

CONTINUOUS ACCEPTANCE DURATION LIMIT (CADL) REVIEW

MEETING NAME Imbalance Settlement Group

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Purpose of paper For Information

Classification Public

Summary The Continuous Acceptance Duration Limit (CADL) is a pricing parameter used to identify short duration Bid Offer Acceptances (BOAs). These are likely to be associated with system balancing actions, and may be repriced in the Imbalance Price calculation.

CADL has been 15 minutes since its introduction in 2001, although how CADL actions input in to the Imbalance Price calculation changed in 2009.

This review covers the period 1 August 2016 to 31 July 2018, using analysis provided by National Grid (NG). Our findings suggest that the current limit should be 10 minutes.

We invite the Imbalance Settlement Group (ISG) to note this analysis, and offer their views on whether the CADL should change. We will return to the October 2018 ISG meeting with an updated joint CADL and DMAT paper, including the questions for the planned industry consultation.

1. Background information

1.1 The Continuous Acceptance Duration Limit (CADL) flags Bid Offer Acceptances (BOAs) with duration of 15 minutes or less, as these actions tend to be associated with system balancing actions. The Replacement Price may then reprice these CADL flagged actions during the Imbalance Price calculation. Introduced in 2001, the CADL has not changed from the initial 15-minute duration.

1.2 The Balancing and Settlement Code (BSC), Section T, 1.9 states that:

1.9.1 For the purposes of the Code, the "Continuous Acceptance Duration Limit" (CADL) shall be 15 minutes or such other amount (in minutes) determined by the Panel and approved by the Authority.

1.9.2 The Panel may revise such amount from time to time subject to the approval of the Authority.

1.9.3 In revising the amount of the Continuous Acceptance Duration Limit from time to time, the Panel shall consult with Parties and consider the views expressed in the course of such consultation prior to making its determination (and shall provide a detailed summary of such views to the Authority)

Note that any change to the CADL requires the Panel to consult with BSC Parties before giving its determination and the Authority (Ofgem) will need to approve any change.

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- 1.3 [Modification P217 'Revised Tagging Process and Calculation of Cash Out Prices'](#), implemented in November 2009, altered the operation of CADL in the Imbalance Price calculation. Prior to November 2009, tagged CADL actions were excluded from the Imbalance Price calculation. Since November 2009, CADL actions are flagged and may be repriced using the Replacement Price.
- 1.4 NG's analysis splits all BOAs into two groups: Actions from specific Fast Reserve plants, and actions from all other plants (Non-Fast Reserve). Details of the number and volume of Fast Reserve and Non-Fast Reserve flagged BOAs, and covered the period 1 August 2016 to 31 July 2018 (referred to as the analysis period), split into two annual periods (see attachments ISG209/02A and ISG209/02B for NG reports).

2. [National Grid Analysis of CADL \(2016 – 2018\)](#)

- 2.1 When reviewing the CADL, ELEXON request NG provide detailed analysis of energy and system balancing actions for the previous two years.
- 2.2 Their methodology defines plants that offer Fast Reserve actions as those which match, individually or as a group, the following minimum criteria:
 - Initial ramp rate is greater than or equal to 25 MW/min; and
 - BOA size is greater than or equal to 50 MW; and
 - Start point is greater than or equal to the unit's Stable Export Limit (SEL), unless it is a hydro or open cycle gas turbine (OCGT) station.
- 2.3 The Transmission Company provided analysis on the volume flagged by CADL in the Energy Imbalance Price calculation, defining if it was considered as either Fast BOAs volume or Non-Fast BOAs volumes. During the review period, five Hydro power stations accounted for 94.8% of Fast Reserve BOAs, with 14 Gas power stations accounting for the remaining 5.2%.¹
- 2.4 The analysis includes modelling the flagging of actions at various durations of CADL. The aim is to find the most appropriate level of CADL, where the largest numbers of Fast Reserve BOAs are flagged, whilst leaving other actions unflagged. NG's analysis is included as Attachment A (2016-17) and Attachment B (2017-2018).
- 2.5 Table 1, based on the analysis provided by NG, shows how the Fast and Non-Fast BOAs Reserve Volumes flagged differ across varying CADL time values for period 1 August 2017 to 31 July 2018 (note period 1 August 2016 to 31 July 2017 is shown in Attachment A). Previous analysis has highlighted that at the current CADL of 15 minutes, the percentage of Fast and Non-Fast Reserve CADL actions has been similar (at around 50% each).

¹ Note there is ongoing investigation by National Grid into the data behind the calculation; however it is not expected to have a material impact on the figure. For the avoidance of doubt, the data issue only affects this figure.

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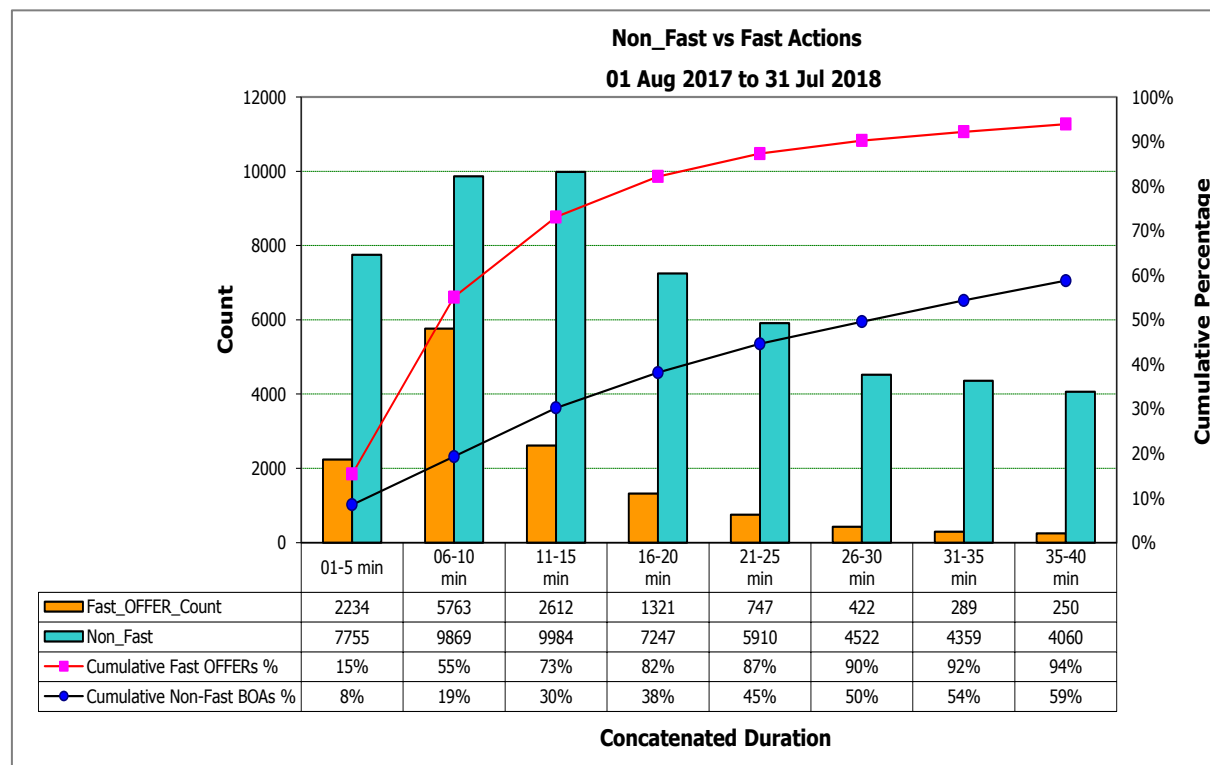
Table 1: Volume of 'Fast' and 'Non-Fast Reserve' BOAs flagged (duration from 10-20 minutes)

CADL FLAGGED BOAs vs TOTAL BOAs (01 Aug 2017 to 31 July 2018)						
Duration (min) (cumulative)	Cumulative CADL Flagged Fast BOAs (MWh)	Cumulative All CADL flagged BOAs (MWh)	CADL Flagged Fast BOAs as % of All CADL flagged BOAs	All CADL Flagged BOAs as % of all BOAs	CADL Flagged Fast BOAs as % of all BOAs	CADL flagged Non Fast BOAs as % of All BM BOAs
(a)	(b)	(c)	(b)/(c)	(d) = (e)+(f)	(e)	(f)
10	94,853	186,548	50.8%	1.2%	0.6%	0.6%
11	109,683	226,778	48.4%	1.4%	0.7%	0.7%
12	121,729	258,058	47.2%	1.6%	0.8%	0.9%
13	131,737	290,220	45.4%	1.8%	0.8%	1.0%
14	142,961	325,363	43.9%	2.0%	0.9%	1.1%
15	153,133	355,795	43.0%	2.2%	1.0%	1.3%
16	162,113	393,384	41.2%	2.5%	1.0%	1.4%
17	171,119	423,436	40.4%	2.6%	1.1%	1.6%
18	178,797	460,769	38.8%	2.9%	1.1%	1.8%
19	187,642	493,597	38.0%	3.1%	1.2%	1.9%
20	194,769	530,039	36.7%	3.3%	1.2%	2.1%

- 2.6 **Table 1** shows that at the current 15 minute CADL, 43.0% of CADL flagged actions are Fast Reserve, with 57.0% classed as Non-Fast Reserve. Only by reducing the CADL to 10 minutes does the percentage of Fast Reserve CADL flagged actions exceed Non-Fast Reserve actions (50.8% vs 49.2%).
- 2.7 Next, NG plotted the count of Fast and Non-Fast BOAs, and showed these as cumulative percentages by time band (**Graph 1**). Increasing the CADL above 15 minutes (for Fast BOAs) leads to the cumulative percentage curve flattening, capturing lower numbers of Fast actions. It also leads to a greater number of non-Fast BOAs being flagged. Therefore, the effectiveness of CADL decreases as the CADL value increases past 15 minutes.

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Graph 1: Graphical representation of the count of 'Fast' and 'Non-Fast Reserve' BOAs concatenated between 1 minute and 40 minutes duration.



2.8 From **Graph 1**, we can conclude:

- The count of 'Fast Reserve' BOAs peaked at 5,763 in the interval 06 – 10 minutes, with the count of Non-Fast Reserve BOAs peaking at 11 - 15 minutes (9,984).
- With a CADL of 10 minutes, 55% of Fast BOAs would be correctly flagged, and 19% of Non-Fast BOAs would be incorrectly flagged as CADL.
- At 11-15 minutes, the percentage of correctly flagged Fast Reserve BOAs rises to 73%; however, the percentage of Non-Fast BOAs incorrectly flagged would rise to 30%.
- The 'Fast Reserve' BOAs decreases rapidly when CADL rises above 10 minutes.
- Increasing the CADL above 15 minutes leads to a much higher number of 'Non-Fast' actions flagged, compared with 'Fast' actions.

2.9 The data provided by the Transmission Company suggests a CADL of between 10 and 15 minutes, with evidence it should be reduced to 10 minutes.

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3. ELEXON Analysis of CADL

3.1 Given the impact changing the CADL could have on Industry, ELEXON undertook further analysis of the CADL. This analysis is shown in Appendix 1, and used data for period 1 August 2016 to 31 July 2018. Our main findings were:

- The percentage of CADL flagged actions, as a proportion of total actions, has consistently been higher for Buy actions. Although the percentage of CADL flagged actions has been consistent over the analysis period, it did peak in March 2017 (see **Graph 3** in the appendix).
- Once the CADL increases above 10 minutes, the volume of Non-Fast BOAs flagged exceeds the volume of Fast BOAs flagged; increasing the CADL above 10 minutes decreases effectiveness.
- When comparing the Cumulative Fast and Non-Fast Reserve actions by duration, the volume of Non-Fast BOAs flagged is higher than the volume of Fast BOAs flagged above 10-minute duration (see **Graph 4** in the appendix). This supports the view that CADL values above 10 minutes decrease the effectiveness of this parameter.
- The volume of flagged Fast Reserve BOAs has decreased slightly from the review in 2016; in contrast, the volume of Flagged Non-Fast Reserve BOAs has increased rapidly (see **Graph 5** in the appendix).
- Over time, the cost of Fast Reserve has increased to above Frequency Response. As actions are chosen based on merit order, it has become more likely for plants offering Frequency Response to be called before plants offering Fast Reserve (see **Graph 6** in the appendix).
- There has been significant increase in BM and Non-BM STOR (see **Graph 7** in appendix).

3.2 As changing the CADL duration will affect the Imbalance Price, the impact of various scenarios (setting the CADL at 0, 10, 12 or 20 minutes) were analysed for both Live and post Nov-18 parameters (see **Tables 4 and 5** in the appendix). We concentrated on changing the CADL from 15 to 10 minutes in duration, using data for period 1 August 2016 to 31 July 2018, and our main findings were:

- Reducing the CADL from 15 to 10 minutes would have resulted in 2.4% of Imbalance Prices changing under both the Live scenario and post November 2018 scenarios. Therefore, Imbalance Prices would remain unchanged in 97.6% of Settlement Periods.
- Where the Imbalance Price would change under the Live scenario, 39.9% of these price changes were within +/- £1/MWh of the original price. For the post Nov-18 scenario, this fell to 30.2%.
- The average price would have increased by £6.30 in the Live scenario (£10.69 post Nov-18), with the maximum change in Imbalance Price being £109.70 (£195.00 post Nov-18).

4. The impact of TERRE and MARI products on CADL

4.1 We have also examined the potential impact of Trans European Replacement Reserve Exchange (TERRE) and Manually Activated Reserves Initiative (MARI) products on the CADL. It appears TERRE will not have an impact, as ELEXON do not use TSO Acceptance Data to calculate volumes, and so it does not have an associated price. As MARI is scheduled to occur from 2022, and is likely to follow a similar process to TERRE, it seems unlikely that it will negatively impact the CADL.

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5. Next step

- 5.1 Our analysis, undertaken with help from National Grid, suggests that the CADL should be changed to 10 minutes duration. We are planning to return to the next ISG (210, scheduled for 23 October 2018) with further analysis, having collated the CADL and DMAT analysis into a joint review.
- 5.2 ELEXON also intend to consult with Industry on any parameter changes, and will undertake a joint consultation on both CADL and DMAT. Therefore we will include the consultation questions we intend to ask for comment with the October 2018 paper.
- 5.3 Depending on the outcome of both ISG meetings, and the Industry consultation, we plan to take a paper to the December 2018 Panel meeting. Note if any changes to parameters are agreed by the Panel, these will need to be approved by the Authority (Ofgem).

6. Recommendations

- 6.1 We invite you to:
 - a) **NOTE** the analysis presented in this paper;
 - b) **RECOMMEND** whether you believe a change should be made to the CADL, and if so to what duration;
 - c) **AGREE** we return to the October 2018 ISG meeting (ISG210) with collated analysis of CADL and DMAT, and a set of suggested questions for the Industry Consultation.

Appendices

Appendix 1 - ELEXON CADL analysis

Attachments

Attachment A – National Grid Electricity Transmission – 2016/17 CADL Review

Attachment B – National Grid Electricity Transmission – 2017/18 CADL Review

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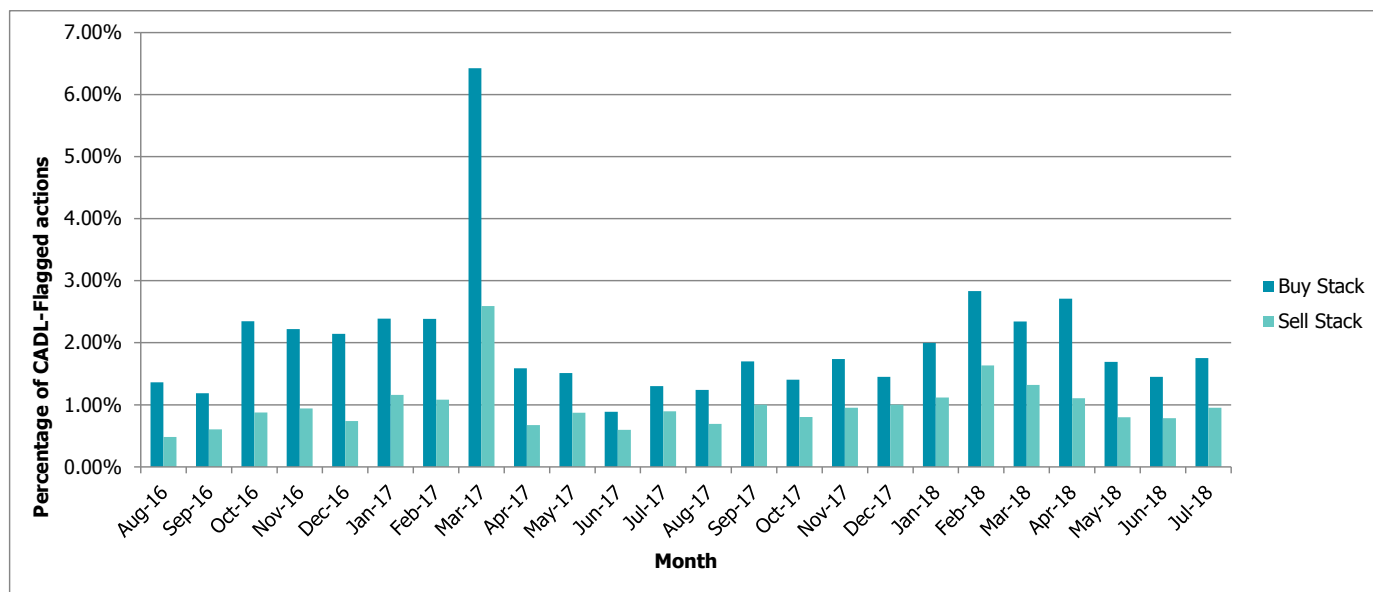
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Appendix 1 - ELEXON Analysis of CADL (1 August 2016 to 31 July 2018)

Historic Data

We have looked at the CADL-Flagged actions as a proportion of all actions (CADL-Flagged, CADL-Unflagged, SO-Flagged and SO-Unflagged actions) for the period August 2016 to July 2018, in order to gain some appreciation for the amount of CADL-Flagged actions. This is summarised in Graph 3 below:

Graph 3: The proportion of CADL-Flagged actions as a percentage of all actions for 1 August 2016 to 31 July 2018.



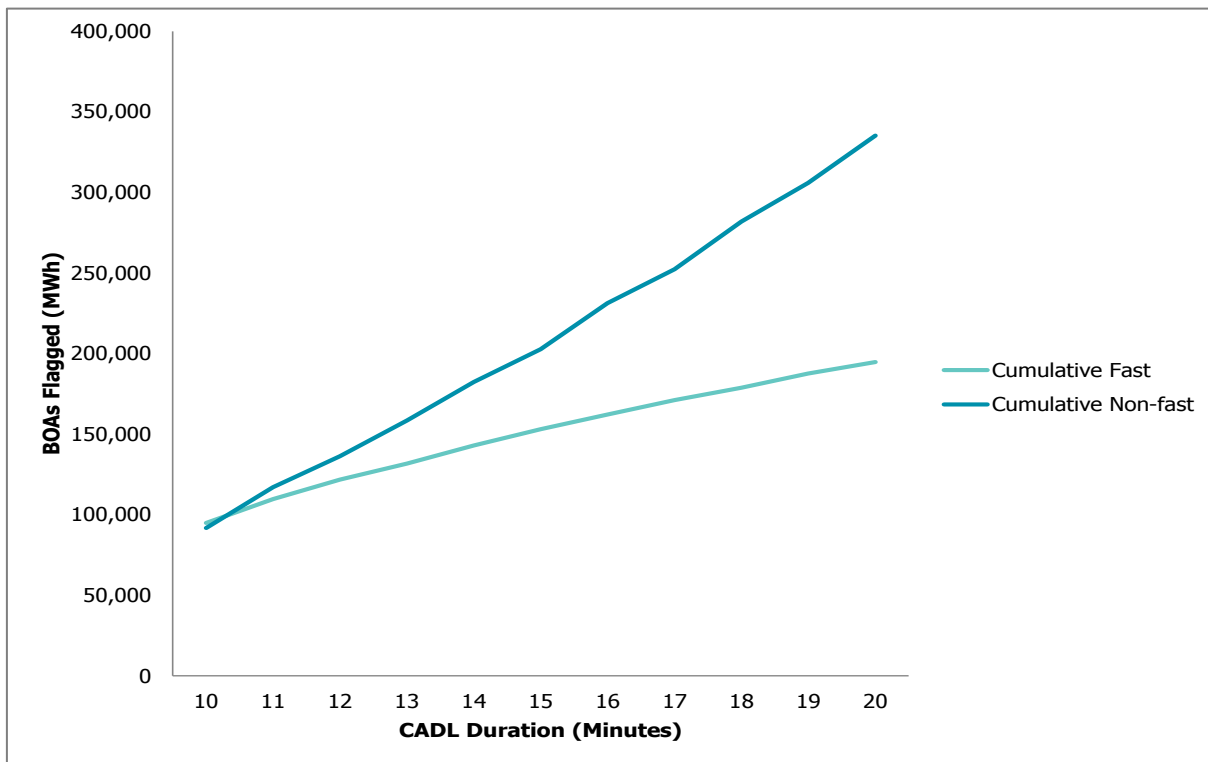
As can be seen the proportion for both the buy and sell stack peaked in March 2017 of 6.42% and 2.59% respectively. More recently, the proportion has stayed relatively constant.

ELEXON analysis using National Grid data

Using the data from **Table 1**, a graphical representation of the Cumulative Fast and Non-Fast Reserve actions has been created (**Graph 4**). This shows that once the CADL duration increases above 10 minutes, the volume of Non-Fast BOAs flagged is higher than the volume of Fast BOAs flagged. This implies that CADL values above 10 minutes decrease the effectiveness of this parameter.

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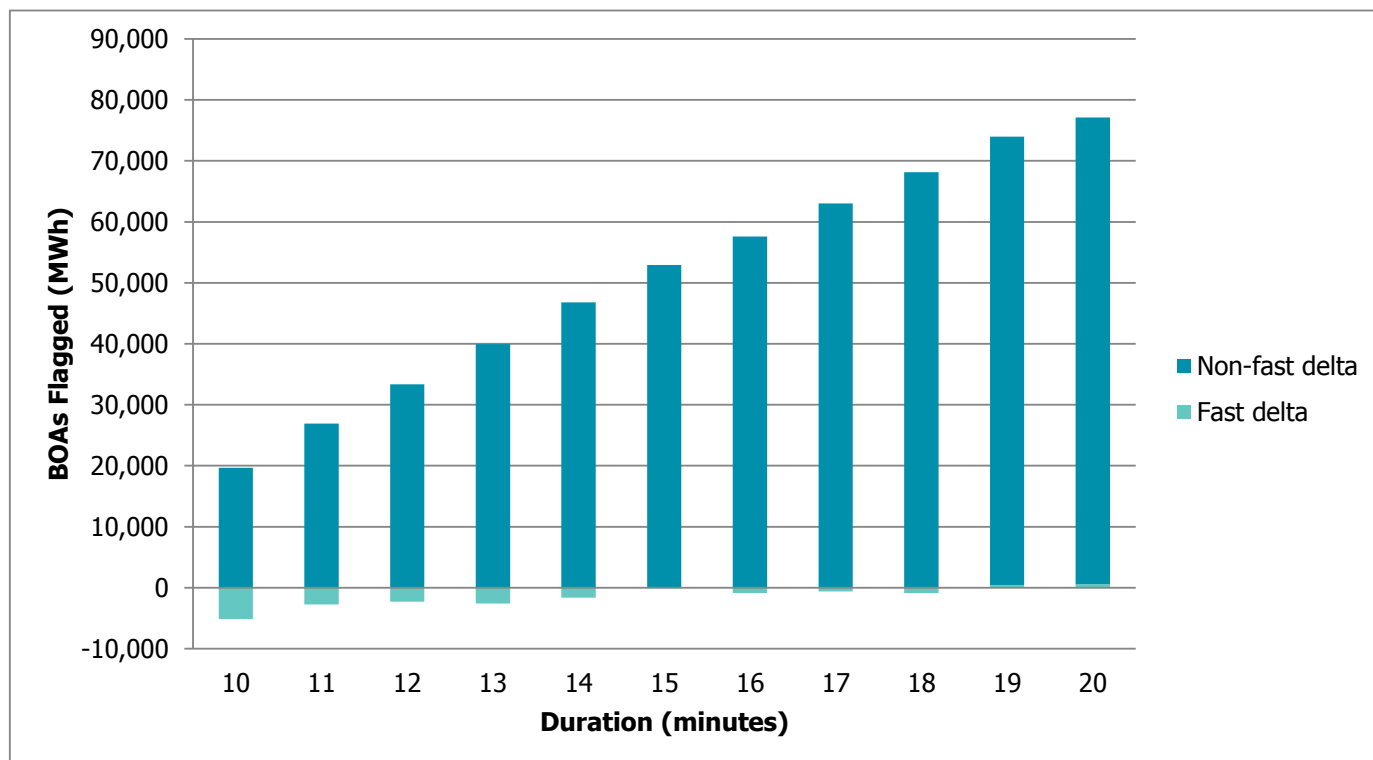
Graph 4: Volume of 'Fast' and 'Non-Fast Reserve' BOAs between 10 and 20 minutes duration.



We have also compared the cumulative Fast and Non-Fast Reserve data for this analysis period with the data used in the 2016 review (2016 review based on data 1 August 2014 – 31 July 2016), for a CADL duration of between 10 and 20 minutes (**Graph 5**).

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Graph 5: The cumulative difference of Fast Reserve and Non-Fast Reserve, for 2018 versus 2016 review.



This analysis shows that whilst the flagged volume of Fast Reserve BOAs has decreased slightly from the review in 2016, the volume of Flagged Non-Fast Reserve BOAs has increased rapidly. At the current 15-minute CADL level, there are 52,788 more flagged Non-Fast BOAs in the 2018 review than there was in the 2016 review, whilst the number of Fast BOAs has fallen by 133.

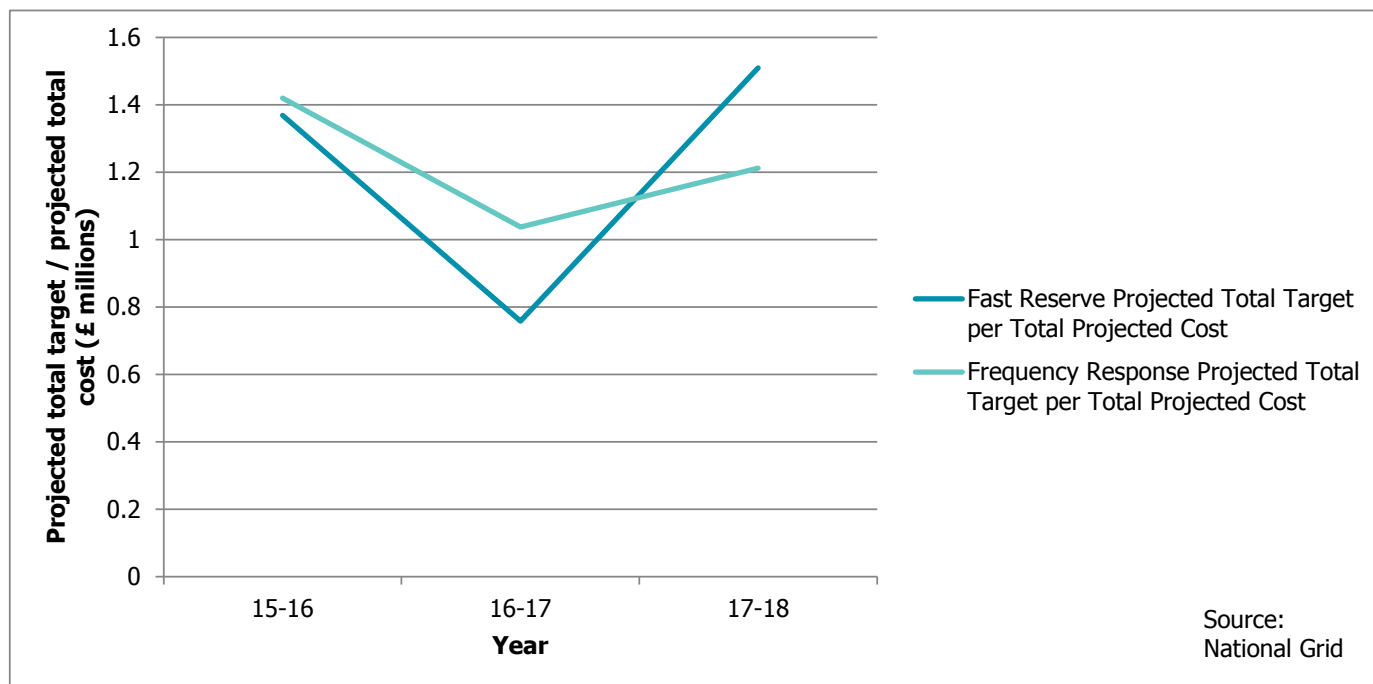
Cost Analysis

Using data provided by National Grid and their Monthly Balancing Services Summary (MBSS) documents for the period 2015/2016 to 2017/2018, ELEXON carried out a cost analysis of BM Frequency Reserve against Fast Reserve to gain an understanding of the possible commercial positioning going forward. Operationally, these two BM services can be utilised alternatively to manage peak periods and correct frequency deviations due to generation shortfalls or demand ramp.

Graph 6 shows the projected total target (i.e. the budget for the year per projected unit cost). This highlights that over time, Fast Reserve has become more expensive to utilise than Frequency Response. As actions are dispatched using the "least cost principle of merit order", Frequency Response actions could be more likely to be called than Fast Reserve.

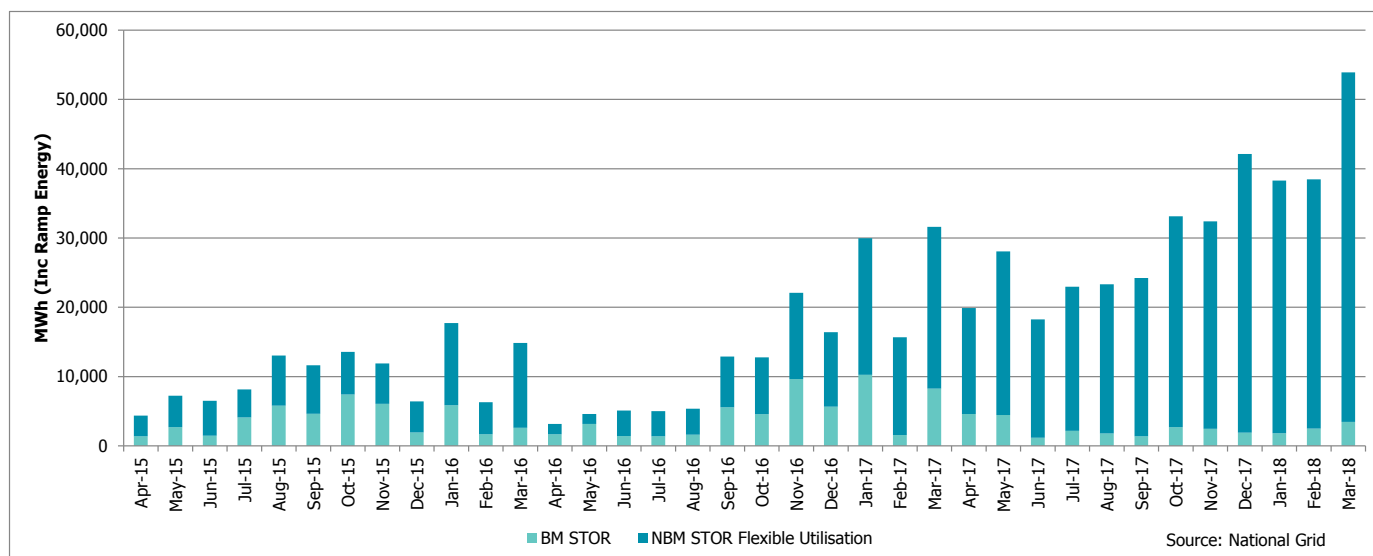
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Graph 6: Projected total target per total unit cost for BM Frequency Reserve and BM Fast-Reserve



Furthermore, there has been significant increase in BM and Non-BM STOR (**Graph 7**). This could explain the reason to the relatively decreased utilisation of Fast Reserve generation units, since the short duration actions that CADL flags could be met by STOR (including Demand-Side STOR).

Graph 7: BM STOR and Non-BM STOR, with Flexible Utilisation



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Analysis of actions CADL-Flagged, but not SO-Flagged

This section looks at the number of CADL-Flagged but not SO-Flagged actions. This allows us to identify those actions that are purely picked up by the CADL mechanism. This has been analysed across various scenarios split into buy and sell actions. The results can be seen in table 3 below (based on data for period 1 August 2016 to 31 July 2018).

Table 3: Actions CADL-Flagged, but not SO-Flagged (where PAR = 50MWh and VoLL = £3,000/MWh)

CADL Value	Count of Buy Actions	Count of Sell Actions
10 minutes	25,345	13,905
15 minutes	52,118	35,405
20 minutes	73,962	55,941

Impact on Imbalance Prices of changing the CADL (under Live and post Nov-18 scenarios)

Table 4 shows the impact on Imbalance Prices to changes in the CADL value. This shows the impact of changing the CADL to 0, 10, 12, and 20 minutes, for both Live and posts Nov 18 scenarios (based on data for 1 August 2016 to 31 July 2018):

Table 4: Number of Imbalance Price changes due to change in CADL (Live and post Nov-18 scenarios)

CADL Scenarios	CADL – Live (Current) parameters				CADL – Nov-18 parameters			
	0 min	10 min	12 min	20 min	0 min	10 min	12 min	20 min
Settlement Periods with change in Imbalance Price	1,524	844	527	736	1,528	848	518	739
% of Total Settlement Periods	4.35%	2.41%	1.50%	2.10%	4.36%	2.42%	1.48%	2.11%
Average Price Change (£/MWh)	£8.85	£6.30	£5.92	£5.56	£17.27	£10.69	£9.97	£8.61
Maximum Price Change (£/MWh)	£142.72	£109.70	£109.70	£77.55	£230.04	£195.00	£189.60	£135.00

Reducing the CADL from 15 to 10 minutes would have resulted in 2.41% of Imbalance Prices changing under the Live scenario, and 2.42% under post November 2018 scenarios. The average price would have increased by £6.30 in the Live scenario (£10.69 post Nov-18), with the maximum change in Imbalance Price being £109.70 (£195.00 post Nov-18).

Table 5 shows how these Imbalance Price changes are spread, by grouping the number of price changes into bands (for both Live and post Nov-18 scenarios).

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Table 5: Frequency analysis of Settlement Periods for period August 2016 to July 2018 (under Live and post Nov-18 scenarios)

		CADL – Live (Current) parameters				CADL – post Nov-18 parameters			
		0 min	10 min	12 min	20 min	0 min	10 min	12 min	20 min
Number of Settlement Periods with an Imbalance Price Change (£/MWh)	< -£20	61	37	20	20	150	68	42	45
	-£20 to -£10	63	33	22	55	75	48	31	60
	-£10 to -£5	56	27	17	73	39	22	16	76
	-£5 to -£1	81	44	32	136	34	22	14	177
	-£1 to £0	47	27	23	307	11	9	6	236
	£0 to £1	365	310	198	27	274	247	159	14
	£1 to £5	313	179	109	40	265	191	119	27
	£5 to £10	207	74	42	21	174	82	43	21
	£10 to £20	204	76	40	29	199	81	47	33
	> £20	130	37	24	28	307	78	41	50
Total of Settlement Periods changing		1,524	844	527	736	1,528	848	518	739
% of Settlement Periods changing		4.35%	2.41%	1.50%	2.10%	4.36%	2.42%	1.48%	2.11%
% of Settlement Periods with change of more than +/- £1/MWh		3.18%	1.44%	0.87%	0.34%	3.52%	1.67%	1.00%	1.38%

Note: Period 1 August 2016 to 31 July 2018 contains 35,040 Settlement Period

Table 5 shows that how Imbalance Prices would vary if the current 15 minute CADL parameter was change to 0, 10, 12 or 20 minutes (under both the Live and post Nov-18 scenarios). For the period 1 August 2016 to 31 July 2018, if the CADL were 10 minutes:

- The Imbalance Price would **not** change in 97.59% of Settlement Periods under the current Live scenario. Of the 2.41% of Settlement Periods where the different Imbalance Price does change, the majority of these see a change of +/- £1/MWh hour (844 Settlement Periods have a different Imbalance Price, with 337 of these within +/- £1/MWh of the current price).
- The Imbalance Price would **not** change in 97.58% of Settlement Periods under the post Nov-18 scenario. Of the 2.42% of Settlement Periods where the different Imbalance Price does change, the majority of these see a change of +/- £1/MWh hour (848 Settlement Periods have a different Imbalance Price, with 256 of these within +/- £1/MWh of the current price).

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We can conclude that, under both the current Live and post Nov-18 scenario, changing the CADL parameter does not change the Imbalance Price in the majority of Settlement Periods. Where the Imbalance Price does change, in most cases the change is small, with the price changing by +/- £5/MWh in only 0.81% of Settlement Periods.

Market Condition reflectiveness

This section considers the difference between the Replacement Price and the Initial price for those actions that have been CADL-Flagged but not SO-flagged. This shows what the CADL actions are repriced to, and whether they are reflective of market conditions.

The averages of the Replacement price minus the Initial Price, for Buy and Sell actions, across different CADL durations, are shown in Table 6 below:

Table 6: Replacement Price minus Initial Price, across different CADL durations.

Average difference (£/MWh)	CADL Duration			
	10 mins	12 mins	15 mins	20 mins
Buy Actions	-£30.06	-£29.16	-£27.95	-£25.23
Sell Actions	£29.40	£21.55	£16.30	£12.47

Where the CADL duration is set to 10 minutes, the flagged Buy actions are (on average) £30.06 more expensive than the Replacement Price, which is used as a proxy to the market conditions (where a replacement price has been applied). For the corresponding Sell actions, these are (on average) £29.40 different. This occurred in 2291 settlement periods.