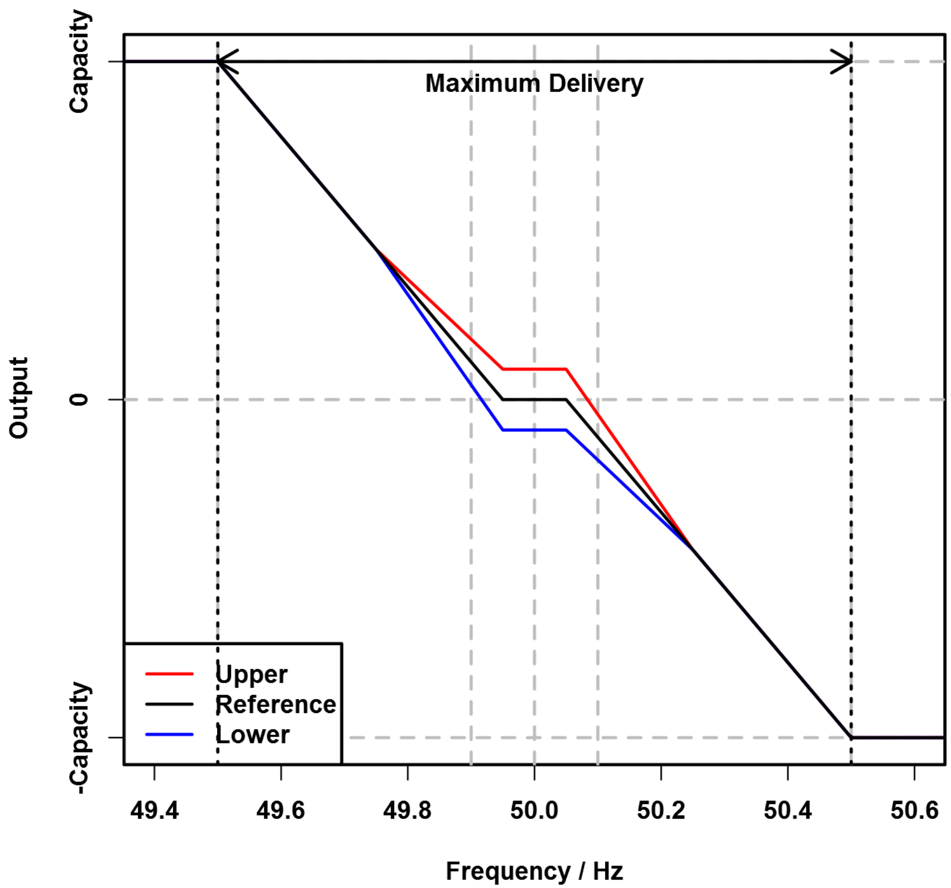
Design Principles

- In order to be *useful*, the EFR service must provide power to control frequency post-fault
  - Frequencies that are outside 50±0.25Hz are definitely post-fault
- Pre-fault, the requirements can be relaxed significantly
  - Frequencies that are within 50±0.25Hz *may* be pre-fault
  - Frequency control still needs to occur pre-fault
  - Therefore we have an envelope that is narrower towards the edges of the pre-fault range



Design Tradeoff: Maximum Delivery

Maximum delivery is specified to be 50±0.5Hz



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Design Tradeoff: Maximum Delivery

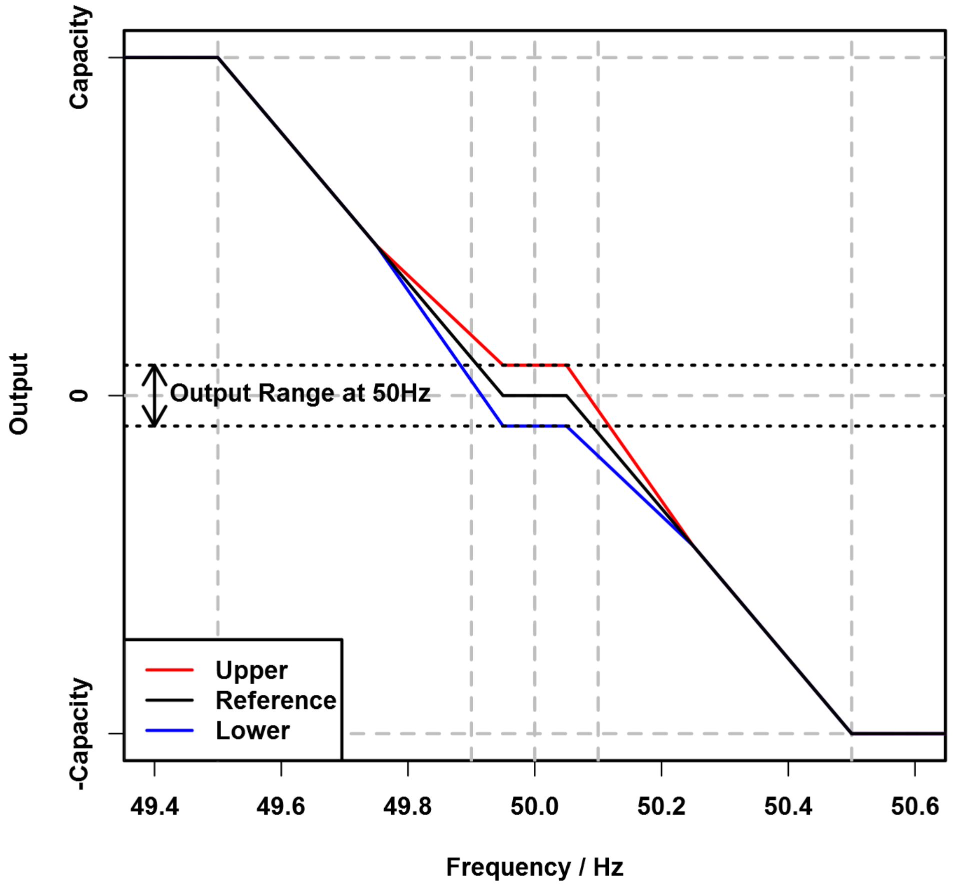
Maximum delivery is specified to be 50±0.5Hz

- Increasing this figure above 0.5Hz means that the service is no longer delivering full power at the frequency limits set in the SQSS
  - SQSS is Security and Quality of Supply Standards
  - Therefore increasing this figure above 0.5Hz makes the service less *useful*

- Lowering the figure below 0.5Hz has several effects:
  - From the providers point of view, Increases the amount of energy throughput required
  - From the power systems point of view, it is increasing the gain in the frequency control. At times of low demand and inertia, this makes the system more likely to be unstable

Design Tradeoff: Output Range At 50Hz

Output can vary between ±9% of capacity at 50Hz



Design Tradeoff: Output Range At 50Hz

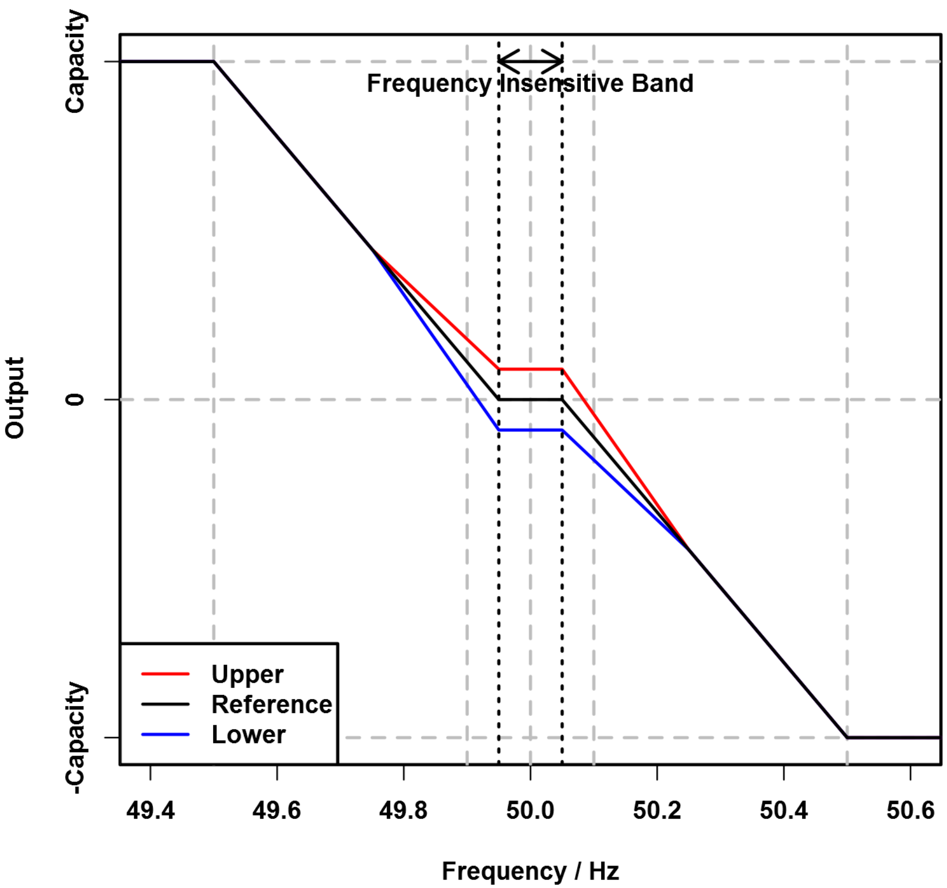
Output can vary between ±9% of capacity at 50Hz

- Increasing this figure:
  - Allows the provider more flexibility, in principle lowering the costs of providing the service
  - But, makes the service less *useful* for managing pre-fault frequency
  - And, for large enough values, is actively harmful to pre-fault frequency

- 9% is the largest possible value for a *useful* service
  - Increasing the figure above ±9% means that pre-fault frequency becomes sufficiently hard to control that the EFR service is no longer *valuable*

Design Tradeoff: Frequency Insensitive Band

Frequency Insensitive Band is 50±0.05Hz or 50±0.015Hz



Design Tradeoff: Frequency Insensitive Band

Frequency Insensitive Band is 50±0.05Hz or 50±0.015Hz

- Increasing this figure:
  - Allows the provider more flexibility, lowering the costs of providing the service
  - Lowers the amount of energy throughput required
  - But, makes the service less *useful* for managing frequency (pre-fault)
  - Increasing the figure above ±9% means that pre-fault frequency becomes sufficiently hard to control that the EFR service is no longer *valuable*

- Why ±0.05Hz and ±0.015Hz?
  - 0.05Hz is the largest possible value for a *useful* service
    - Increasing the figure above ±0.05Hz means that pre-fault frequency becomes unacceptable
  - ±0.015Hz is the width of the mandatory frequency response deadband
    - Therefore an EFR service with ±0.015Hz can always replace mandatory frequency response within the value assessment

Why Two Envelopes?

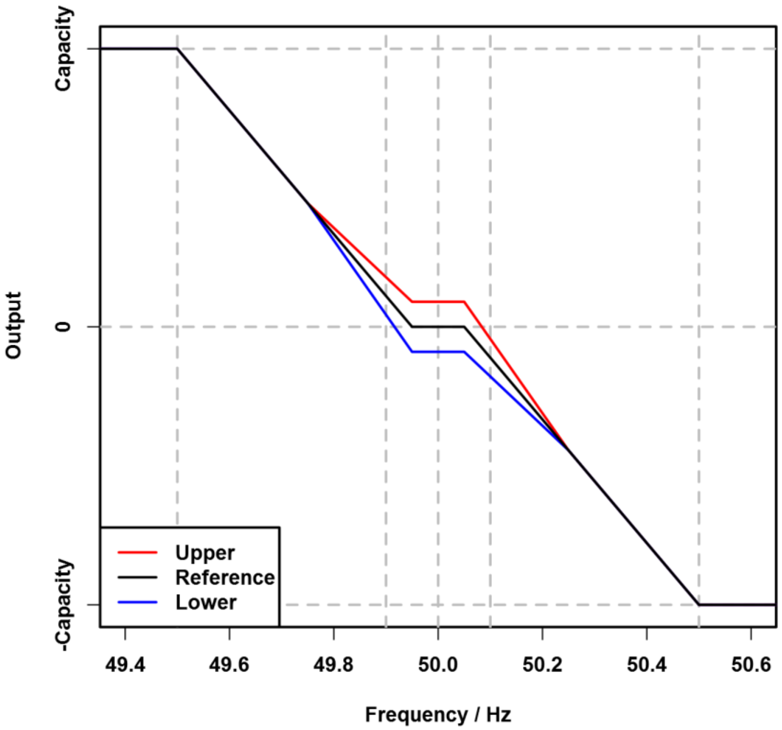
- We are offering two EFR service specifications, the only difference is a frequency insensitive band of ±0.05Hz or ±0.015Hz

- It is likely that more people will be able to provide an EFR service with a ±0.05Hz frequency insensitive band
  - And this service is sufficient to manage the system (in addition to mandatory frequency response) when inertia is low

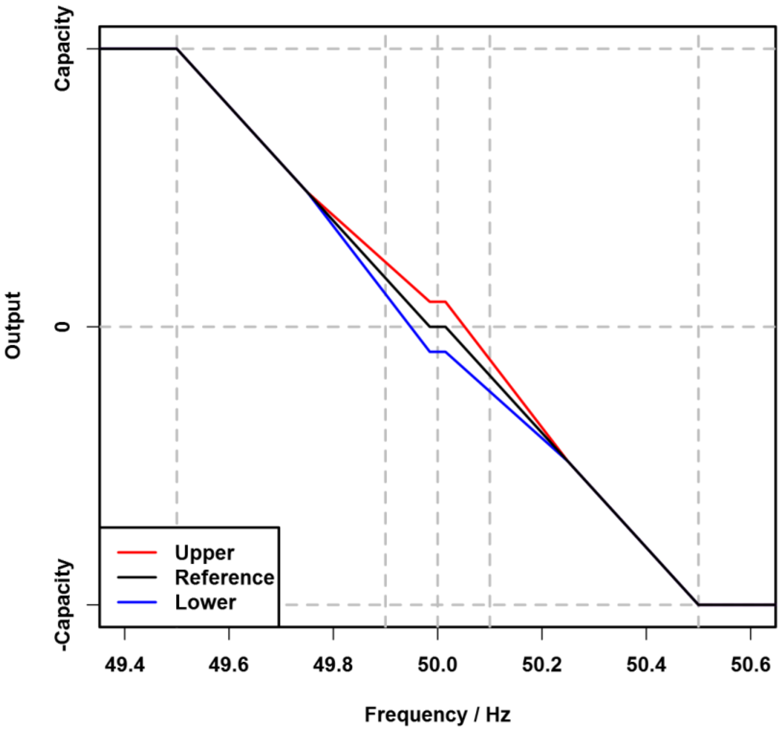
- When inertia is high, then a service with a ±0.015Hz frequency insensitive band, is more valuable
  - This is because it can meet the "minimum dynamic" requirement (and the 0.05Hz service cannot)
  - This will be explained later in the Assessment section

Technical Specification: Envelopes

Specification 1 (Wide)

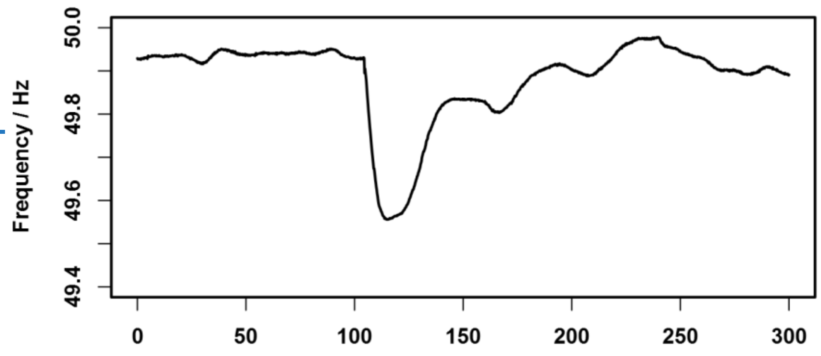


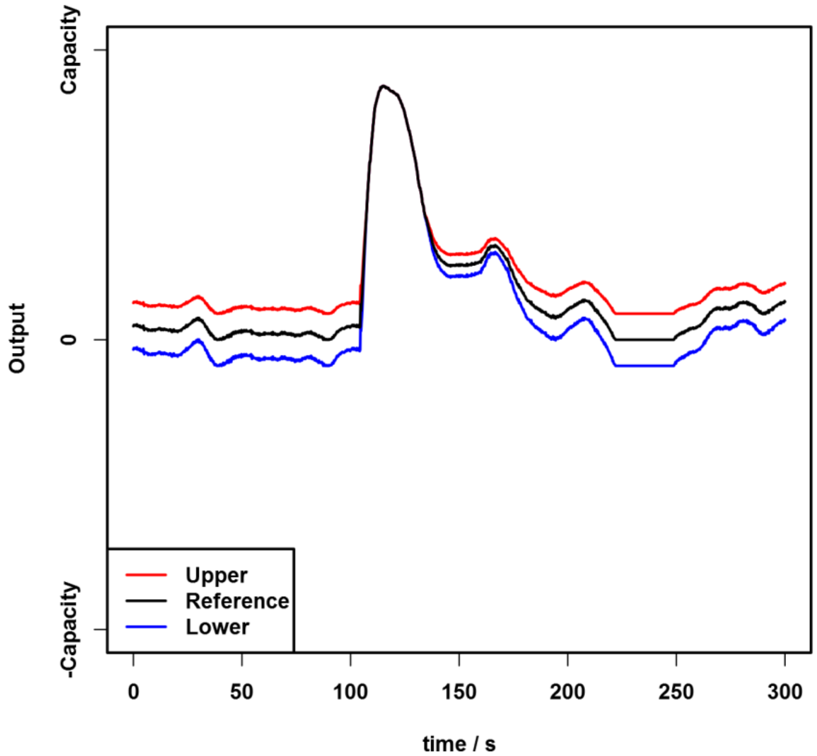
Specification 2 (Narrow)



Illustration

- The graphs on the right show how the values for Upper / Reference / Lower from specification 1 (wide) change for a frequency event
- The output should remain within the Upper (red) and Lower (blue) lines
- t=0-90s: The envelope is wide pre-fault
- t=110s: During the fault, the envelope is narrowed (to nothing)
- t=240s: When frequency is within the frequency insensitive band, the variation in frequency doesn't change the expected output range





Technical Specification

Ramp Rates / Duration

Design: Ramp Rate Restrictions

- As frequency moves away from 50Hz, we require EFR to change output
  - This can be expressed as a need to 'follow the ramp of the reference line as frequency changes'
- If frequency is moving slowly, EFR can take advantage of the flexibility in the envelope
  - Flexibility means the range between Lower (blue) and Upper (red)
  - This only exists if frequency is near 50Hz
  - But the output cannot change too quickly, or the change in output will cause a frequency issue

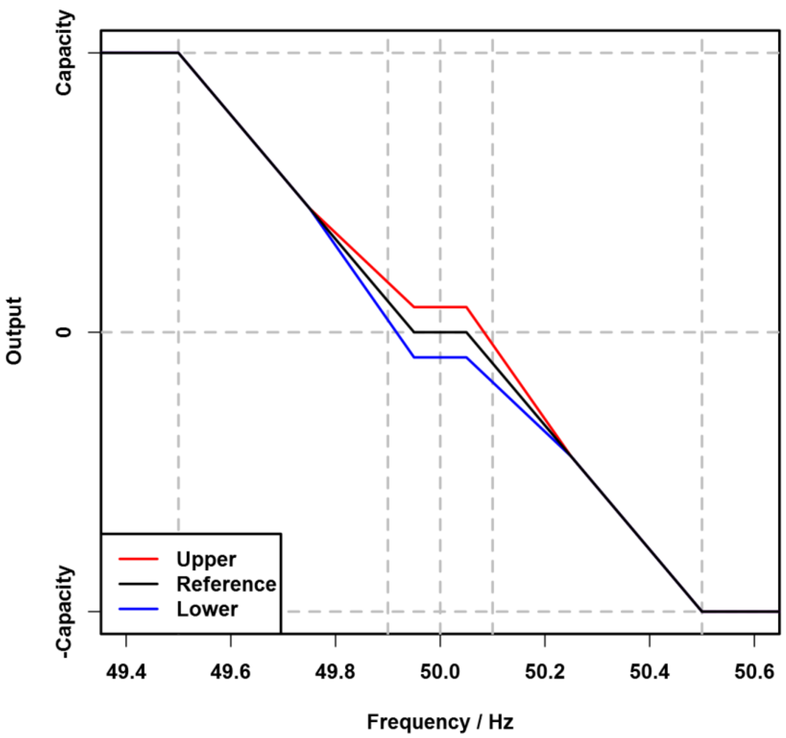


Illustration Ramp Rates

- Upper graph shows the envelope over time for a frequency event
- Lower graph is produced by subtracting the value of Reference (the black line) from all lines in the upper graph
- The output, drawn on the lower graph, should not ramp more quickly than 1% capacity/sec
  - Unless that would cause the unit to go outside the range Lower to Upper

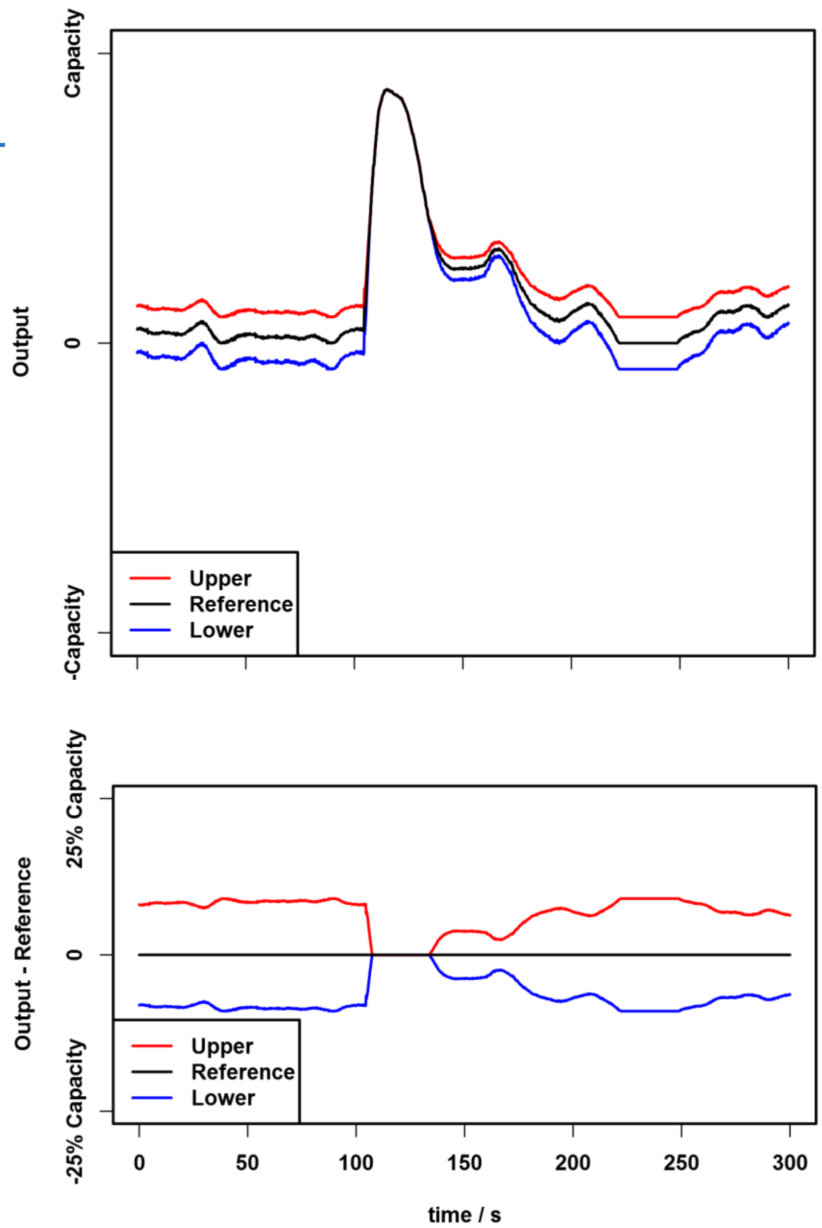


Illustration Ramp Rates

- The output, drawn on the upper graph, should not ramp more quickly than 1% capacity/sec
  - Unless that would cause the unit to go outside the range Lower to Upper

- For example, if at 30s an EFR provider were generating +2.5% of capacity…
- Then they are compliant with the ramp rate limits as long as their output remains in the shaded area

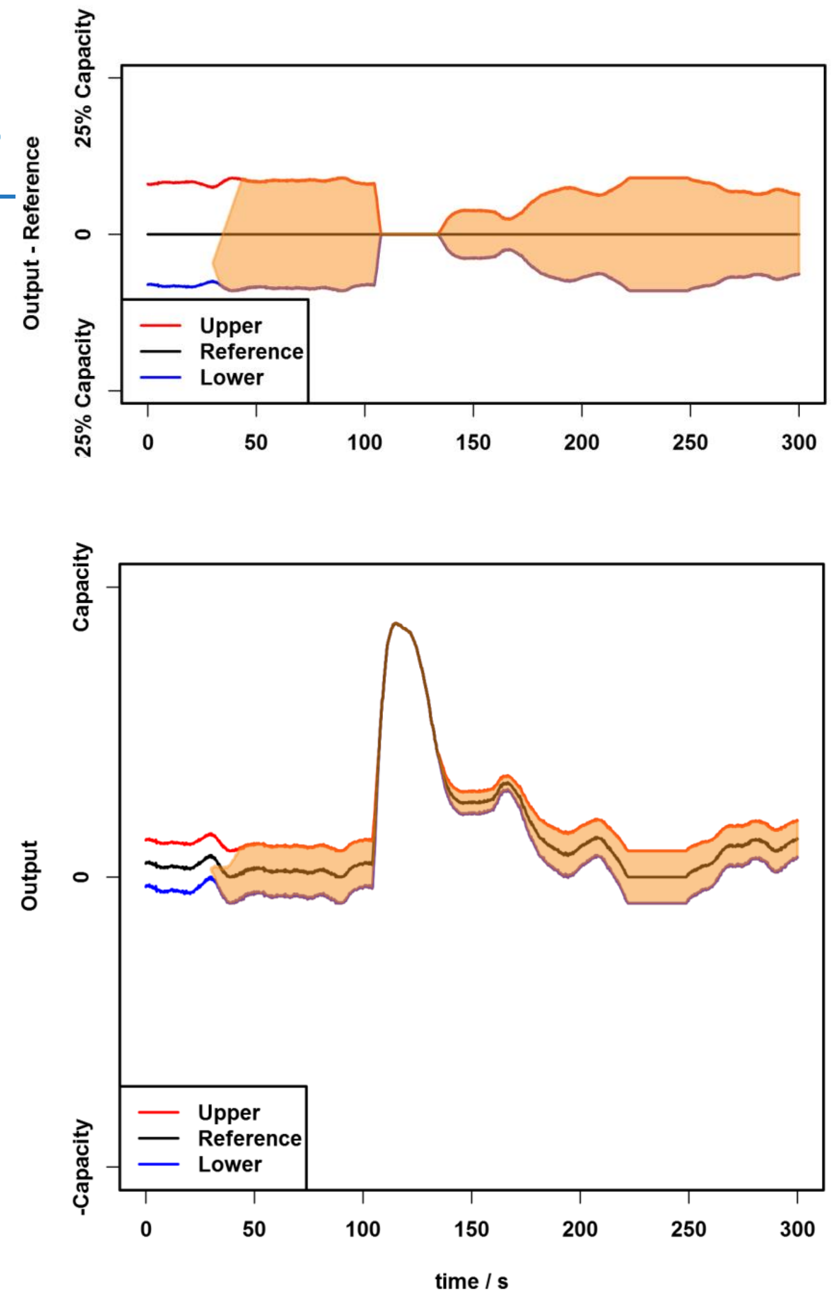
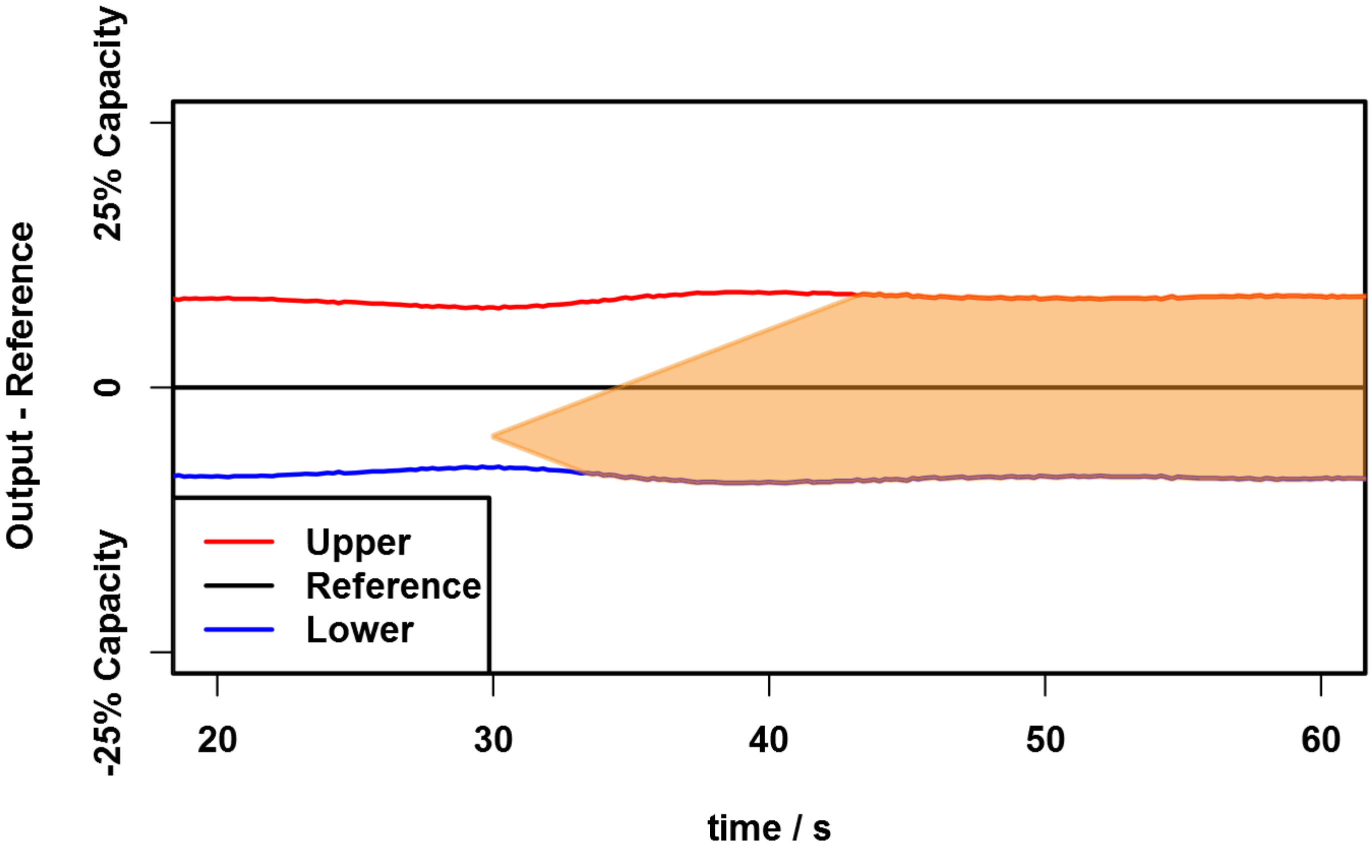


Illustration Ramp Rates: Zoomed in



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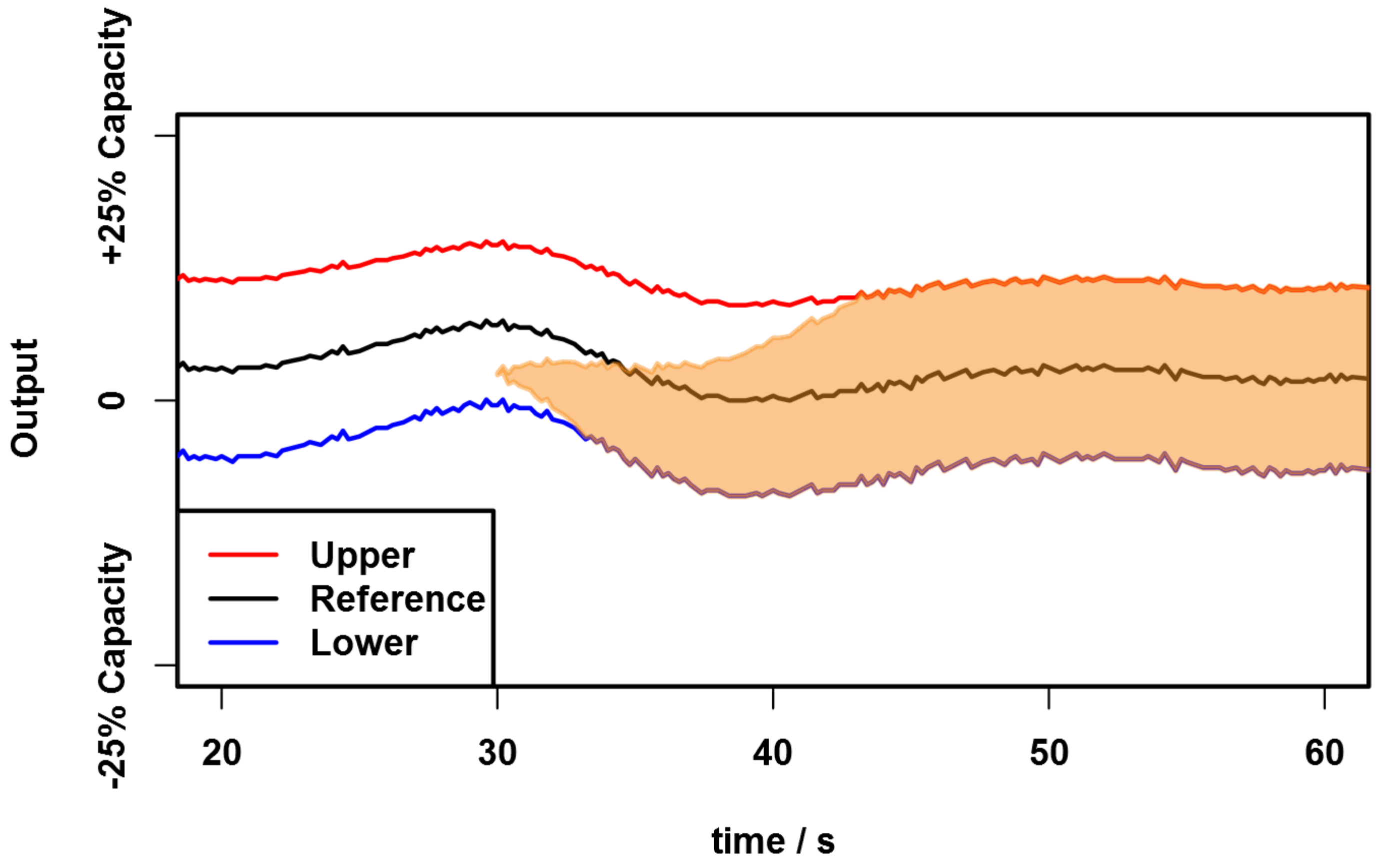
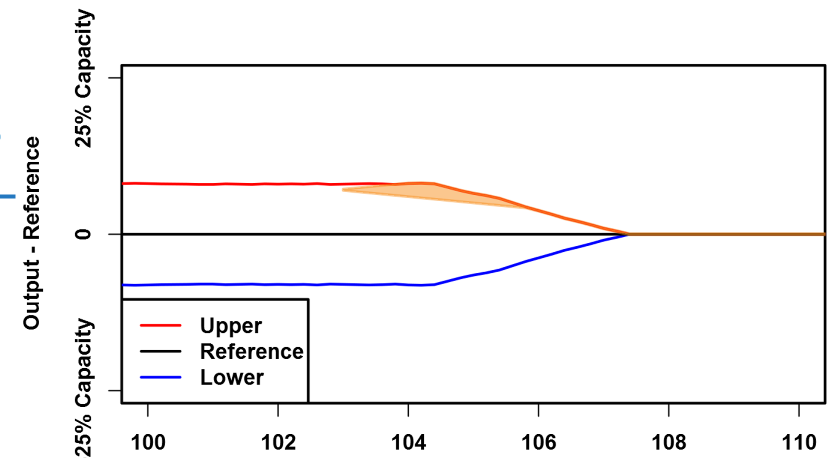
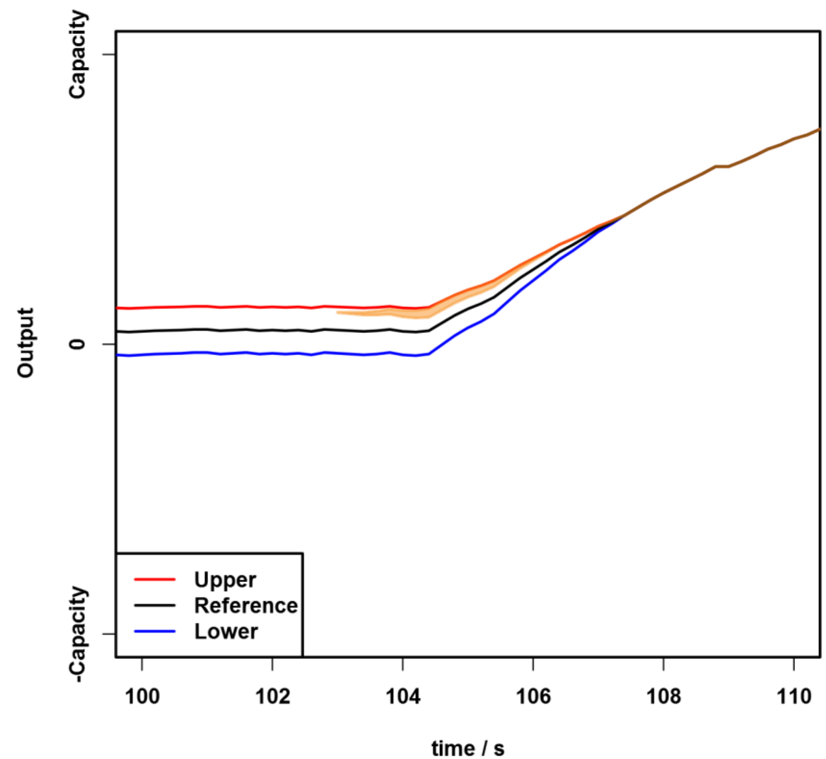


Illustration Ramp Rates

- The output, drawn on the upper graph, should not ramp more quickly than 1% capacity/sec
  - Unless that would cause the unit to go outside the range Lower to Upper

- For example, if at 103s an EFR provider were generating +12% of capacity…
- Then they are compliant with the ramp rate limits as long as their output remains in the shaded area





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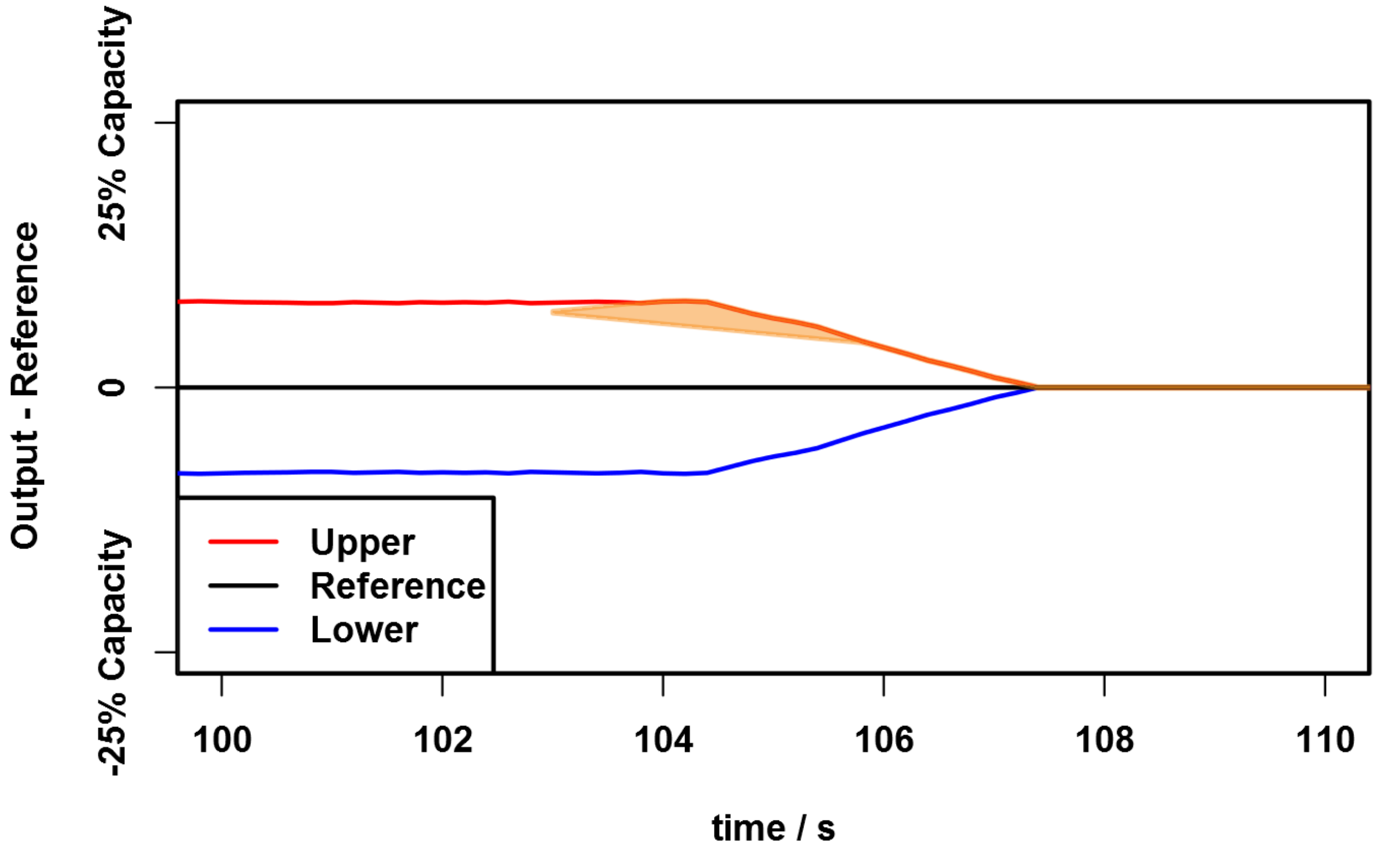

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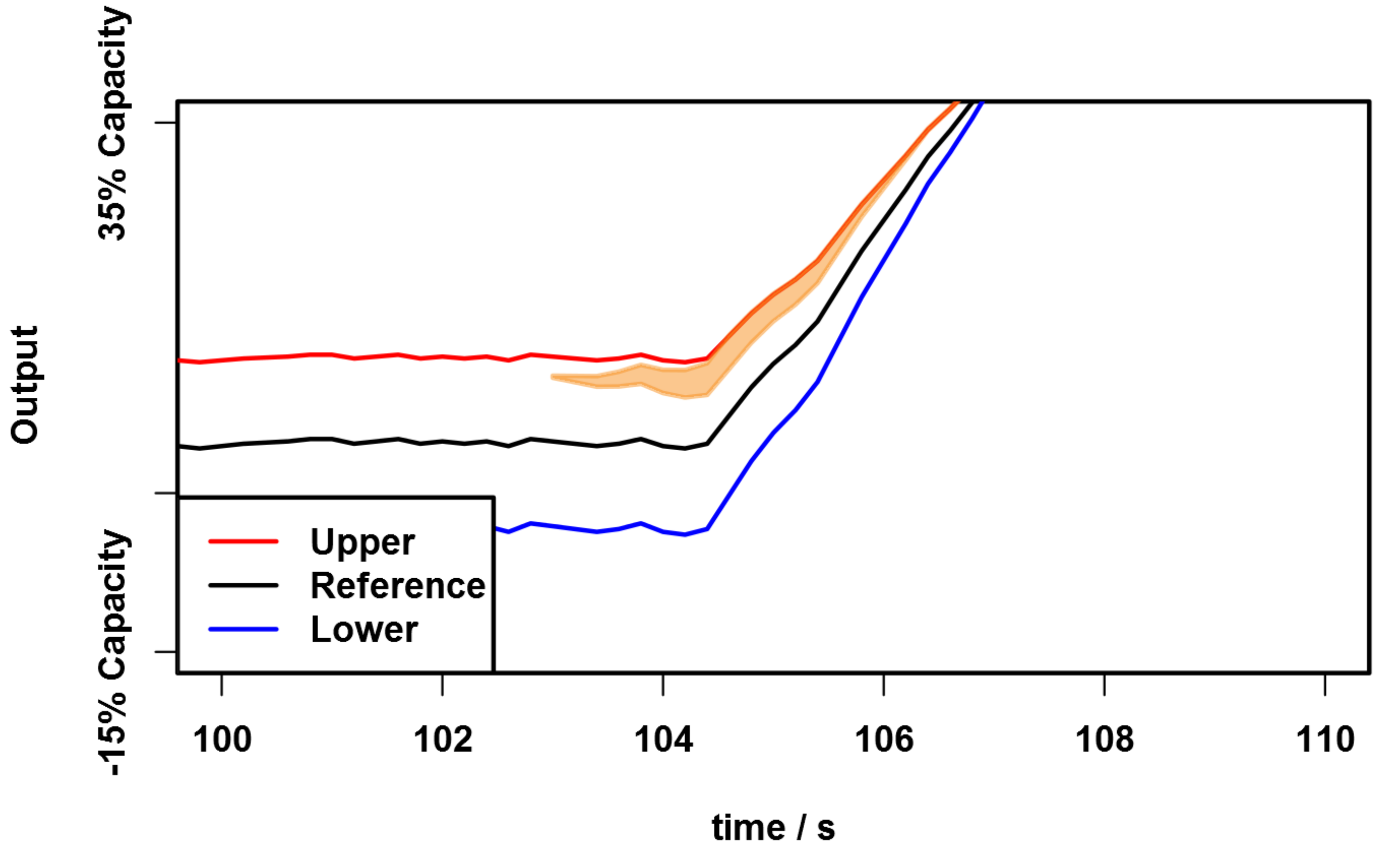

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Design Tradeoff: Minimum Duration

Minimum delivery duration is specified to 15 minutes

- Lowering this figure:
  - Service may not be delivering power for long enough to allow the various reserve services to deliver
  - Therefore decreasing this figure below 15 minutes makes the service less *useful*

- Increasing this figure:
  - From a providers point of view, increases the amount of energy throughput required
  - From National Grid's point of view, is not necessary as the reserve services will deliver by 15 minutes

Questions?

Assessment Process

Pete Underhill

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Frequency Response – Current Services

- Mandatory Frequency Response
  - All transmission connected generators must have response capability
- Commercial – Tendered/Bilateral services
- FCDM, Static services – bilateral services
  - Demand tripping via low frequency relay
  - FCDM from aggregate providers with minimum capability of 3MW
  - Static response services from large-scale electricity users
- Firm frequency response – Tendered services
  - A contracted frequency response service provided on a cost benefit basis when compared to mandatory service
  - Can be provided by generators or consumers (demand)

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Response procurement strategy

- The response requirements can be split into two:
  - PSH that can only be met by full frequency range dynamic response
  - PSH that can be met by both dynamic and static response including dynamic with a wide deadband
- Contracts are taken to procure response at a lower overall cost than alternative sources
- For pre-fault control the current alternative source is mandatory frequency response services
- For post-fault control there are currently sufficient tenders and optional services to fill the requirement so the alternative source are competing contracts

Mandatory Frequency Response

- MFR is dynamic response across the full frequency range with a +/-0.015Hz deadband at 50Hz
- Holding prices for each of P, S and H capability are submitted Month-Ahead via the FRPS website
- MFR can only be provided from plant that is running
- To provide both High Frequency and Low Frequency capability plant must be part loaded (not at Max or min output)
- Exact part load point for each unit will change its relative PSH capability so bids and offers may be taken to position plant to get the best capability at lowest cost

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Mandatory Frequency Response 2

- If a unit is held in response mode they are paid based on their submitted PSH prices for the capability of PSH they can deliver
- NG control room has an optimiser that runs continuously to select the lowest cost mandatory units to meet the response requirement (once any contracts have been taken into account)
- For a unit to provide low frequency response they require a certain amount of headroom on the unit (and hence on the system)
- For a unit to provide H frequency response they require a certain amount of footroom on the units (and hence on the system)

Difference between MFR and contracted response

- Mandatory response holding is optimised in real time (FRDF runs every 5mins). Positioning cost and holding costs for the required volume are optimised.
- Reserve is planned from day ahead to real time with actions taken to ensure there is sufficient headroom and footroom on the system to allow enough MFR to meet the response requirements.
- Contracted response is assessed against a forecast of reserve creation cost, holding and positioning costs.
- Contracted response typically has a single fee for the bundled capability and reserve value.
- If a contract is accepted, the unit is nominated, reducing the requirement for reserve, holding and positioning cost in real time.

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Assessment Process Summarised

- Requirements – Do we need the response volumes during the tendered period?
- Will the tender price present savings when compared with alternatives for the same service and time period?
- Compared against other tenders for the same period, is this the most valuable option?
- If the tender is for more than month ahead, does the tender represent savings compared to our forecast expectation of future tenders for the same time period?

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Assessment Principles

Cost benefit analysis:

- **Contract Cost** VS **Alternative Cost**

Contract cost is simple to calculate, using:

- Tendered fees
- Tendered hours
- Estimated availability and nomination

The total cost is the sum of availability and nomination:

- **Availability Cost (£) =**

Availability fee (£/hr) x Forecast available hours

- **Nomination Cost (£) =**

Nomination fee (£/hr) x Forecast nomination hours

What costs would the contract displace?

- Provision from Mandatory – **Holding** and **Positioning** costs
- Creation of **reserve for response**
- Minimum benefit threshold accounts for uncertainties
- Alternative contracts and tendered services

Assessment Principles – Alternative Costs

1. Creating reserve for response

- For each 1MW of response we hold 1.8MW of reserve on synchronised units – known as “reserve for response” a component of Operating Reserve
  - *Response contracts ‘lock in’ a portion of the response requirement and displaces the equivalent reserve for response*

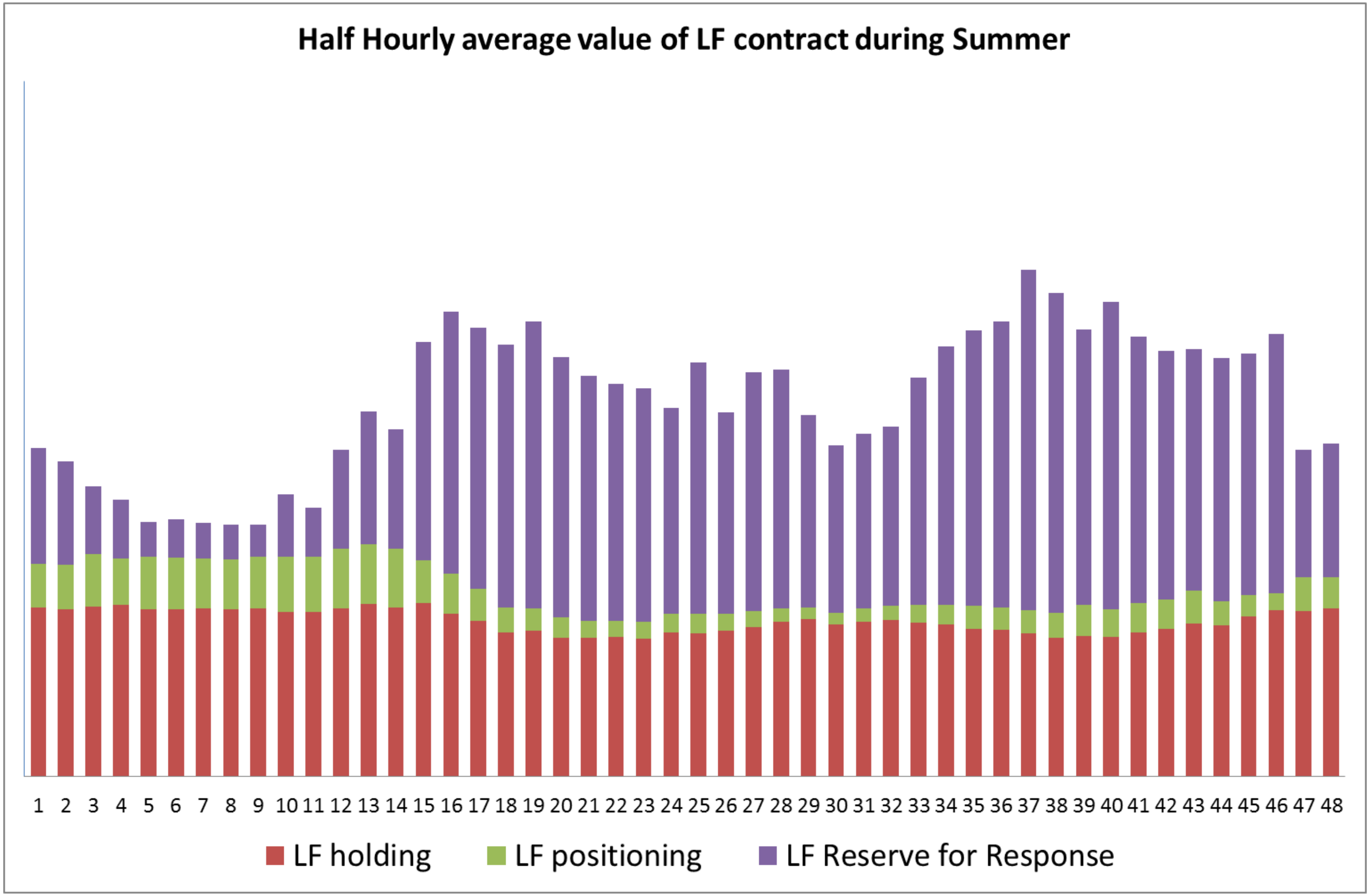
2. Positioning

- Fine tuning response capabilities by moving units up and down using BOAs
  - *Contracted units do not need to be positioned so offsets a proportion of positioning BOA*

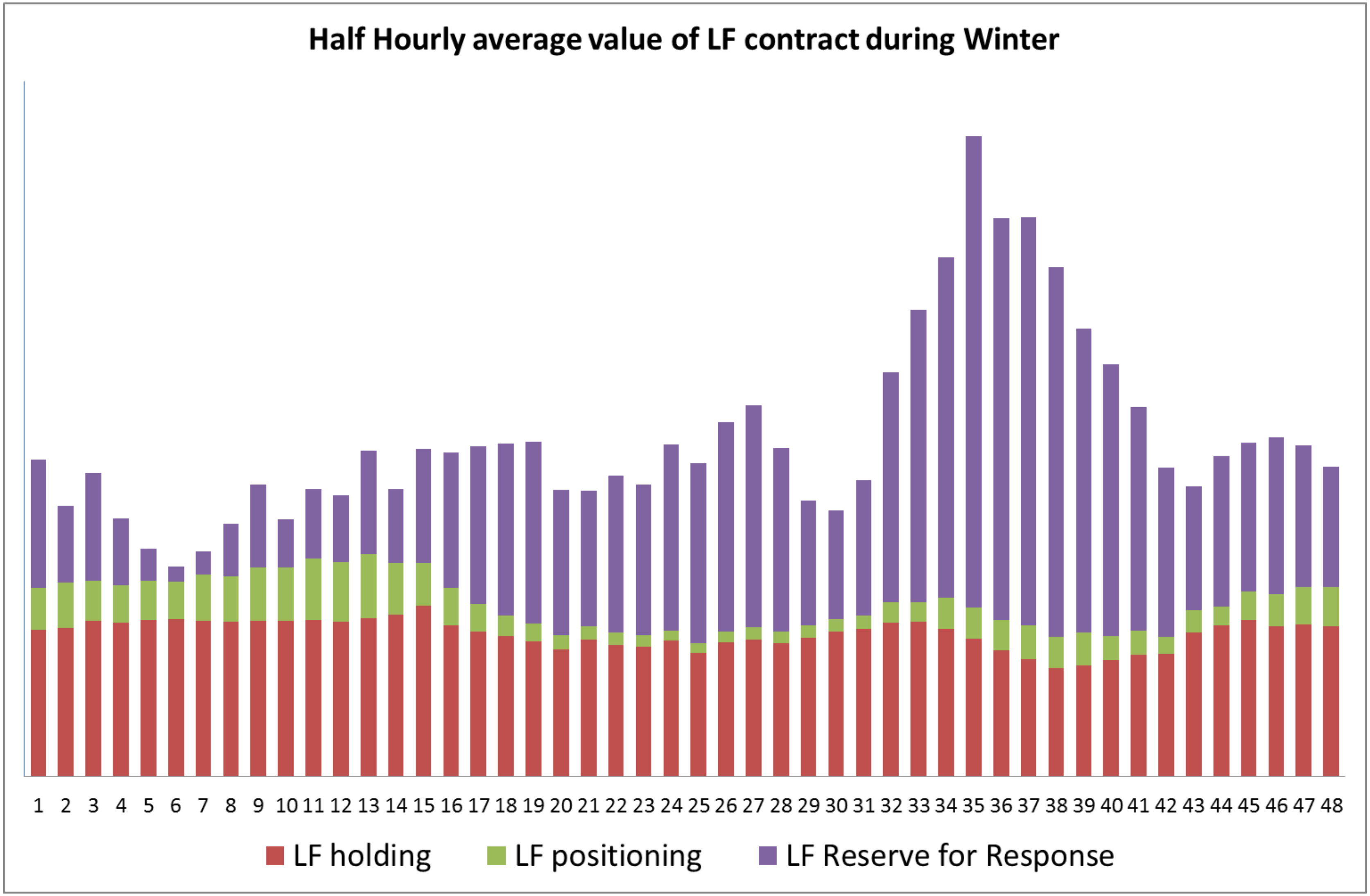
3. Holding

- Units are instructed to hold response and are paid a Holding fee
  - *Contracted units are paid a combined fee that covers all capability*

Response contract component value



Response contract component value



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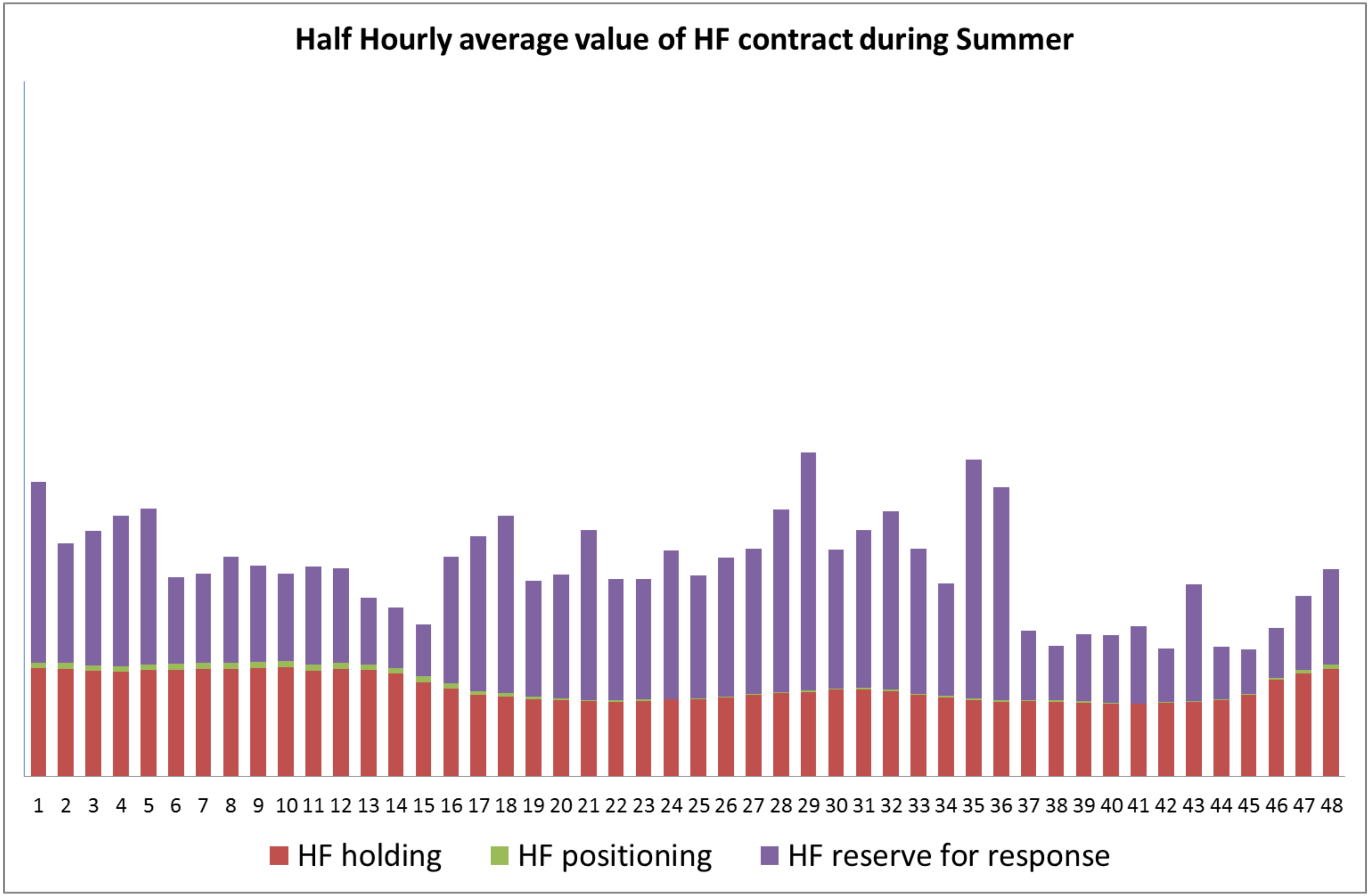

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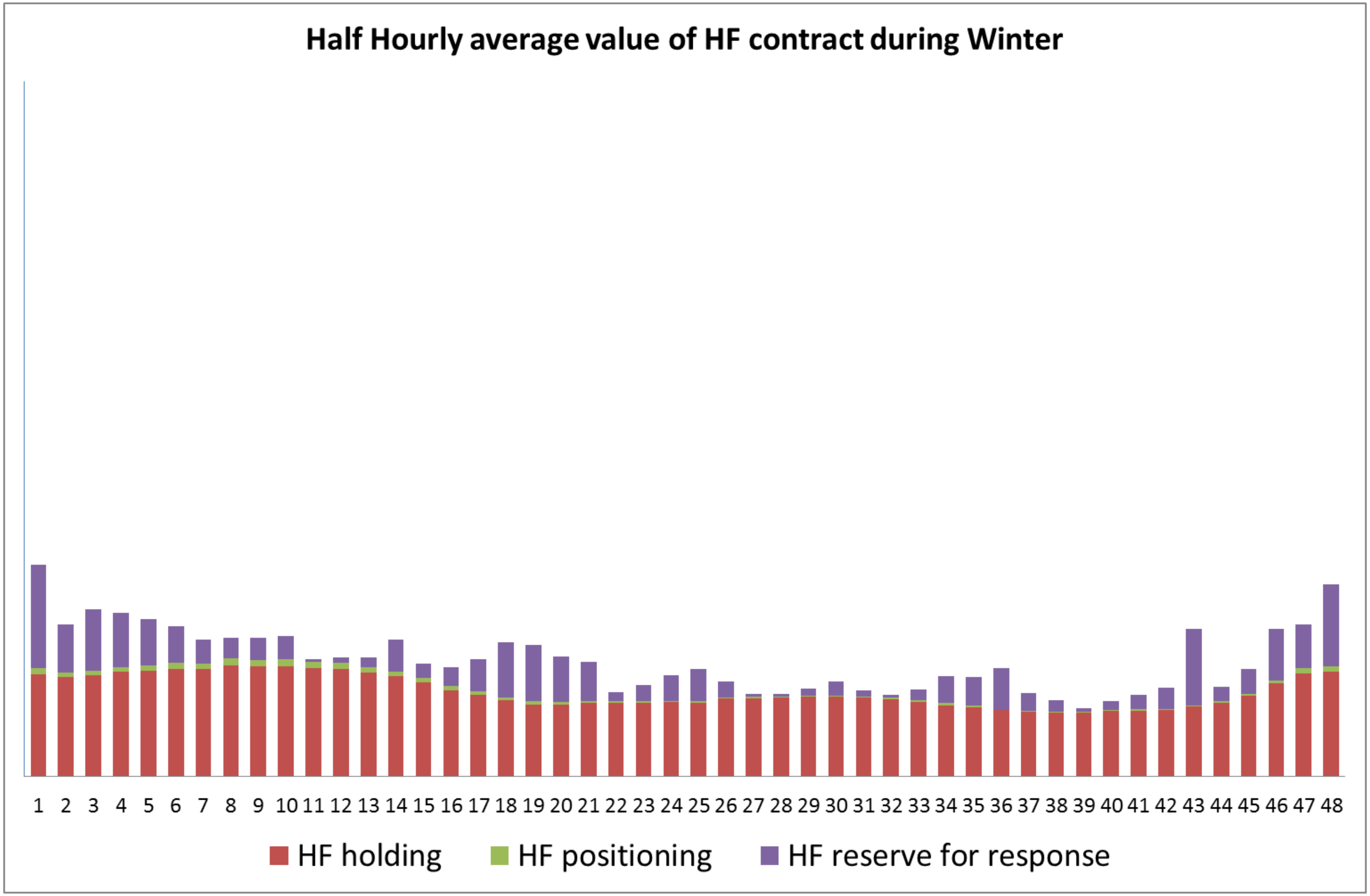

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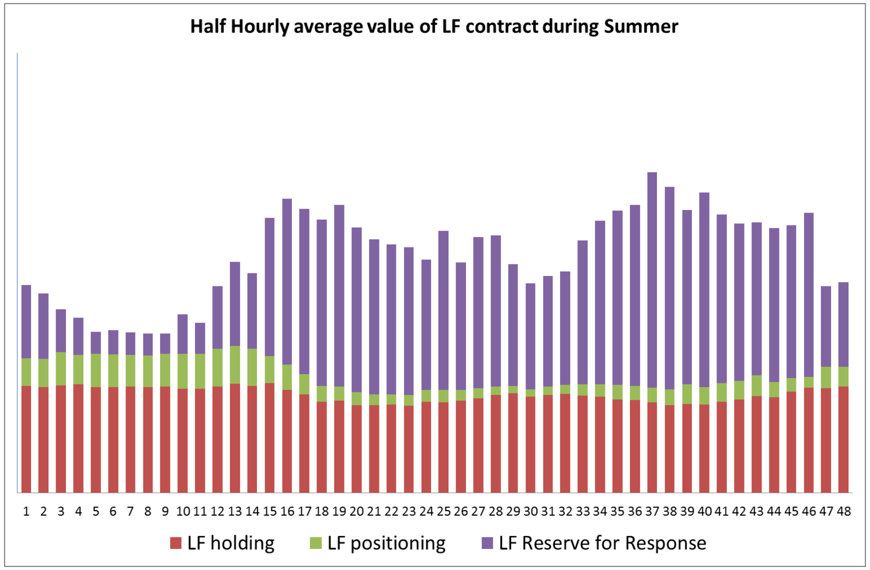
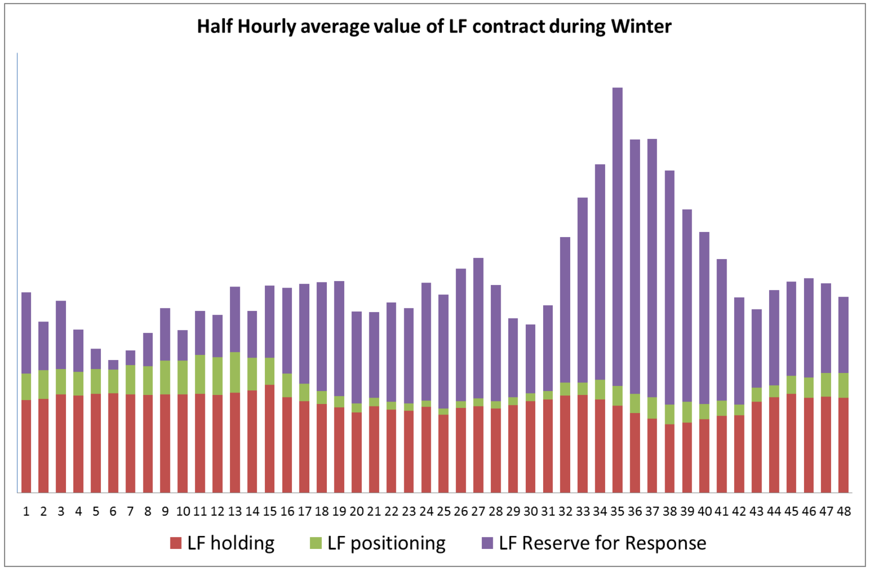
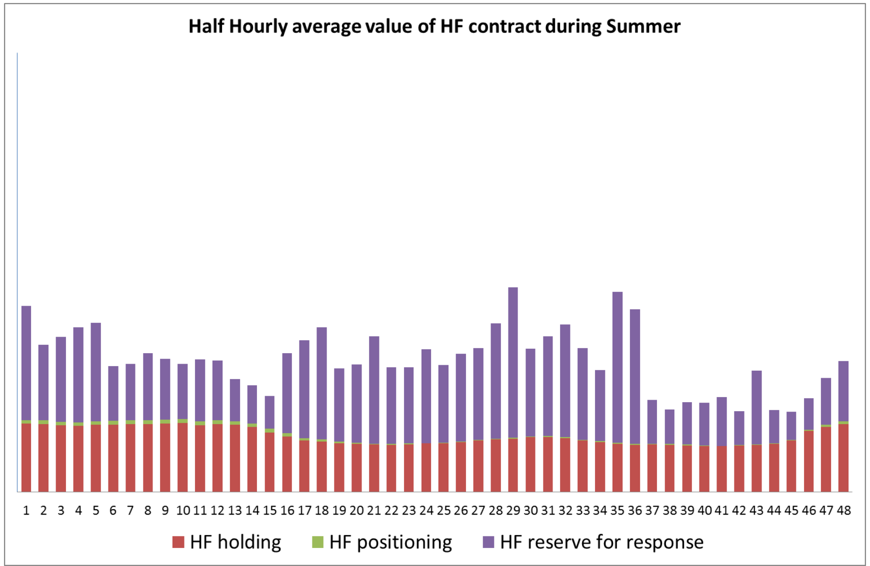
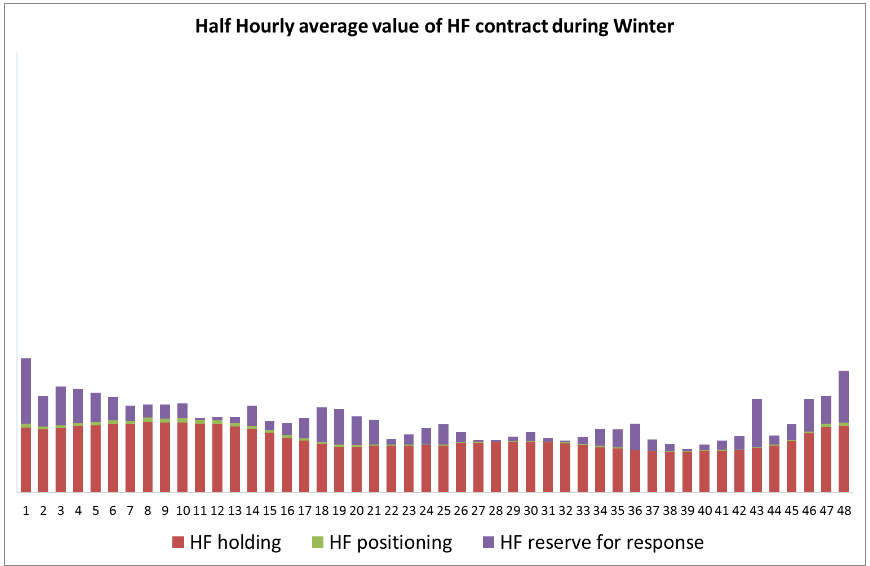








Assessment of EFR Value

Roy Cheung

Assessment: Outline

- Illustration of How to Assess Value
  - Primer
  - Worked examples
- Forecasting Value
  - Equivalent alternative response volumes
  - Future Requirements for Balancing Services
- Forecasted Value

Assessment

Illustration of How to Assess Value

Assessing Value

- The value of an EFR provider can be broken into two parts:
  - Pre-fault
  - Post-fault

- Value can be quantified by calculating how much alternative response services can be replaced with the EFR provision
  - Benchmark: Mandatory Frequency Response

Pre-Fault Value

- The pre-fault requirement for response is usually expressed as a “minimum dynamic response requirement”.
  - This response is used to make sure that pre-fault frequency is kept near 50Hz
  - Usually 550MW, rises to 700MW overnight
  - Published in FFR market information report

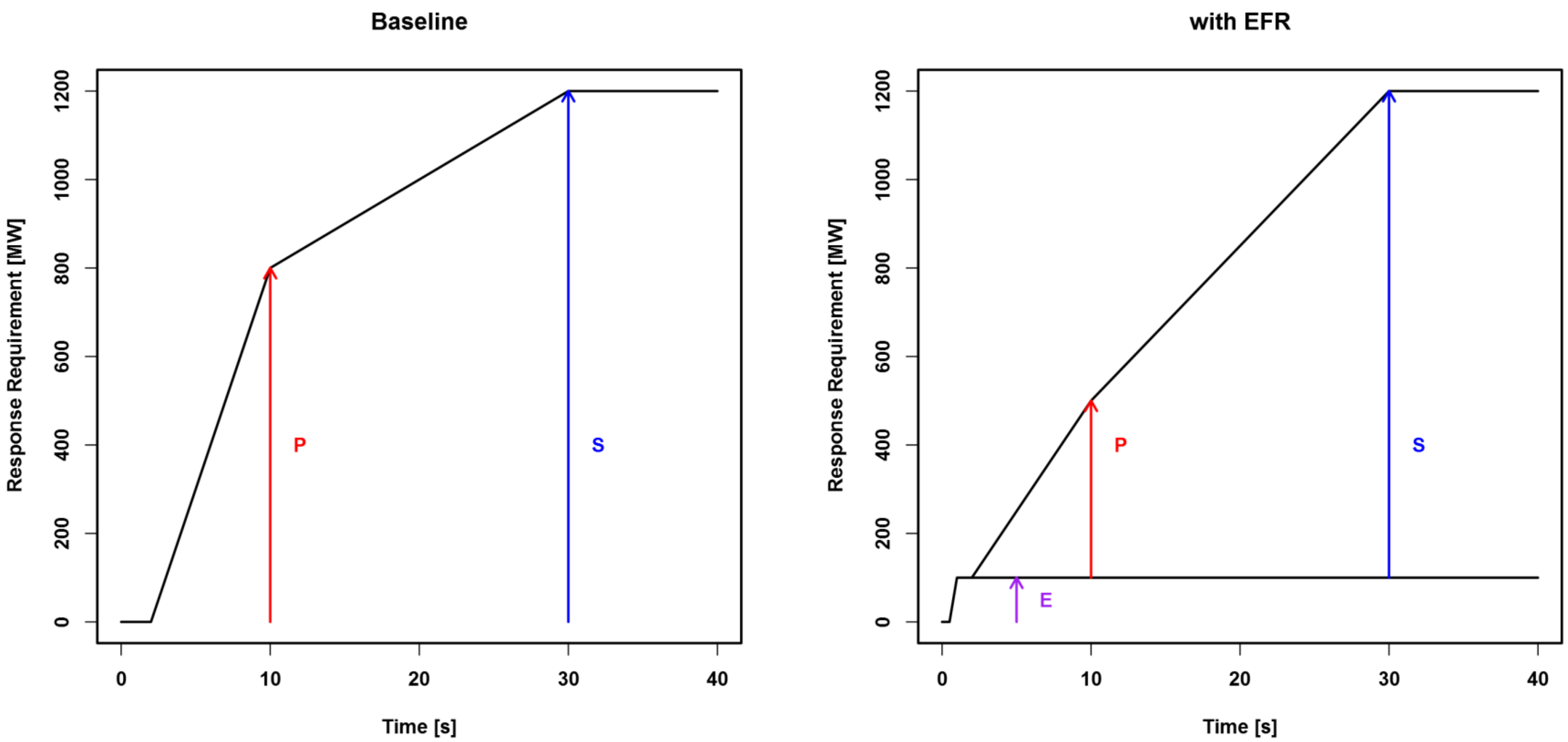
- The ±0.015Hz EFR service can meet the minimum dynamic response requirement
- The ±0.05Hz EFR service cannot

Post-Fault Value

- The post-fault response requirement is calculated by
  - estimating the amount of response required to contain all potential faults to the frequency standards
    - 50±0.5Hz from the Security & Quality of Supply Standards. (except for infrequent loss, where the limit is 50-0.8Hz)
  - This clearly requires the pre-fault frequency to be controlled acceptably

- Because the ±0.015Hz EFR service provides response pre-fault, there is less response available post-fault
  - Therefore; at times when pre-fault frequency is controlled acceptably, the ±0.05Hz service can replace more mandatory frequency response

Alternative MW Saved



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Worked Example – Summer Minimum

- Summer Minimum has low demand and low inertia
  - This results in a large requirement for primary and secondary response
- Modelling the requirements assuming 200MW of EFR:
  - Reduces the amount of primary required by much more than 200MW
  - Reduces the amount of secondary response by 200MW

		Baseline	Narrow	Wide
Scenario	Demand (MW)		22 000	
	Inertia (MVAs)		120 000	
	loss event (MW)		-1 000	
services	EFR (MW)		200	200
	Primary (MW)	2800	2145	1970
	Secondary (MW)	1170	970	970
	Minimum Dynamic Req. (MW)	700	700	700
200MW EFR saves...	Primary (MW)		655	830
	Secondary (MW)		200	200

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Worked Example – Winter Peak

- Winter Peak has high demand and high inertia
  - This results in a low requirement for primary and secondary response
- Modelling the requirements assuming 200MW of EFR:
  - Reduces the amount of primary required by 200MW for the ±0.015Hz EFR service
  - Doesn't reduce the amount of primary required for the ±0.05Hz EFR service
  - Reduces the amount of secondary response by 200MW

Scenario	Demand (MW)		60 000	
	Inertia (MVAs)		370 000	
	loss event (MW)		-1 260	

		Baseline	Narrow	Wide
services	EFR (MW)		200	200
	Primary (MW)	550	350	550
	Secondary (MW)	955	755	755
Minimum Dynamic Req. (MW)		550	550	550
200MW EFR saves...	Primary (MW)		200	0
	Secondary (MW)		200	200

Worked Example - Summary

- The ±0.015Hz service has value all year round

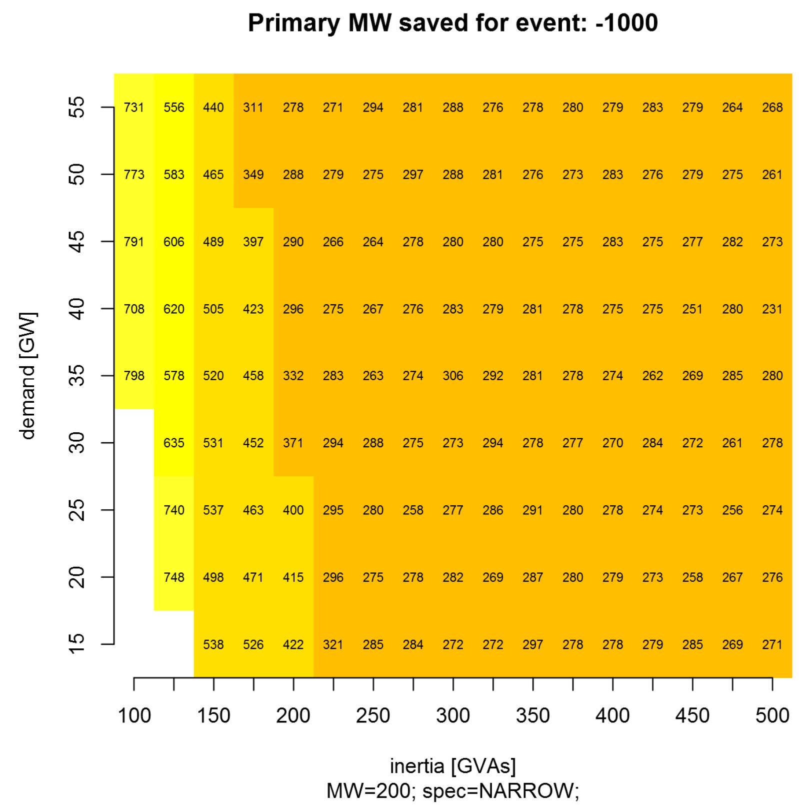
- The ±0.05Hz service has
  - More value (than the ±0.015Hz service) at times of low demand/inertia
  - No value at times of very high demand/inertia

Assessment

Forecasting Value

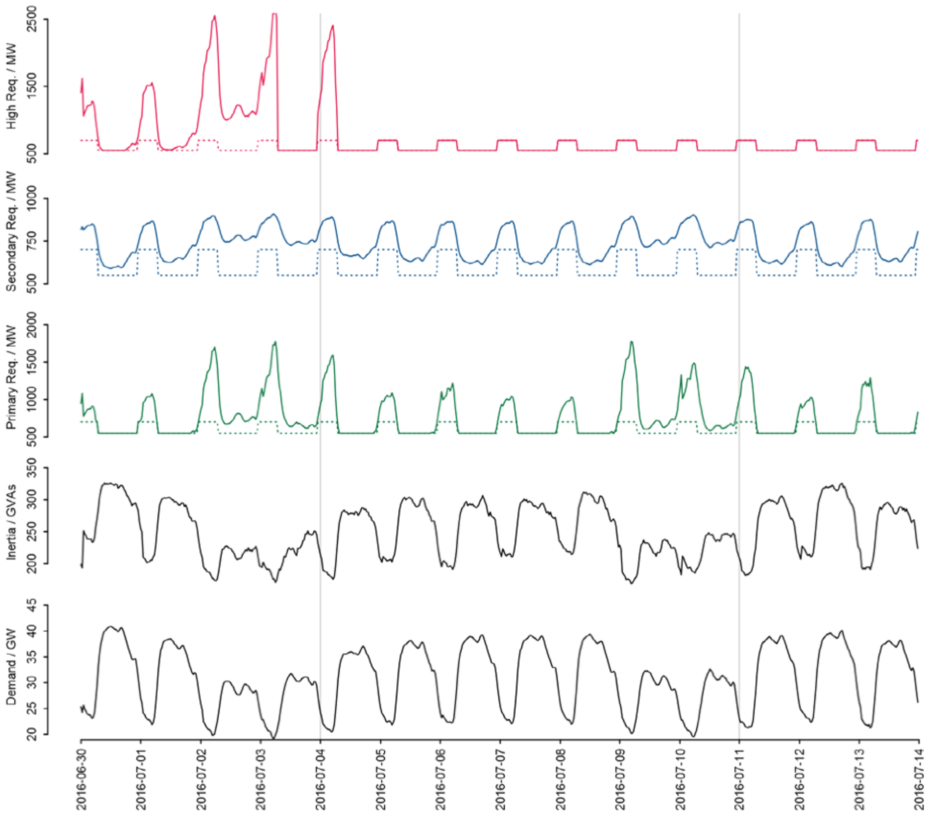
Forecasting Value

- Create equivalent post-fault MFR matrices, given:
  - EFR volume
  - Loss size (to be secured)
  - Range of
    - Demand
    - Inertia



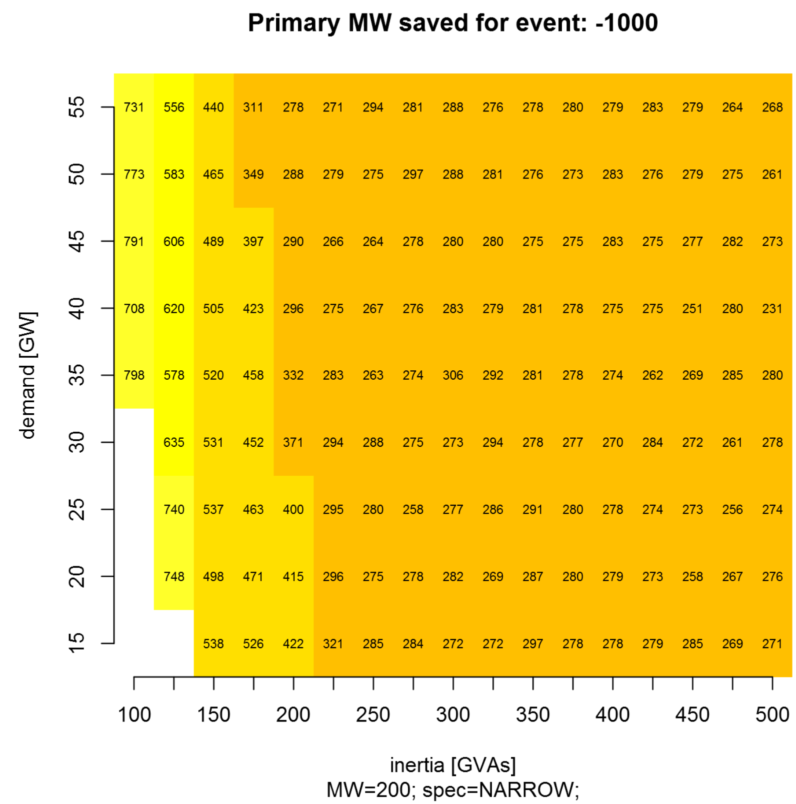
Future Requirements for Balancing Services

- Per half hour forecasts for
  - Demand
  - Inertia
  - Primary/Secondary/High Response Requirements
    - Assuming no EFR
  - Primary/Secondary/High Minimum Dynamic Response Requirements
- Power Responsive campaign
  - Based on FES / SOF 2015
- Combine with equivalent response matrices
  - Generate a timeseries of EFR value



Forecasting Value

- Create equivalent post-fault MFR matrices, given:
  - EFR volume
  - Loss size (to be secured)
  - Range of
    - Demand
    - Inertia
- EFR value primarily driven by system inertia



SOF 2015: Inertia

		Month								
		2016-4	2016-5	2016-6	2016-7	2016-8	2016-9	2016-10	2016-11	2016-12
GVA.s	250	116	91	124	76	107	97	94	68	70
	240	107	108	91	75	90	66	72	80	76
	230	101	114	85	100	79	95	58	98	84
	220	77	122	87	146	132	61	58	86	90
	210	71	119	91	135	117	80	98	66	108
	200	36	65	100	98	114	79	82	35	52
	190	28	59	98	88	79	80	71	9	35
	180	3	40	44	77	90	78	30	2	14
	170		12	14	20	27	35	5	6	4
	160				1	2	18	4	9	7
	150					1				2

SOF 2015: Inertia

Year - Month

GVA.s	2016/17 4	5	6	7	8	9	10	11	12	1	2	3
500												
490												
480												
470												
460												
450										2	3	
440									3	9	2	
430									21	20	2	
420								5	19	30	2	1
410								10	34	26	23	5
400							3	26	37	44	20	4
390							3	32	70	93	30	18
380							8	40	33	88	62	30
370							13	42	23	62	63	32
360							25	49	32	51	76	40
350						5	40	##	70	75	73	60
340	55	5				19	66	63	67	49	87	##
330	84	47	15	1	9	77	##	59	55	73	88	77
320	##	76	70	47	59	95	90	##	78	63	70	##
310	##	96	##	84	86	70	99	87	81	69	75	90
300	94	##	96	##	84	68	##	97	79	91	85	##
290	90	##	##	##	92	96	##	85	55	##	77	62
280	79	92	##	98	99	##	70	49	60	99	72	79
270	##	##	89	96	##	##	80	49	70	67	75	##
260	##	92	86	54	##	92	##	66	59	50	70	##
250	##	91	##	76	##	97	94	68	70	49	87	65
240	##	##	91	75	90	66	72	80	76	42	55	79
230	##	##	85	##	79	95	58	98	84	54	44	85
220	77	##	87	##	##	61	58	86	90	63	21	64
210	71	##	91	##	##	80	98	66	##	44	21	63
200	36	65	##	98	##	79	82	35	52	38	44	48
190	28	59	98	88	79	80	71	9	35	19	17	33
180	3	40	44	77	90	78	30	2	14	16		4
170		12	14	20	27	35	5	6	4	1		
160				1	2	18	4	9	7			
150					1				2			
140												
130												
120												
110												
100												

GVA.s	2017/18 4	5	6	7	8	9	10	11	12	1	2	3
500												
490												
480												
470												
460												
450								2			4	
440								3	13	1	9	
430								2	12	9	12	
420								18	23	16	19	3
410								17	47	29	46	8
400							3	17	44	31	57	11
390							1	28	49	48	52	29
380							11	49	43	61	49	40
370							9	43	51	59	65	32
360							31	32	58	51	82	31
350		1				4	78	45	42	50	48	54
340	27	19				10	95	##	39	68	71	73
330	48	51	7	2		40	##	88	59	##	85	95
320	84	44	50	43	11	##	58	84	62	94	##	##
310	90	57	83	80	43	##	90	62	82	81	85	##
300	99	##	##	92	##	77	##	77	##	60	97	87
290	##	##	##	##	##	73	78	66	80	69	81	76
280	90	92	##	##	##	99	64	##	57	55	65	##
270	##	92	##	79	##	##	##	63	79	58	62	##
260	94	99	67	96	##	70	##	54	59	71	51	93
250	75	##	79	##	##	81	79	55	57	83	63	64
240	96	88	83	##	##	81	82	61	70	64	75	73
230	##	##	99	99	80	99	69	80	65	66	35	90
220	##	83	##	##	##	94	68	92	54	61	10	93
210	89	##	##	##	##	83	68	82	79	65	11	53
200	54	##	88	##	##	64	74	64	58	50	3	23
190	77	82	98	87	##	72	58	24	54	28	3	13
180	35	65	49	49	47	75	38	10	31	15		2
170	15	39	16	13	9	52	17	1	4	12		1
160	9	6	1	21	14	1	6	2	6	2		1
150	3						2		7			
140							2					
130												
120												
110												
100												

GVA.s	2018/19 4	5	6	7	8	9	10	11	12	1	2	3
500												
490												
480												
470												
460											4	
450									9		2	
440								1	15	1	1	
430								5	12	9	11	
420								17	40	7	22	
410							5	26	49	26	49	
400							9	32	26	55	72	8
390							6	30	50	37	65	7
380							11	44	65	61	53	28
370						1	15	40	53	64	62	37
360						2	45	50	38	69	56	42
350	12	14				21	61	49	39	68	50	70
340	60	30				48	70	62	58	56	67	69
330	##	46			6	40	65	77	55	73	75	98
320	83	28	31	14	36	61	83	78	69	##	93	##
310	##	60	91	55	56	76	##	##	60	77	67	##
300	##	78	##	67	65	80	##	93	73	85	72	##
290	64	##	##	##	70	89	##	71	82	86	64	85
280	70	##	##	##	##	##	75	75	65	81	82	84
270	83	##	82	##	##	##	80	66	60	75	56	92
260	##	81	68	87	##	75	83	60	73	66	65	94
250	##	88	##	99	##	##	87	56	60	57	45	80
240	##	64	##	97	90	##	83	61	60	73	37	85
230	##	##	94	78	79	82	72	69	58	54	21	84
220	86	95	89	##	83	58	56	##	68	52	49	80
210	79	##	##	##	91	74	77	76	50	71	17	34
200	26	##	94	##	94	63	84	52	69	36	15	44
190	27	87	82	92	##	96	59	16	50	10	33	46
180	19	45	32	52	##	52	33	12	27	15	33	4
170	18	25	18	32	45	44	7	4	21	14	6	
160	10	3	4	12	37	16	10	3	17	7		
150			4		16	13	4	6	12	3		
140			4		10	8			3			
130						1			2			
120												
110												
100												

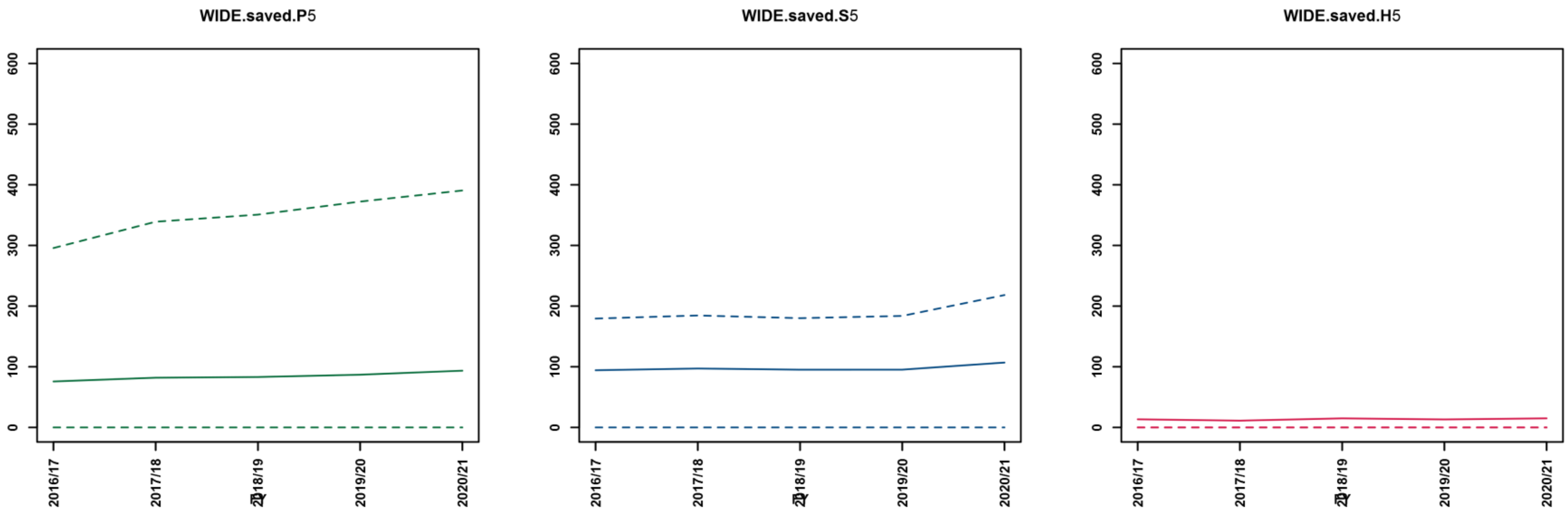
GVA.s	2019/20 4	5	6	7	8	9	10	11	12	1	2	3
500												
490												
480												
470												
460										2		
450										5		
440										12	2	1
430									4	32	6	4
420								8	33	22	32	5
410							1	8	45	31	36	6
400							3	29	55	69	36	8
390							11	58	76	65	34	37
380							19	66	67	49	55	24
370							20	52	57	74	40	36
360		2					69	68	36	54	74	43
350		22				8	75	74	54	42	77	60
340	16	21				43	90	62	61	83	83	##
330	33	24	10		1	37	51	71	40	68	81	##
320	62	43	44	18	22	52	74	58	47	64	90	83
310	71	72	94	79	41	76	85	70	52	74	98	77
300	##	98	99	92	##	83	69	88	41	79	74	77
290	##	##	##	##	93	93	93	70	55	69	83	72
280	##	##	76	##	##	89	##	87	77	50	83	80
270	##	99	83	##	##	##	##	49	80	61	86	##
260	##	78	68	##	##	75	81	56	75	74	79	##
250	##	94	90	89	69	99	86	59	62	64	42	81
240	##	70	##	##	82	##	94	67	51	57	49	84
230	96	##	##	##	##	77	54	87	67	47	31	67
220	##	##	91	##	##	50	57	86	69	49	48	59
210	##	##	##	##	##	87	69	53	59	45	22	47
200	59	##	##	##	##	96	31	58	41	56	15	23
190	60	85	##	##	92	98	59	26	46	31	25	27
180	28	62	50	70	65	71	51	15	36	31	7	18
170	19	27	25	31	56	37	27	13	36	20	4	8
160	3	10	6	6	24	31		2	28	9		7
150		3			6	14	4		12			4
140				1	1	4	1		14			6
130				3	3				8			8
120									4			
110												
100												

GVA.s	2020/21 4	5	6	7	8	9	10	11	12	1	2	3
500												
490												
480											9	
470										1	6	
460										4	7	
450										2	9	
440								1	1	7	32	
430								3	23	29	28	
420								7	16	23	19	3
410							3	13	25	16	21	
400							2	20	30	54	44	7
390							7	57	70	76	71	4
380						2	13	34	64	84	60	6
370						4	22	52	56	75	73	13
360						10	30	40	89	98	61	37
350	5	3				28	56	62	84	79	40	49
340	5	17				56	81	67	58	72	87	84
330	20	19		10	2	67	55	72	64	78	82	##
320	63	43	15	48	47	66	80	77	69	90	##	95
310	82	36	82	53	80	61	99	68	79	68	74	##
300	89	42	##	43	75	66	78	73	86	59	65	73
290	62	33	82	81	59	70	93	69	77	69	68	65
280	87	80	98	96	60	85	80	66	98	81	67	##
270	##	##	##	93	38	77	85	62	57	85	69	89
260	##	##	##	##	73	86	96	66	42	66	56	##
250	##	##	90	##	##	78	95	70	68	57	22	##
240	##	##	87	97	##	82	82	85	69	58	39	86
230	##	##	84	##	##	84	71	66	71	35	23	74
220	##	96	##	77	##	71	45	55	59	23	17	61
210	89	##	##	95	84	51	90	90	67	33	33	60
200	59	##	##	##	93	77	87	55	21	34	24	42
190	73	##	##	##	##	63	57	44	15	17	15	67
180	44	87	71	91	76	66	34	29	5	10	5	30
170	25	49	45	46	##	87	5	18	8	2	2	13
160	16	23	31	17	68	41	26	3	4	1		
150	8		7	26	45	38	11		7			
140	3			4	12	19	7	15	6			
130						5		1		2		
120					1							
110												
100												

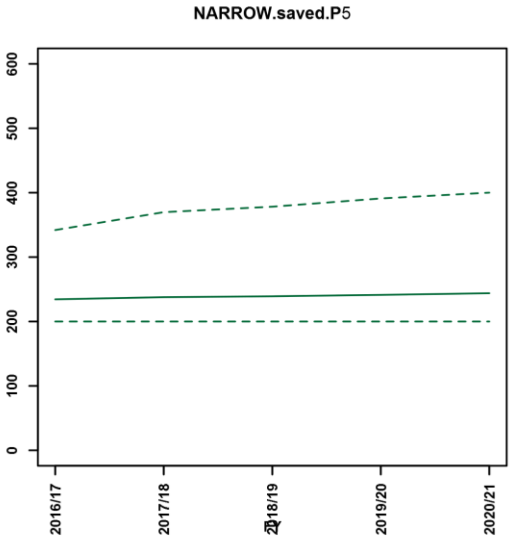
Assessment

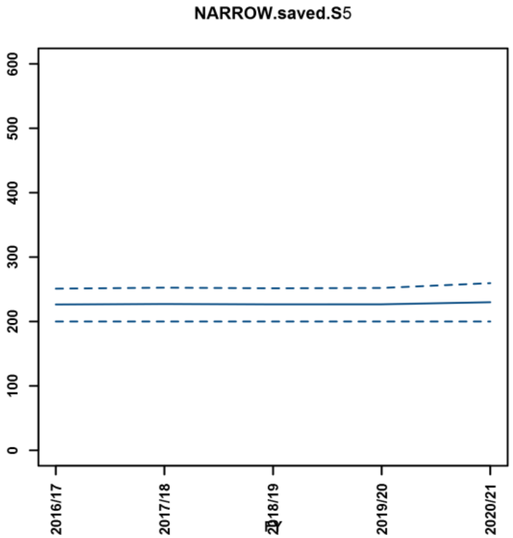
Forecasted Value

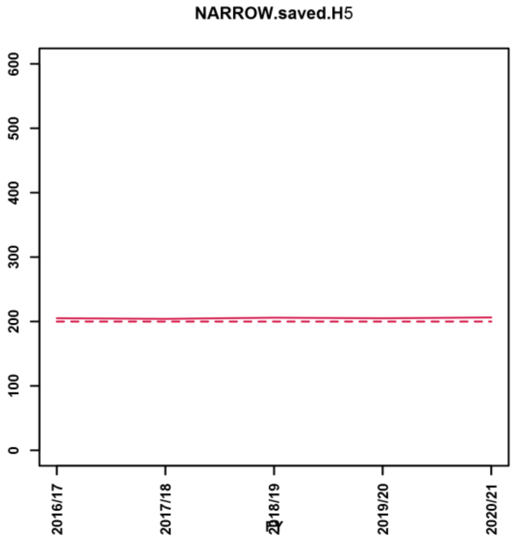
Forecasted Value: Service 1 (Wide)



Forecasted Value: Service 2 (Narrow)



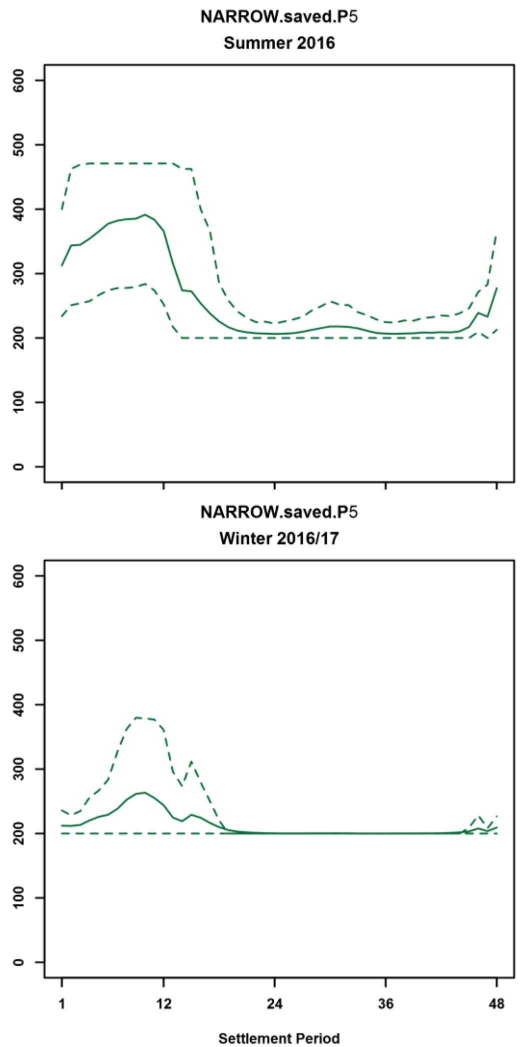




Forecasted Value

- Additional value data to be released

- Enable prospective participants to see when EFR delivers most value, for example:
  - Summer vs Winter

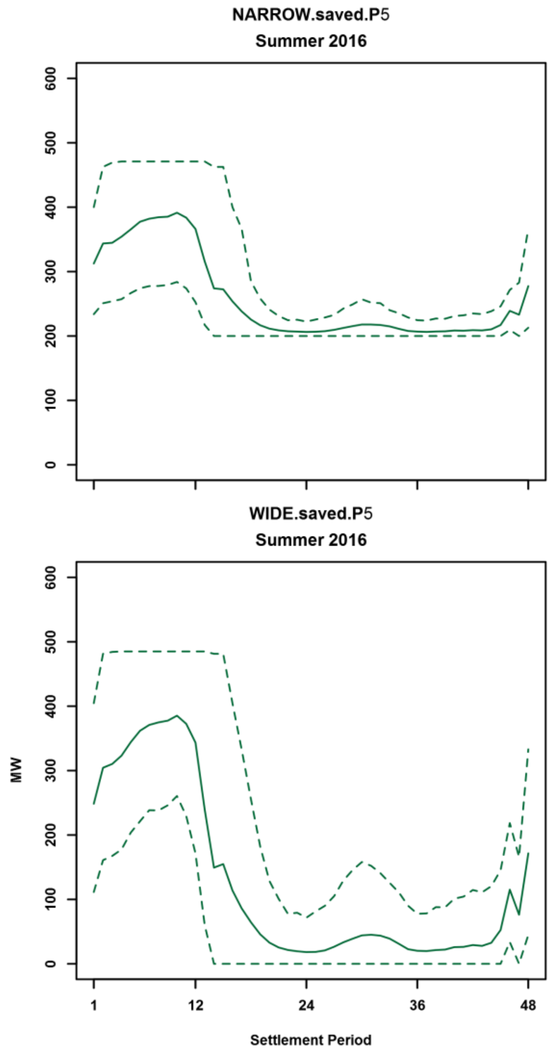


Forecasted Value

Forecasted Value

- Additional value data to be released

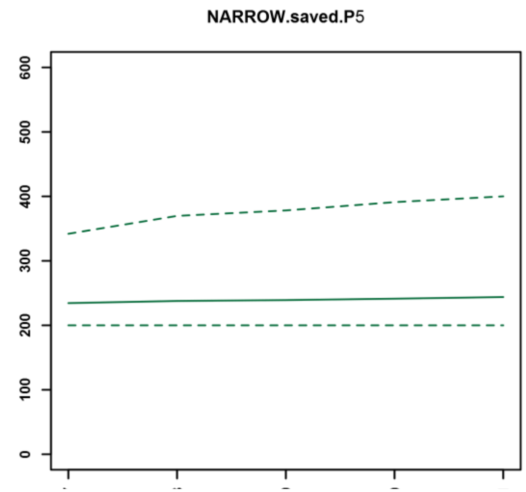
- Enable prospective participants to see when EFR delivers most value, for example:
  - Summer vs Winter
  - (Wide) Service 1 vs (narrow) service 2

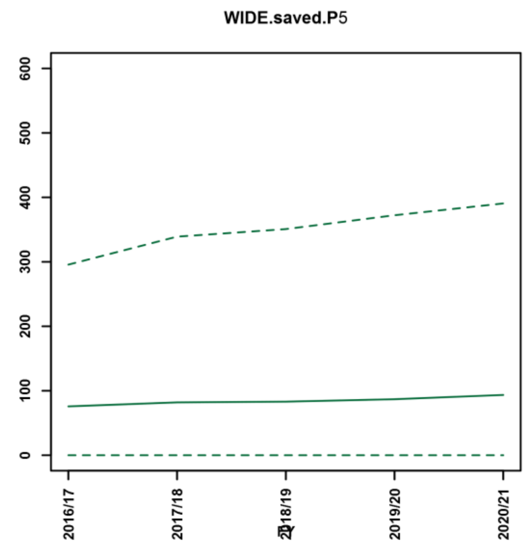


Forecasted Value

- Additional value data to be released

- Enable prospective participants to see when EFR delivers most value, for example:
  - Summer vs Winter
  - (Wide) Service 1 vs (narrow) service 2
  - Now vs Future





Questions?

Tendering Process

Adam Sims

nationalgrid

Overview

- Tender window
- Bid Bond
- Assessment process
- Notification of results

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Tender Window

- The tender process will be run on a web platform (Ariba)
- The web platform will be open from 08:00 11th July to 17:00 15th July
- Each pre-qualified party will be sent a unique log-in ID and password prior to the tender
- Parties will be able to upload
  - Stage 1 assessment documents
  - Stage 2 assessment spreadsheet

Stage 1 Assessment Documents

- These must be in .pdf format in a single combined document
- Where criteria cannot be met, this should be highlighted and reasons why provided
- If all the documents are not provided, NGET may reject the tender

Bid Bond

- Bid Bond will be £2k/MW per site location
- Bonds must be per site to allow NGET to draw down only on bonds for failing sites
- Multiple service bids from the same site do not require additional funds to be posted
- Parent Company Guarantee is no longer an option, the bond must be cash/letter of credit from a financial institution
- The form of the bond may be in the standard form of the relevant bank or insurance company, but must be on demand and in a form acceptable to NGET

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Bid Bond

- Bonds for unsuccessful tenders will be returned on the contract award date
- Successful bonds will be held until Commercial Operations Date (COD), and bonds must be valid for 18 months from the
- Bonds will be called on in three situations:
  - Failure to meet Conditions Precedent in the contract by the Long Stop Date
  - Failure to pass the Post Tender Milestone Test
  - Failure to pass the Proving Test by the Long Stop Date

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Stage 1 Assessment Documents

- Company Name
  - A successful contract will be formed between NGET and the company whose details are provided
  - Only one contract can be formed per pre-qualified party
  - Certificate of Incorporation is provided by Companies House upon application
  - Successful contracts may be novated to SPVs with NGET’s agreement

Stage 1 Assessment Documents

- Site location
  - Demonstrate that you have a chosen site
  - Provide details of the site(s): grid ref, map (site diagram with connection point, ELD if available), MPAN

- Land Rights
  - This can be through a variety of ways: MOU with landowner, option to lease, outright ownership
  - Any parties must use reasonable endeavours to agree a contract, after a successful tender
  - Needs to match Company Name or demonstrate relationship

Stage 1 Assessment Documents

- Connection offer / agreement
  - Evidence of a connection offer or agreement
  - Connection date must be earlier than 18 months from contract award
  - Connection application may be provided, but any award will be a condition precedent and must be demonstrated by the Post Tender Milestone Test
  - Connection agreement (BCA, BEGA, etc.) must demonstrate that sufficient capacity is available for the EFR service, and no restrictions are in place
  - This needs to match the tendered MW, site location(s), and Company Name (or demonstrate relationship)

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Stage 1 Assessment Documents

- Construction contract
  - Demonstrate EPC / OEM contract or bids received
  - This needs to match the tendered MW values, site locations, backstop date and Company Name (or demonstrate relationship)
- Programme of Works
  - This should be from the EPC contractor or bidding process
  - Identifying key milestones, risks and mitigations
  - For DSR, this should be a growth plan

Stage 1 Assessment Documents

- Financing
  - Demonstration through board minutes or specific letter of intent from the funding party
  - This cannot be a generic funding agreement
  - This needs to match the tendered MW, site location(s) and Company Name (or demonstrate relationship)

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Stage 2 Assessment

EXAMPLE

Company Name	Tendered Unit (BMU/Unit ID)	Type of service	Tender Frames Automatic Completion	Tendered Frames per Service Day - include all 12 months		
				January		
				From (hh:mm)	To (hh:mm)	Duration (h)
Example	EXX1	Service 1 (±0.05 deadband)	24/7 Service	23:00	23:00	24:00
		Service 2 (±0.015 deadband)	24/7 Service	23:00	23:00	24:00
		Select Service Type	Custom			
		Select Service Type	Custom			
		Select Service Type	Custom			
		Select Service Type	Custom			
		Select Service Type	Custom			

Stage 2 Assessment

EXAMPLE

Tendered Price			
Availability Fee (£/h)	Maximum Part Load Point (MW) for storage assets enter 0	Minimum Part Load Point (MW) for storage assets please enter 0	Enhanced Response (max.) @ ±0.5 (MW)
10	100	100	

Notification of Results

- Notification of the assessment results will be published to the industry on the EFR website by 17:00 on 26th August
- This will be in the form of a spreadsheet similar to the Stage 2 assessment form, with additional columns for accepted and rejected
- Contracts will be emailed and posted on this date to successful parties
- The publication date is the contract award date

Questions?

Performance Monitoring

Adam Sims

Performance Overview

- Providers send a monthly report detailing their calculated Service Performance Measure for relevant Settlement Periods in that month
  - Only Settlement Periods within the Service Period are relevant, i.e. your tendered periods of availability
- This will give the Availability Factor to be applied to payment in that Settlement Period

Performance Overview

- NGET check this against metered data provided through the web portal to audit providers’ reports
- NGET will periodically retest delivery of the service to ensure accuracy
- NGET will assess the ASPM monthly based on the previous 12 months Performance Reports

Information Flow

SBSPM

- Second by Second Performance Measure
- Measured every second
- Collared at zero

SPM

- Service Performance Measure
- Average over a Settlement Period

ASPM

- Annual Service Performance Measure
- Average over 12 months

SBSPM Calculation

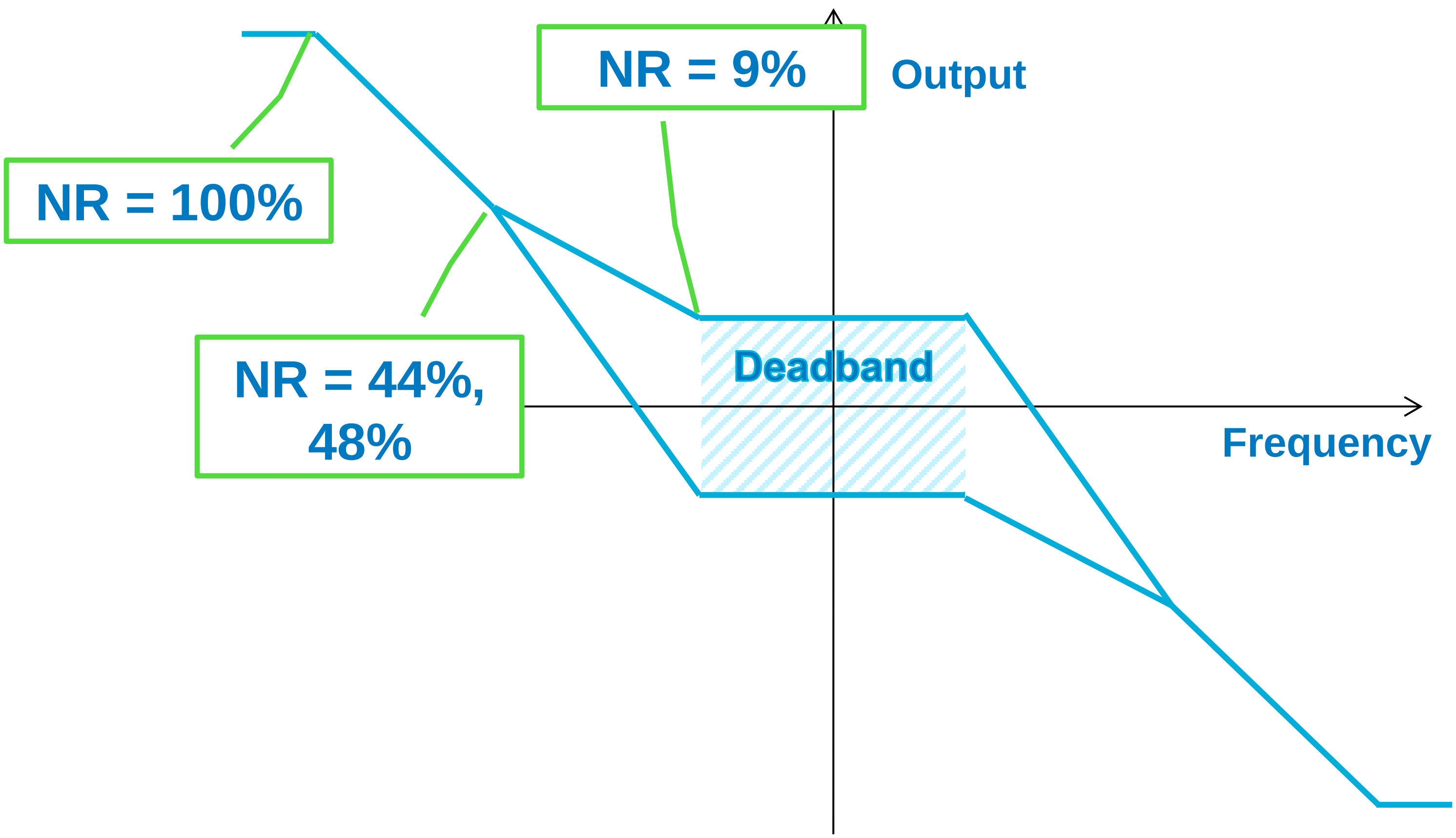
- SBSPM depends on three things:
  - Output of the assets (Actual Response)
  - Contracted Capacity of assets
  - Where the envelope boundaries are

- $$\frac{Actual\ Response\ (MW)}{Contracted\ Capacity\ (MW)} = Normalised\ Response$$

- This is then compared against the envelope boundaries

What is Normalised Response?

- $$\frac{Actual\ Response\ (MW)}{Contracted\ Capacity\ (MW)} = Normalised\ Response$$



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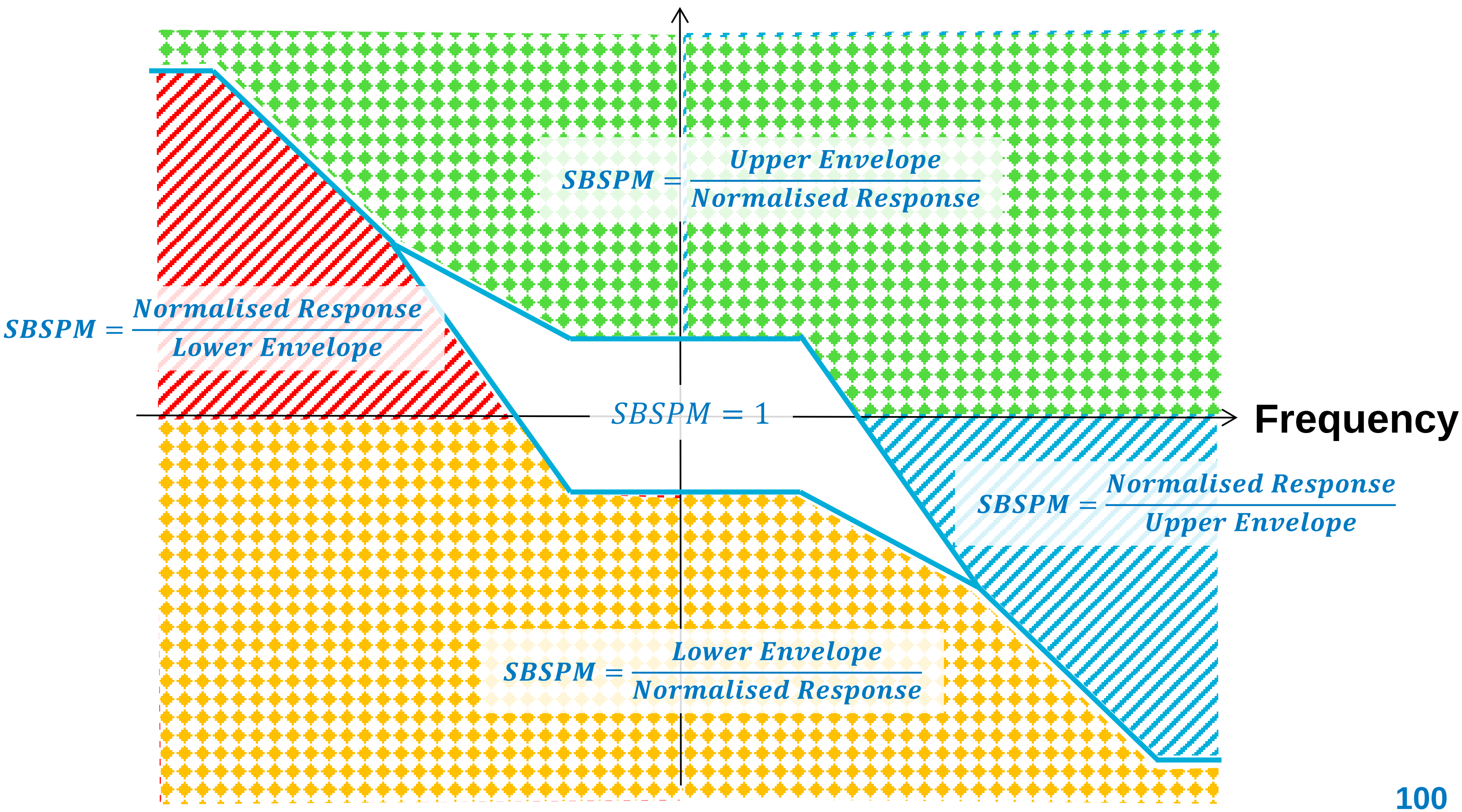
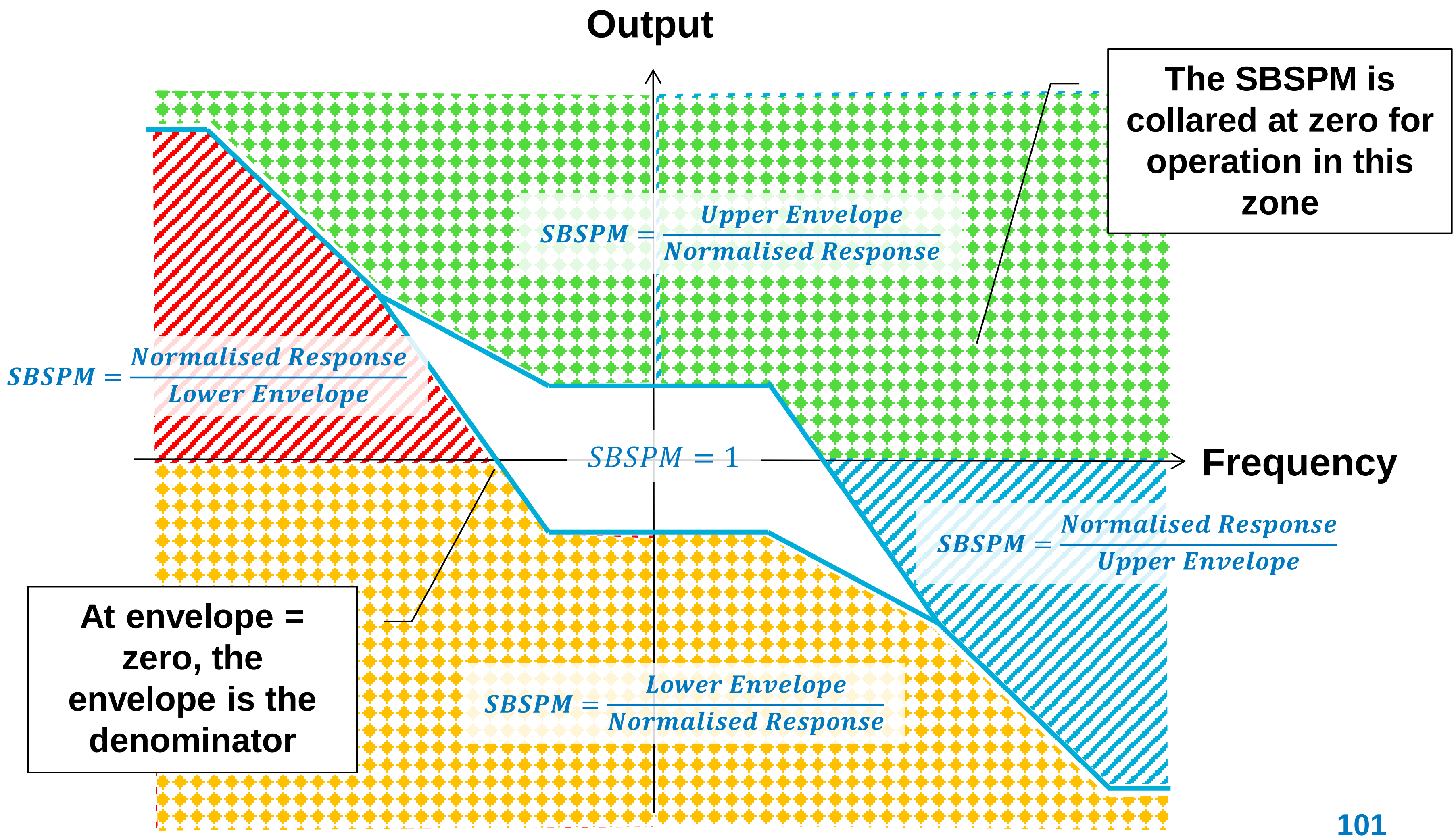
SBSPM Diagram



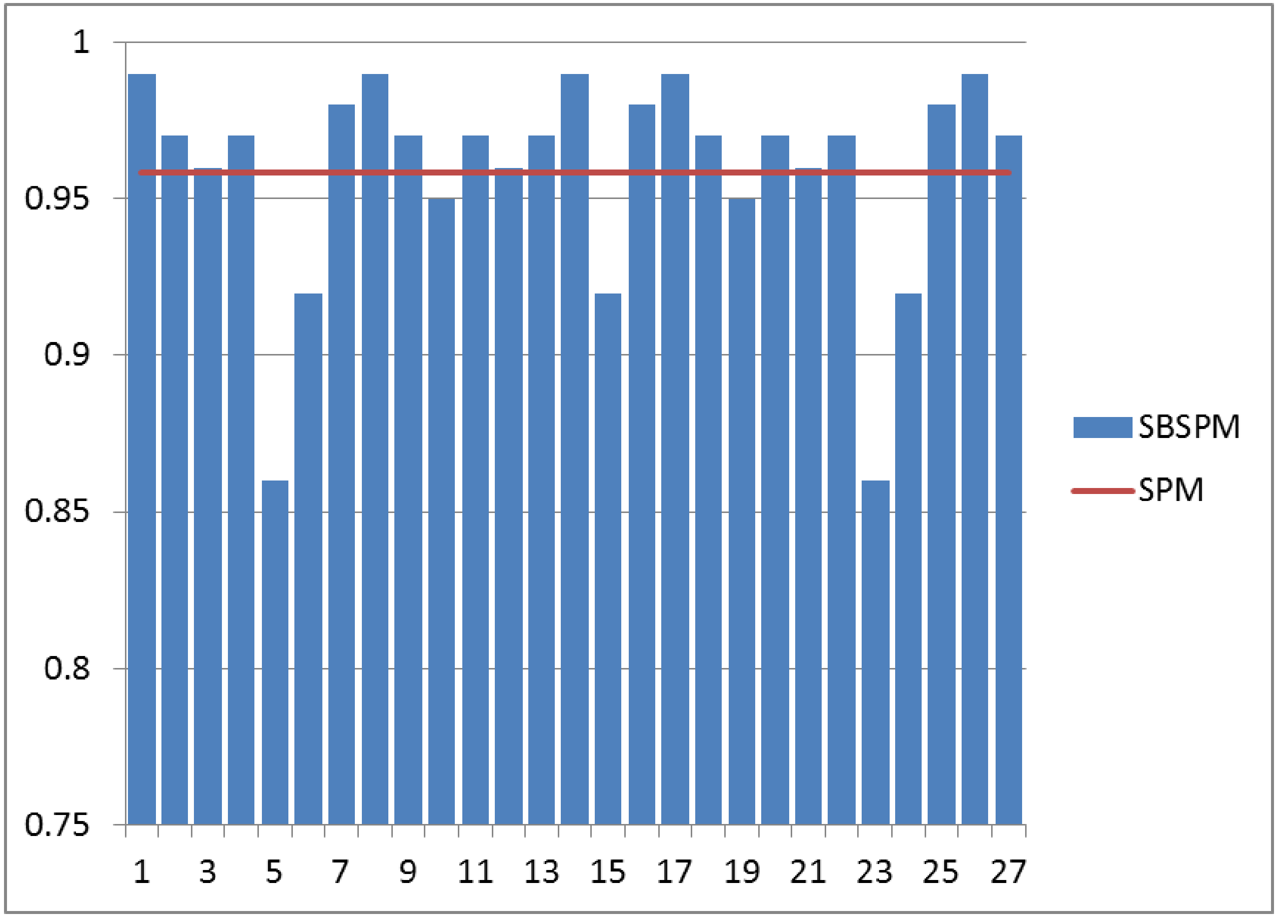
Note this has changed from the ITT

SBSPM Diagram



SPM

- The SBSPM are averaged across a half-hourly Settlement Period to produce the SPM

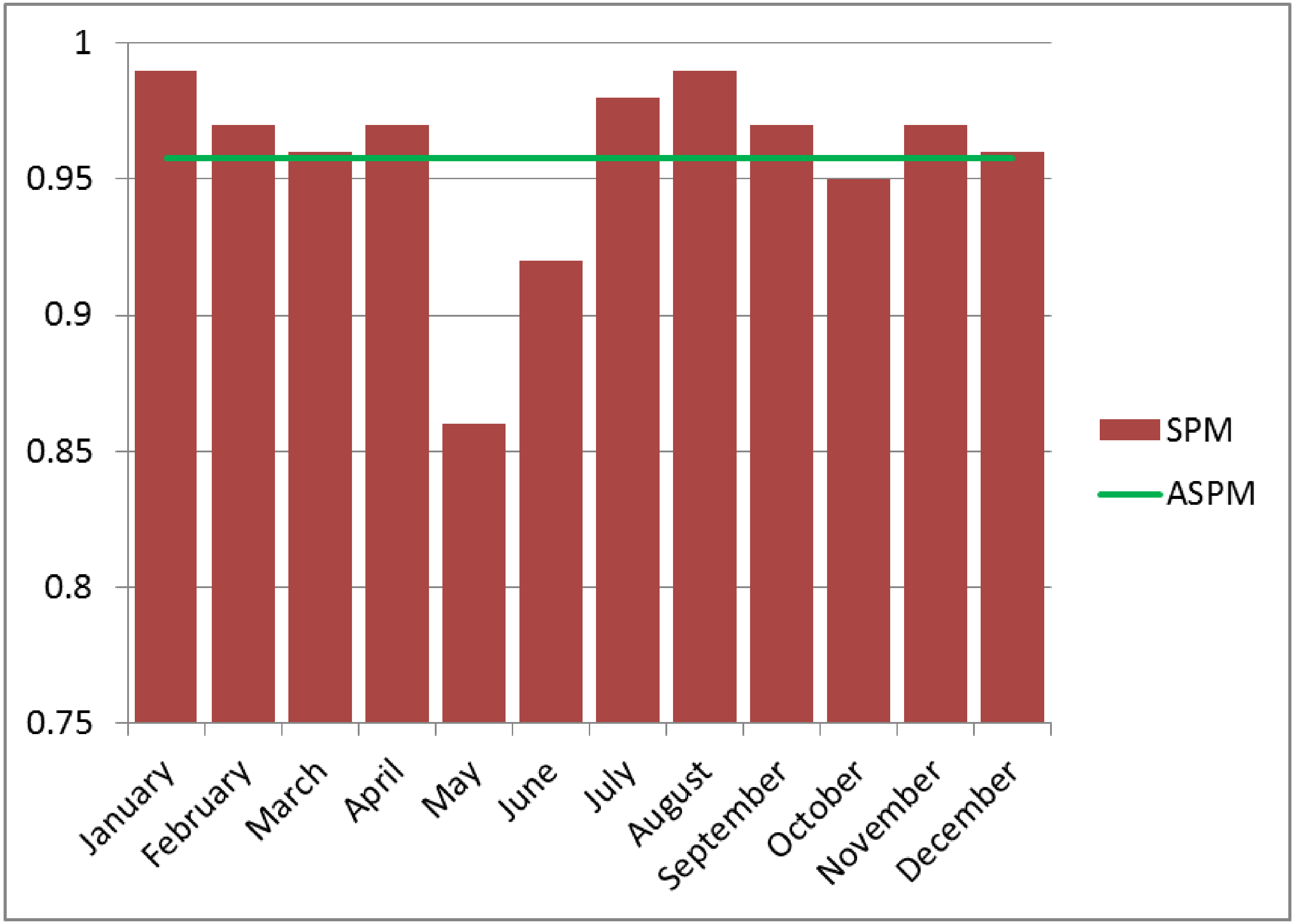


Availability Payment

Service Performance Measure	Availability Factor
<10%	0%
≥10%, <60%	50%
≥60%, <95%	75%
≥95%	100%

$$\boldsymbol{Monthly\ Payment = \sum \frac{Availability\ Rate * Capacity\ * Availability\ Factor}{2}}$$

ASPM


1
0.95
0.9
0.85
0.8
0.75
January
February
March
April
May
June
July
August
September
October
November
December
SPM
ASPM

Questions?

Thank You

Clarifications: commercial.operation@nationalgrid.com