ISG221-SPAR

REPORTING ON AUGUST 2019

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SYSTEM PRICE ANALYSIS REPORT

The System Prices Analysis Report (SPAR) provides a monthly update on price calculations. It is published by the ELEXON Market Operations Team to the Imbalance Settlement Group (ISG), and on the ELEXON Website ahead of the monthly ISG meeting.

This report provides data and analysis specific to System Prices and the Balancing Mechanism[1]. It demonstrates the data used to derive the prices. The data is a combination of II and SF Settlement Runs.

On 1 November 2018, the second part of Modification P305 went live. This reduced the Price Average Reference (PAR) volume to 1MWh, introduced a 'dynamic' LoLP function and increased the Value of Lost Load (VoLL) to £6,000/MWh.

On the 9 August 2019, a Demand Control Event was initiated due to two power station trips just seconds apart. In this scenario, ELEXON recalculates the System Prices for the affected Settlement Periods. This report details the blackout event in Appendix 1.

1 SYSTEM PRICES AND LENGTH

This report covers the month of August. Where available, data uses the latest Settlement Run (in most cases 'II' or 'SF'). In this report, we distinguish between a 'long' and a 'short' market when analysing System Prices, because the price calculation differs between two scenarios.

When the market is long, System Prices are based predominantly on the System Operator's 'Sell' actions such as accepted Bids. When the market is short, System Prices are based predominantly on the System Operator's 'Buy' actions.

	System Price (Long)				
Month	**Min**	**Max**	**Median**	**Mean**	**Std Dev**
August 2019	-65.93	45.00	23.50	22.11	9.46

	System Price (Short)				
Month	**Min**	**Max**	**Median**	**Mean**	**Std Dev**
August 2019	25.22	110.00	53.93	54.30	9.52

1.1 System Price summary by month (£/MWh)

Table 1.1 gives a summary of System Prices for August, with values shown in £/MWh.

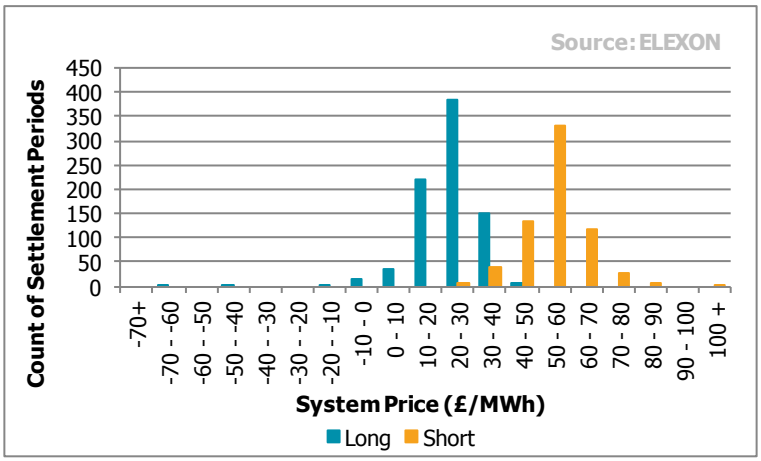
Graph 1.2 shows the distribution of System Prices across Settlement Periods in August 2019 when the market was long and short.

86% of System Prices were between £10/MWh and £60/MWh, regardless of system length. When the system was long, 92% of prices were between £10/MWh and £40/MWh. When the system was short, 88% of prices were between £40/MWh and £70/MWh.

[1] For further detail of the Imbalance Price calculation, see our imbalance pricing guidance: https://www.elexon.co.uk/operations-settlement/balancing-and-settlement/imbalance-pricing/

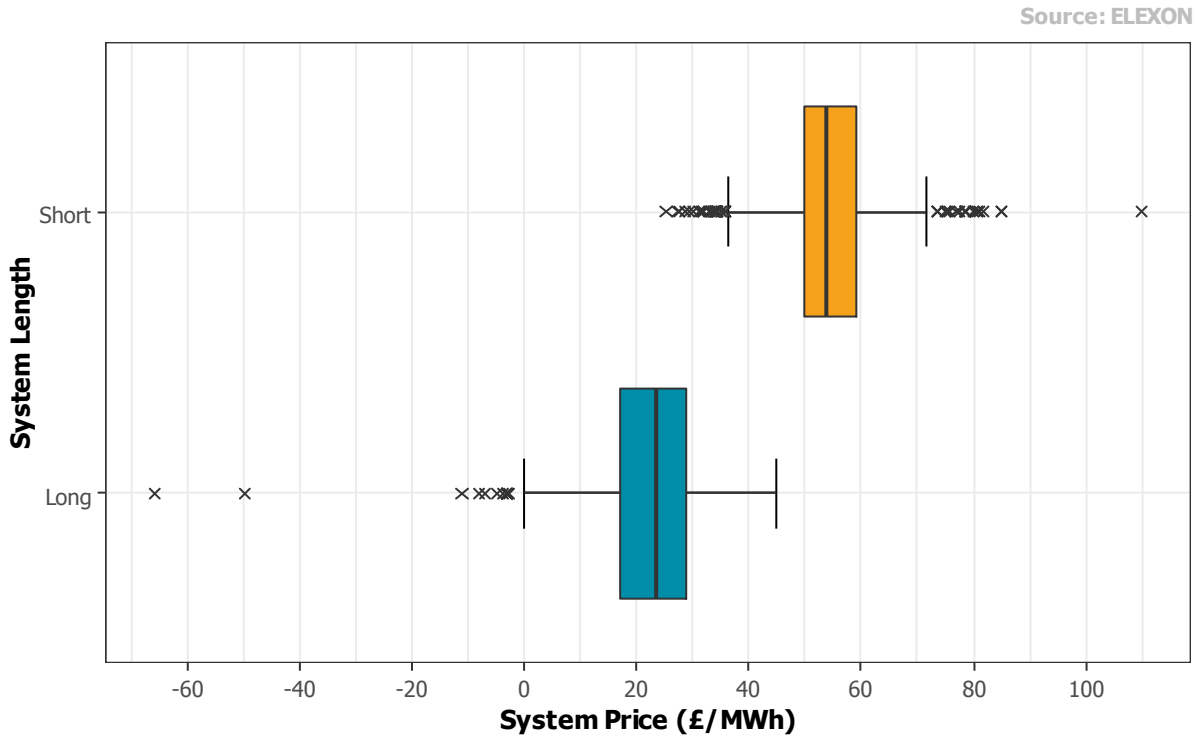
System Prices were £100/MWh or more on one occasion in August 2019, compared to zero times in July. The highest System Price of the month, £110.00/MWh, occurred in Settlement Period 17 on 1 August 2019. This price was set by five Offers from a Pumped Storage BMU, all priced at £110.00/MWh.

There were 17 Settlement Periods where the System Price was less than £0/MWh in August, with the lowest System Price of -£65.93/MWh occurring in Settlement Period 35 on 31 August. The price was set by 10 Bids from five different BMUs, all priced at -£65.93/MWh. All the negative System Prices occurred in the last two days of August 2019, with 10 occurring in consecutive half hours on 30 August between Settlement Period 2 and 11.



1.2 Frequency of System Price spread over the last month

Graph 1.3 displays the spread of System Prices in August 2019 as a box plot diagram, split between a short and long system. The middle line in each box represents the median System Price of the month, which is £53.93/MWh for short Settlement Periods and £23.50/MWh for long Settlement Periods. Each box edge represents the Lower and Upper quartiles (25th and 75th percentile respectively), with the Interquartile Range (difference between the Upper and Lower quartiles) being £9.26/MWh for short System Prices and £11.91/MWh for long System Prices.



1.3 System Price spread over the last month

Outliers are shown on the graph as crosses, and have been defined as being greater than 1.5 times the Interquartile Range (IQR) away from the Upper and Lower quartiles. Under this definition, 15 long and 61 short System Prices in August were outliers. Of the 15 long outliers, all were less than the lower outlier boundary.

The prices of Long outliers ranged from -£65.93/MWh (the lowest System Price of the month) to -£2.91/MWh. The highest System Price of the month, £110.00/MWh, was more than double the median short System Price for the month.

Graph 1.4 shows daily average System Prices over the last month. In August, the average System Price was £22.11/MWh when the system was long and £54.30/MWh when the system was short.

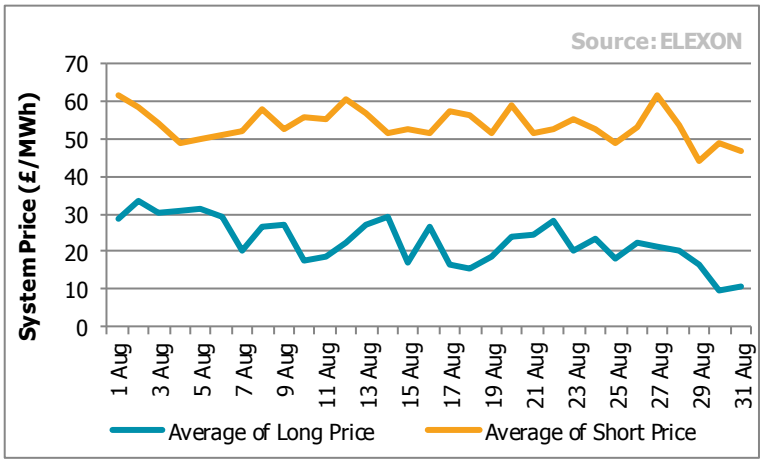
The highest daily average price when the system was short was £61.83/MWh, and occurred on 27 August. The system was short for 42 Settlement Periods.

The lowest daily average price when the system was long was £9.72/MWh on 30 August. The system was long in 29 Settlement Periods on this day.

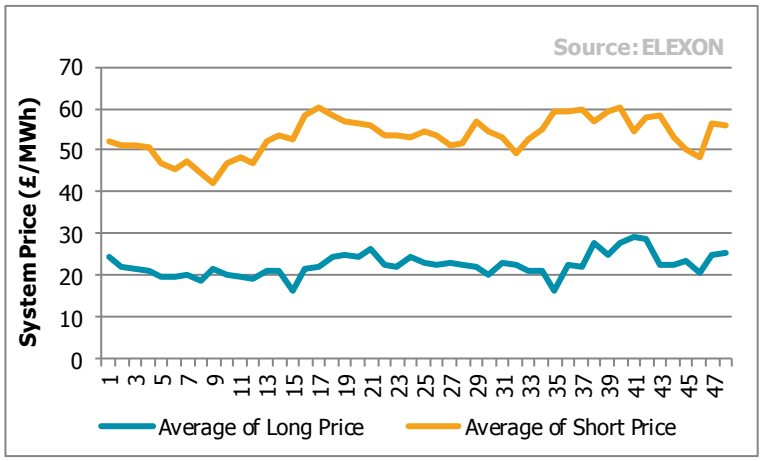
Graph 1.5 shows the variation of average System Prices across the day. Short prices were highest in Settlement Period 40, with long prices lowest in Settlement Period 15.

The lowest average System Price, regardless of market length, occurred during Settlement Period 6, when the System Price was £25.61/MWh.

The daily average long Settlement Period System Prices ranged between £16.40/MWh and £29.15/MWh. Average short Settlement Period prices varied from £42.13/MWh to £60.47/MWh.



1.4 Daily average System Price over the last month

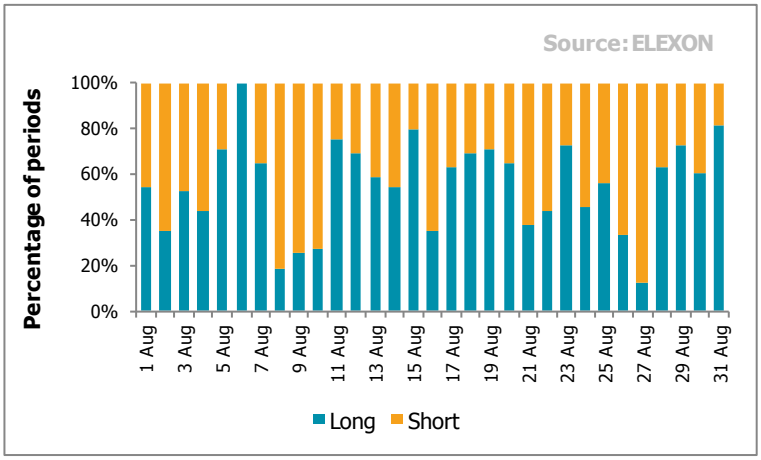


1.5 Average System Price by Settlement Period over the last month

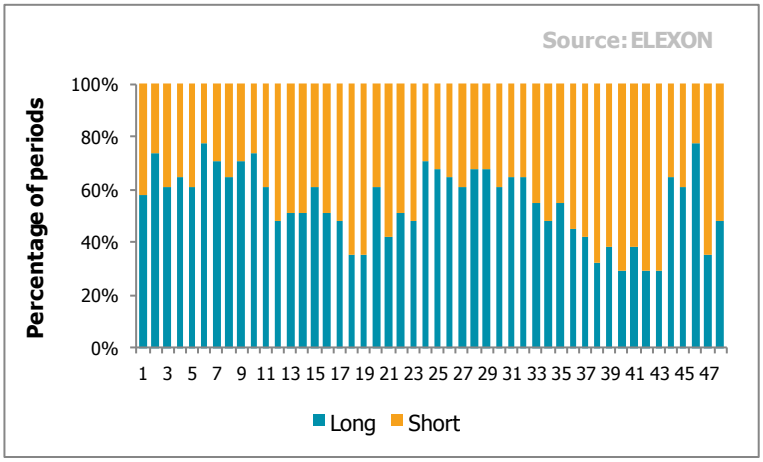
Graph 1.6 shows system length by day, and **Graph 1.7** shows system length by Settlement Period for August. The system was long for 55% of Settlement Periods in August.

On 6 August, the system was long for every Settlement Period. The average Net Imbalance Volume (NIV) on this day was -404MWh. The longest NIV on this day (-747MWh) occurred in Settlement Period 26.

Settlement Periods 6 and 46 had the highest number of long Settlement Periods, with 77% of them being long this month.



1.6 Daily system length by day over the last month



1.7 System Length by Settlement Period

2 PARAMETERS

In this section, we consider a number of different parameters on the price. We consider:

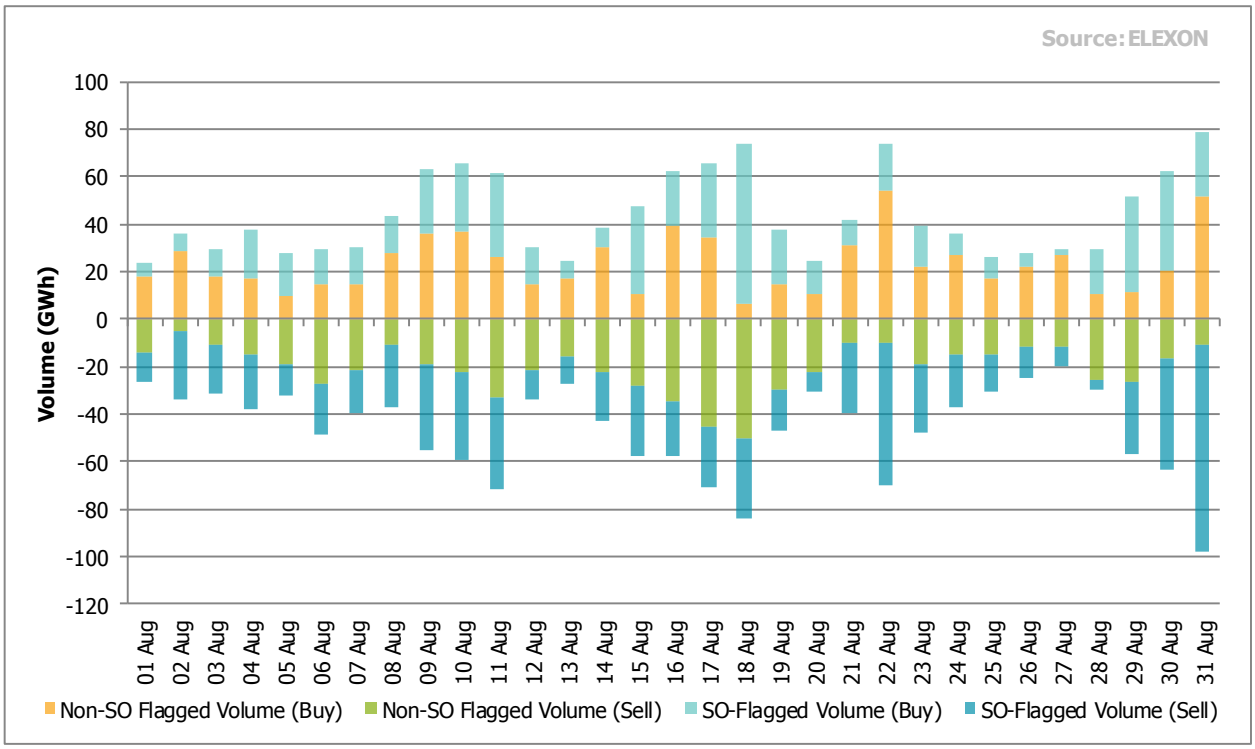
- The impact of Flagging balancing actions;
- The impact of the Replacement Price
- The impact of NIV Tagging;
- The impact of PAR Tagging;
- The impact of DMAT and Arbitrage Tagging; and
- How these mechanisms affect which balancing actions feed into the price.

Flagging

The Imbalance Price calculation aims to distinguish between 'energy' and 'system' balancing actions. Energy balancing actions are those related to the overall energy imbalance on the system (the 'Net Imbalance Volume'). It is these 'energy' balancing actions which the Imbalance Price should reflect. System balancing actions relate to non-energy, system management actions (e.g. locational constraints).

Some actions are 'Flagged'. This means that they have been identified as potentially being 'system related', but rather than removing them completely from the price calculation (i.e. Tagging them) they may be re-priced, depending on their position in relation to the rest of the stack (a process called Classification). The System Operator (SO) flags actions when they are taken to resolve a locational constraint on the transmission network (SO-Flagging), or to correct short-term increases or decreases in generation/demand (CADL Flagging).

Graph 2.1 shows the volumes of Buy and Sell actions in August 2019 that have been Flagged by the SO as being constraint related. On 18 August, 92% of Buy volume was SO-Flagged.



2.1 Daily volume of SO-Flagged/non-Flagged actions over the last month

56% of Sell balancing action volume taken in August had an SO-Flag, compared with 52% last month. 64% of SO-Flagged Sell actions came from Balancing Service Adjustment Actions (BSAAs), 18% from CCGT BMUs and 13% from Wind BMUs. The average initial price (i.e. before any re-pricing) of a SO-Flagged Sell action was -£24.75/MWh.

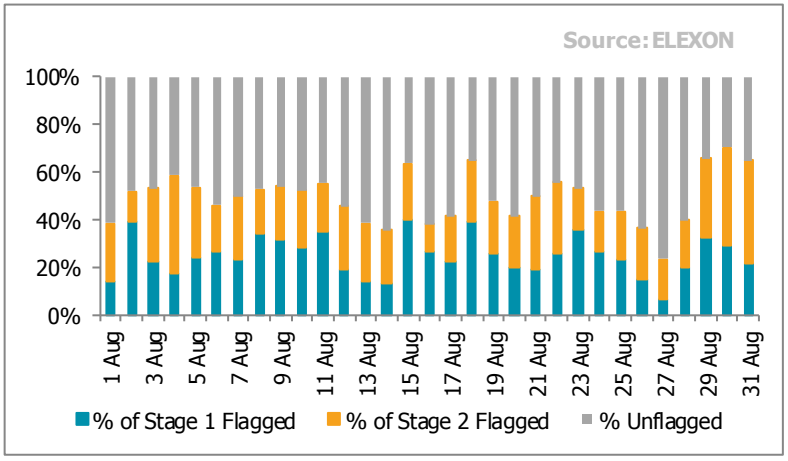
47% of Buy balancing action volume taken in August had an SO-Flag, compared to 39% in July. 50% of SO-Flagged Buy actions came from BSAAs and 48% from CCGT BMUs. The average initial price of a SO-Flagged Buy action was £68.99/MWh.

Any actions with a total duration of less than the CADL are flagged. Since 1 April 2019, CADL has been set at 10 minutes (reduced from 15 minutes).

0.5% of Buy actions and 0.3% of Sell actions were CADL Flagged in August. The majority of CADL Flagged Buy actions (87%), and CADL Flagged Sell actions (77%) came from Pumped Storage BMUs, with CCGT BMUs accounting for a further 8% of CADL Flagged Sell Actions.

SO-Flagged and CADL Flagged actions are known as 'First-Stage Flagged'. First-Stage Flagged actions may become 'Second-Stage Flagged' depending on their price in relation to other Unflagged actions. If a First-Stage Flagged balancing action has a more expensive price than the most expensive First-Stage Unflagged balancing action, it becomes Second-Stage Flagged. This means it is considered a system balancing action and becomes unpriced.

Graph 2.2 shows First and Second-Stage Flagged action volumes as a proportion of all actions taken on the system. Note these are all the accepted balancing actions – only a proportion of these will feed through to the final price calculation.



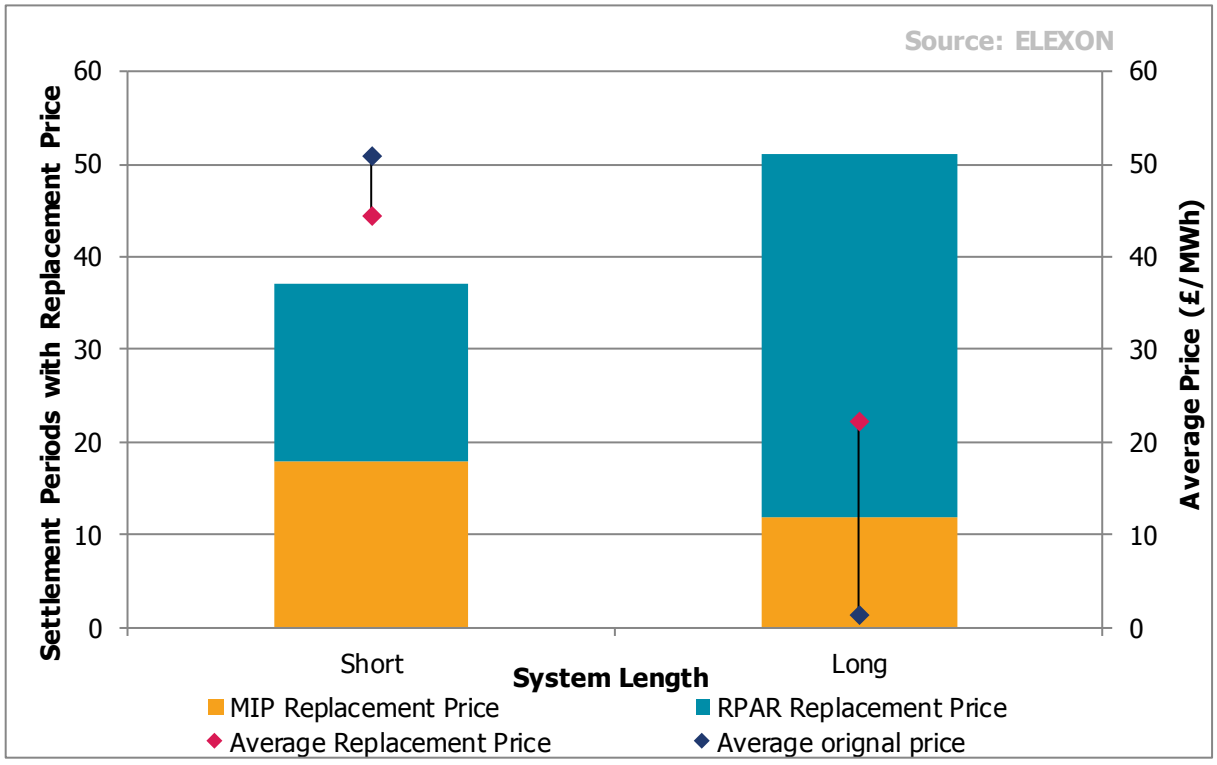
2.2 Flagged Balancing Volumes

In August, an average of 49% of balancing volume received a First-Stage Flag with an average of 50% of this volume going on to receive a Second-Stage Flag. On the 30 August, 70% of balancing volume was flagged; with 58% of this volume receiving a Second Stage Flag.

The Replacement Price

Any Second-Stage Flagged action volumes left in the NIV will be repriced using the Replacement Price. In total, 56% of Sell volume in August were Flagged. Of this Flagged Sell volume, 2% was assigned a Replacement Price.

The Replacement Price is either based on the Replacement Price Average Reference (RPAR currently based on the most expensive 1MWh of Unflagged actions), or if no Unflagged actions remain after NIV Tagging, the Market Index Price (MIP). In August, 58 (4%) Settlement Periods had a Replacement Price based on the RPAR and 30 (2%) Settlement Periods had a Replacement Price based on the MIP. However, the majority of Settlement Periods (94%) did not have a Replacement Price.



2.3 Average Replacement Price, original price of repriced actions and number of Settlement Periods with Replacement Price

Graph 2.3 displays the count of Settlement Periods which had a Replacement Price applied, split by the system length and if the Replacement Price was based on RPAR or the MIP. The graph also displays the average original and Replacement Price of Second-Stage Flagged actions.

Sell actions will typically have their prices revised upwards by the Replacement Price for the purposes of calculating the System Price. The average original price of a Second-Stage Flagged repriced Sell action was £1.43/MWh and the average Replacement Price for Sell actions (when the System was long) was £22.33/MWh.

47% of Buy actions were Flagged; of these Flagged Buy actions, 1% had the Replacement Price applied. Buy actions will typically have their prices revised downwards by the Replacement Price. The average original price of a Buy action with the Replacement Price applied was £50.81/MWh, and the average Replacement Price was £44.38/MWh.

If there are no Unflagged actions remaining in the NIV, the Replacement Price will default to the MIP. This occurred in 12 long and 18 short Settlement Periods in August, compared to 21 long and six short Settlement Periods last month.

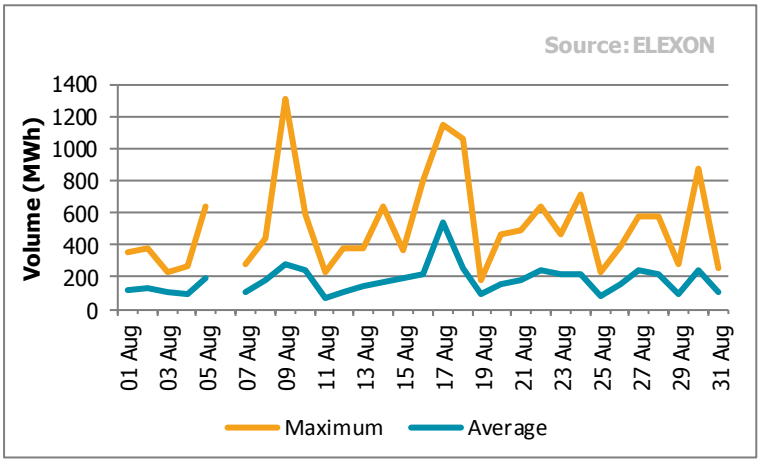
NIV and NIV Tagging

The Net Imbalance Volume (NIV) represents the direction of imbalance of the system – i.e. whether the system is long or short overall. **Graph 2.4** shows the greatest and average NIV when the system was short, and **Graph 2.5** shows the greatest and average NIVs when the system was long. Note short NIVs are depicted as positive volumes and long NIVs are depicted as negative volumes.

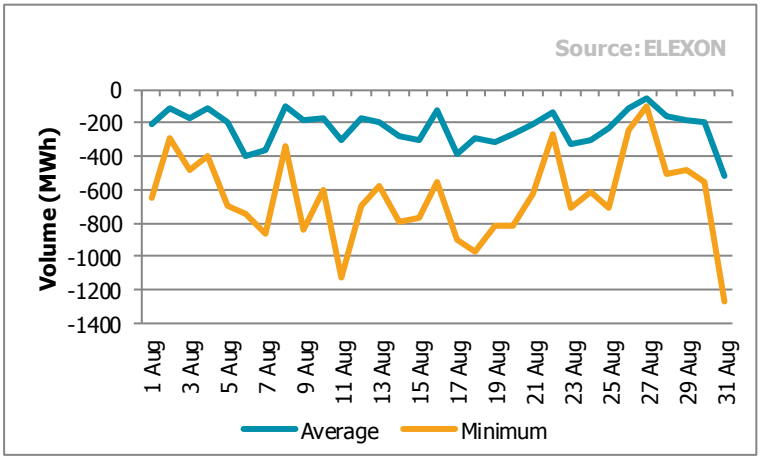
In almost all Settlement Periods, the System Operator will need to take balancing actions in both directions (Buys and Sells) to balance the system. However, for the purposes of calculating an Imbalance Price there can only be imbalance in one direction (the Net Imbalance). 'NIV Tagging' is the process which subtracts the smaller stack of balancing actions from the larger one to determine the Net Imbalance. The price is then derived from these remaining actions.

NIV Tagging has a significant impact in determining which actions feed through to prices. In August, 87% of volume was removed due to NIV tagging. The most expensive actions are NIV Tagged first; hence NIV Tagging has a dampening effect on prices when there are balancing actions in both directions.

The maximum short system NIV of the month (1,303MWh) was seen in Settlement Period 35 on 9 August, where the System Price was £65.00/MWh. Note no data is shown for 6 August as the system was long for every Settlement Period on this day.

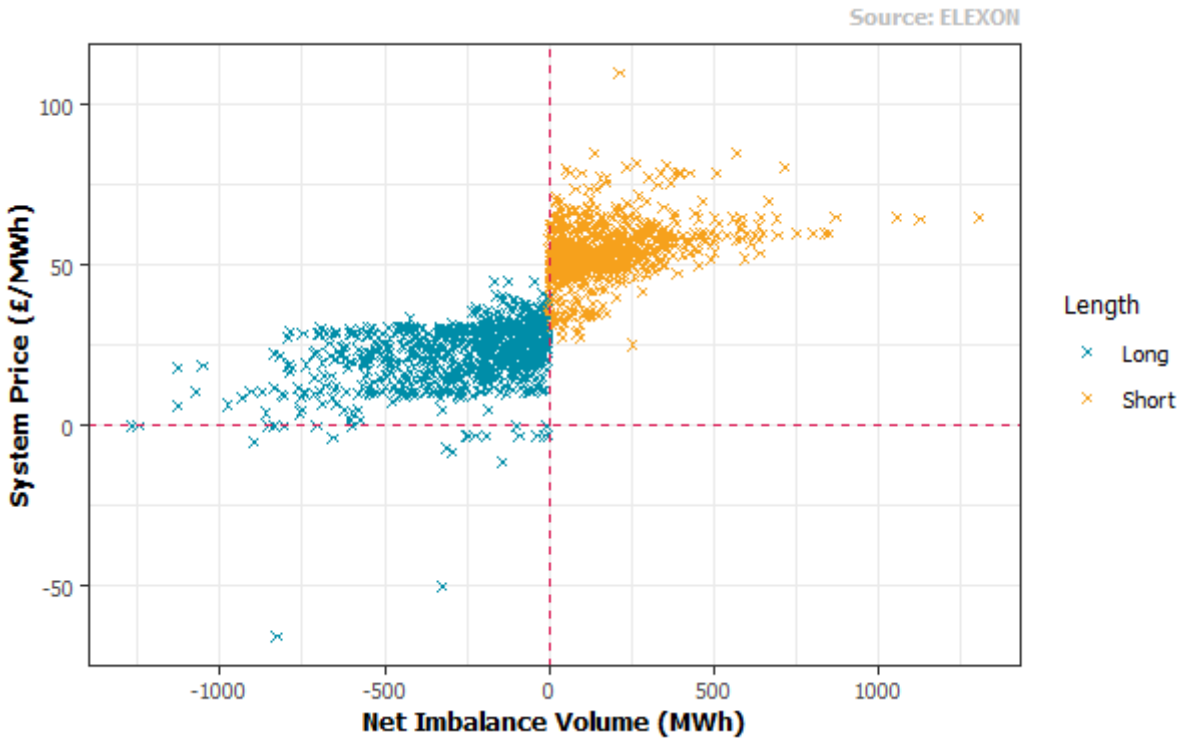


2.4 Short system NIV over the last month



2.5 Long system NIV over the last month

The minimum long system NIV of the month was -1,269MWh, in Settlement Period 31 on 31 August, where the System Price was -£0.05/MWh.



2.6 Net Imbalance Volume and System Price in the last month

Graph 2.6 displays a scatter graph of Net Imbalance Volume and System Prices. The dashed lines display a 0MWh NIV and a £0.00/MWh System Price. There were 820 Settlement Periods with a long (negative) NIV during August. Despite the system being long all day on 6 August, the four lowest NIVs occurred on 31 August from Settlement Period 29 to 32. The average NIV in these four Settlement Periods was -1,179MWh, and the average System Price was £7.15/MWh.

PAR Tagging

PAR Tagging is the final step of the Imbalance Price calculation. It takes a volume-weighted average of the most expensive 1MWh of actions left in the stack. The value of PAR decreased from 50MWh to 1MWh on 1 November 2018 as part of BSC Modification P305.

Following the change of PAR, PAR Tagging is active in almost all Settlement Periods. The only periods not affected by the new parameter have a NIV of less than 1MWh.

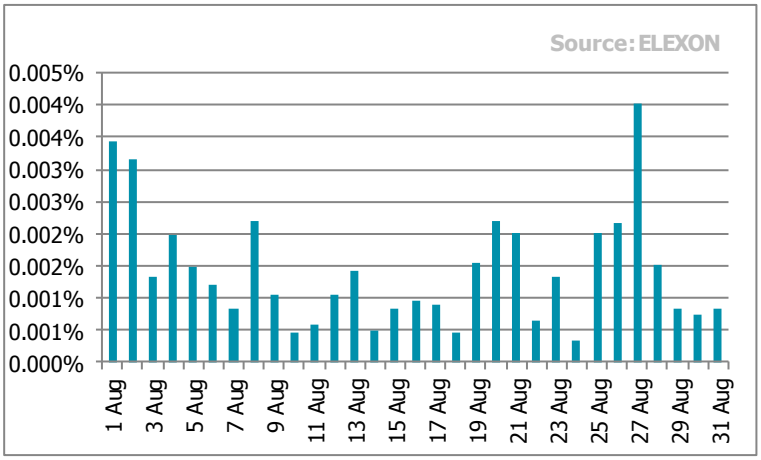
During August, there were five Settlement Periods on five dates where PAR Tagging was inactive. The average NIV in these Settlement Periods was 0.13MWh. Settlement Period 45 on 17 August had the lowest absolute NIV (-0.02MWh), and therefore was the most balanced Settlement Period of the month.

DMAT and Arbitrage Tagged Volumes

Some actions are always removed from the price calculation (before NIV Tagging). These are actions which are less than the De Minimis Acceptance Threshold (DMAT) Tagging or Buy actions which are either the same price or lower than the price of Sell actions (Arbitrage Tagging).

On 1 April 2019, DMAT reduced from 1MWh to 0.1MWh, resulting in less actions being DMAT tagged compared to previous months.

Graph 2.7 shows the volumes of actions removed due to DMAT Tagging. 0.001% of total Buy and Sell volume was removed by DMAT Tagging in August, compared to 0.002% last month. 56% of DMAT Tagged volume came from CCGT BMUs, whilst Other BMUs accounted for 18%.

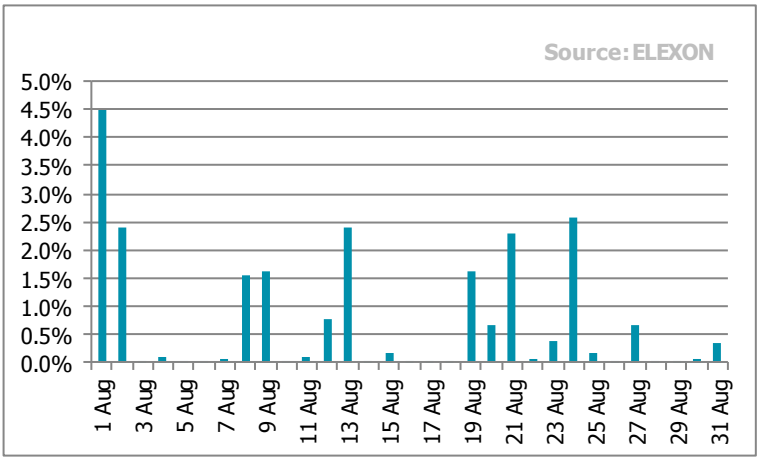


2.7 Daily percentage of DMAT Tagged volume over the last month

Graph 2.8 shows the volumes of actions that were removed due to Arbitrage Tagging. 0.6% of total Buy and Sell volume was removed by Arbitrage Tagging in August. 80% of Arbitrage Tagged volume was from BSAAs, with 17% from CCGT BMUs.

In August, the average initial price of an Arbitrage Tagged Buy action was £21.40/MWh, and for a Sell action was £35.23/MWh. The maximum initial price of an Arbitrage Tagged Sell action was £177/MWh, and the lowest priced Arbitrage Tagged Buy action was -£150.53/MWh.

On 1 August 2019, 2,272MWh of actions were Arbitrage Tagged, representing 4.5% of the daily volume of balancing actions. The average price of an Arbitrage Tagged Buy action was £19.79/MWh, and for a Sell action was £39.06/MWh on this day. 82% of the Arbitrage Tagged actions on this day came from BSAAs and 17% from CCGT BMUs.



2.8 Daily percentage of Arbitrage Tagged volume over the last month

3 BALANCING SERVICES

Short Term Operating Reserve (STOR) costs and volumes

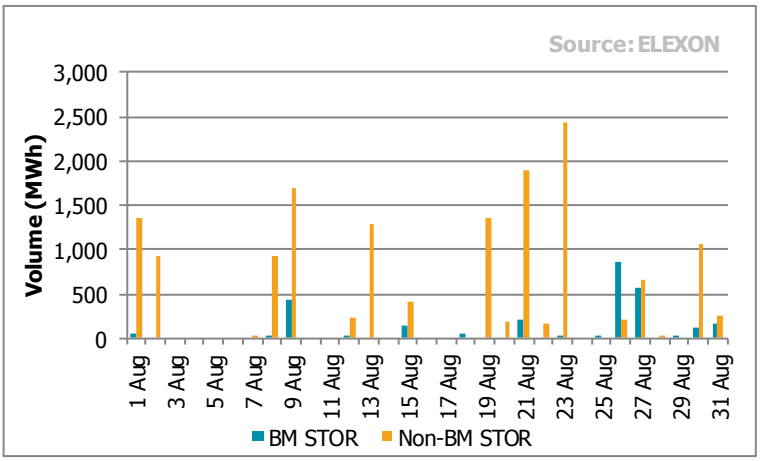
This section covers the balancing services that the System Operator (SO) takes outside the Balancing Mechanism that can affect the price.

In addition to Bids and Offers available in the Balancing Mechanism, the SO can enter into contracts with providers of balancing capacity to deliver when called upon. These additional - sources of power are referred to as reserve, and most of the reserve that the SO procures is called Short Term Operating Reserve (STOR).

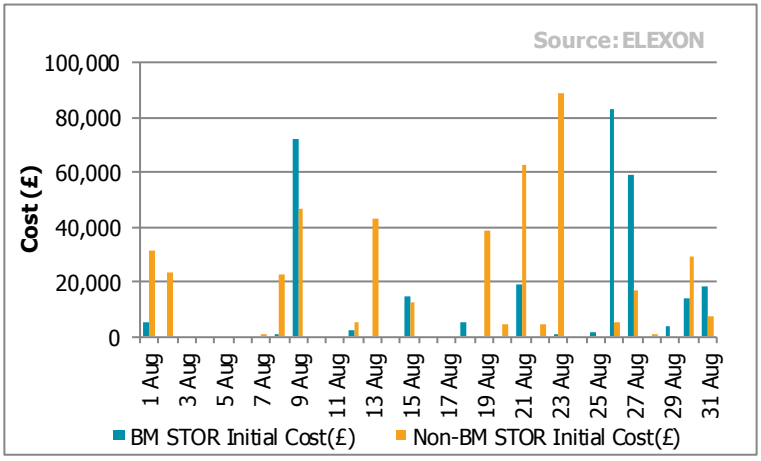
Under STOR contracts, availability payments are made to the balancing service provider in return for capacity being made available to the SO during specific times (STOR Availability Windows). When STOR is called upon, the SO pays for it at a pre-agreed price (its Utilisation Price). Some STOR is dispatched in the Balancing Mechanism (BM STOR) while some is dispatched separately (Non-BM STOR).

Graph 3.1 gives STOR volumes that were called upon during the month – split into BM STOR and non-BM STOR. 85% of the total STOR volume utilised in August came from outside of the Balancing Mechanism.

Graph 3.2 shows the utilisation costs of this capacity. The average Utilisation Price for STOR capacity in August was £42.03/MWh (£113.25/MWh for BM STOR and £29.46/MWh for non-BM STOR).



3.1 Daily STOR vs Non-BM STOR volume across the last month



3.2 Daily STOR vs Non-BM STOR utilisation costs across the last month

On 9 August the largest amount was spent on STOR volume for the month (£119,001), of which 61% of the cost was BM STOR and 39% was non-BM STOR. The utilised BM STOR volume on this day was 423MWh, compared to the average of 86MWh across the month. There was also a Demand Control Event (DCE) on 9 August 2019, which affected Settlement Periods 34, 35 and 36. 20% (336MWh) of the day's non-BM STOR volume was utilised in these three Settlement Periods, accounting for 21% (£10,012) of the daily non-BM STOR cost. Please see this month's appendix for more information.

De-Rated Margin, Loss of Load Probability and the Reserve Scarcity Price

There are times when the Utilisation Prices of STOR plants are uplifted using the **Reserve Scarcity Price (RSVP)** in order to calculate System Prices. The RSVP is designed to respond to capacity margins, so rises as the system gets tighter (the gap between available and required generation narrows). It is a function of **De-Rated Margin (DRM)** at Gate Closure, the likelihood that this will be insufficient to meet demand (the **Loss of Load Probability**, LoLP) and the **Value of Lost Load** (VoLL, set at £6,000/MWh from 1 November 2018).

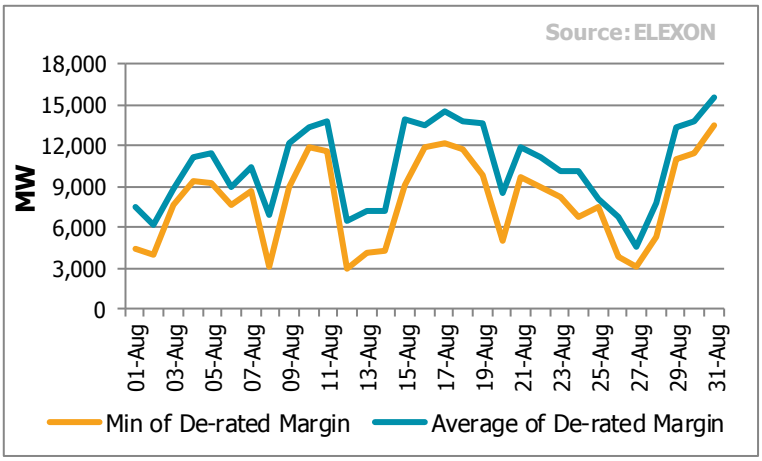
Graph 3.3 shows the daily minimum and average Gate Closure DRMs for August 2019.

The System Operator has determined a dynamic relationship between each DRM and the LoLP[2], which will determine the RSVP.

The minimum DRM in August was 2,919MW on 12 August in Settlement Period 37, compared to 3,073MW in July. This DRM corresponded to a LoLP of 0.0002 and RSVP of £1.05/MWh (see **Table 3.4**).

The RSVP re-prices STOR actions in the Imbalance Price calculation if it is higher than the original Utilisation Price.

In total there were no actions repriced with the RSVP during August. Under a VoLL of £3,000 (the pre-November 2018 scenario), there would have also been zero actions repriced at the RSVP.



3.3 Minimum and average DRMs

3.4 Top 5 LoLPs and RSVPs

Date	SP	DRM	LoLP	RSVP	RSVP Used	System Length	System Price
12/08/2019	37	2,919.32	0.0002	**1.05**	No	Long	25.55
12/08/2019	38	2,937.71	0.0002	**0.99**	No	Long	25.52
27/08/2019	36	3,147.37	0.0001	**0.30**	No	Short	78.50
27/08/2019	35	3,315.45	0.0000	**0.13**	No	Short	78.50
08/08/2019	38	3,102.66	0.0000	**0.09**	No	Short	39.85

[2] The System Operators methodology for LoLP is set out in the LoLP Methodology statement: https://www.elexon.co.uk/wp-content/uploads/2015/10/Loss_of_Load_Probability_Calculation_Statement_v1.0.pdf

4 P305 - PAR ANALYSIS

This section compares live prices with a **PAR 50 pricing scenario**. From 1 November 2018, the System Price calculation parameters changed as part of BSC Modification P305. The changes were:

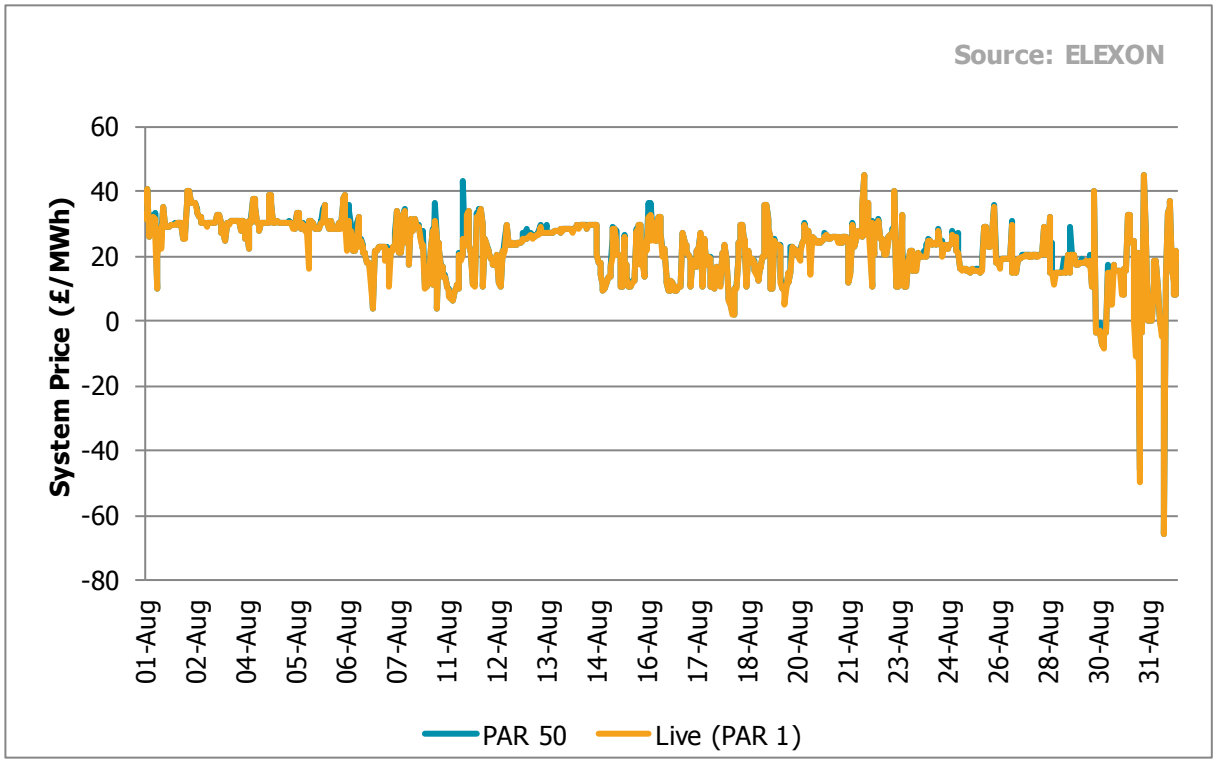
- A reduction in the PAR value from 50MWh to 1MWh;
- The introduction of a 'dynamic' LoLP function; and
- An increase in the VoLL from £3,000/MWh to £6,000/MWh. The PAR 50 scenario uses a VoLL of £3,000/MWh in the RSVP function.

This section looks at the difference in System Prices between a PAR 50 and a PAR 1 scenario for August 2019. Regardless of length, System Prices were different in 46% of Settlement Periods, with 12% of these changes greater than £1/MWh. System Prices are an average of £0.46/MWh lower when the system was long, and £0.90/MWh higher when the system was short, compared to a PAR 50 scenario.

Live System Prices when the system is long are the same or lower compared to PAR 50, and when the system is short prices are the same or higher.

Graph 4.1 compares live System Prices with prices recalculated using the PAR 50 scenario when the system was long.

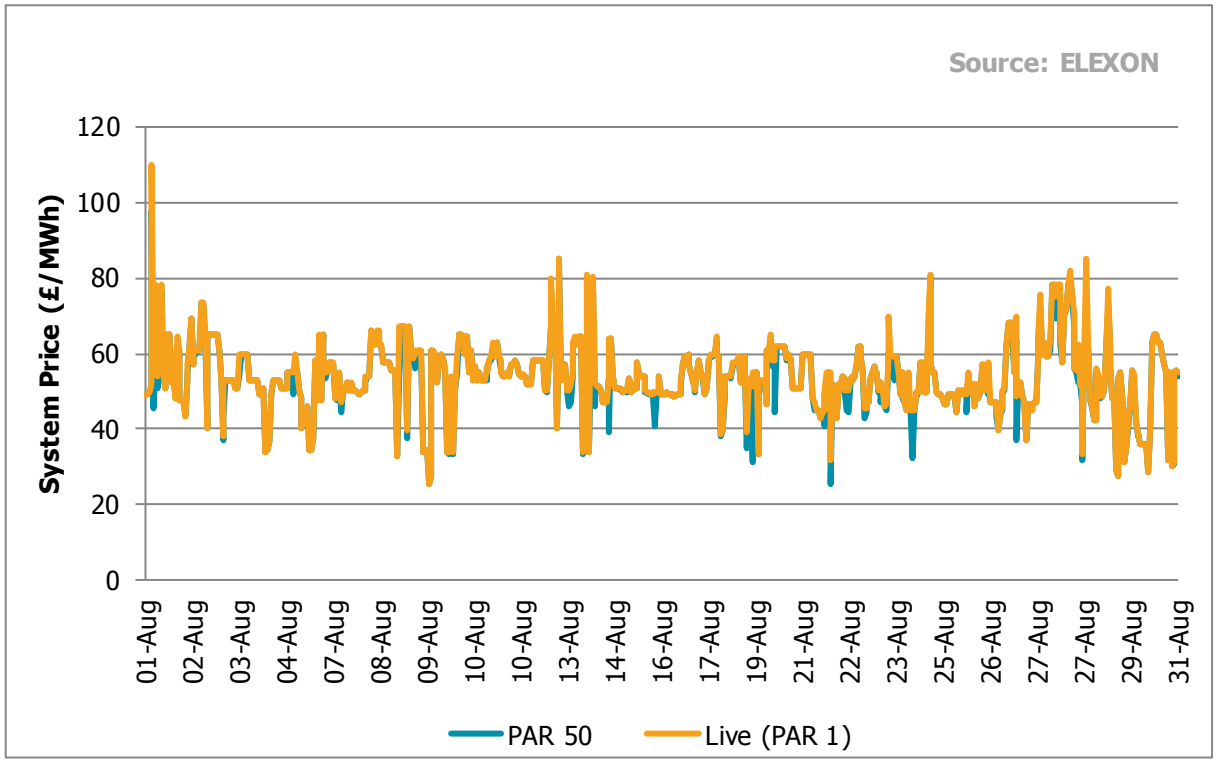
When the system was long and System Prices changed, price changes were less than £1/MWh in 83% of Settlement Periods, and greater than £5/MWh in 5% of Settlement Periods. The biggest shift from the PAR 50 to the live scenario in price was -£18.00/MWh (Settlement Period 26 on 11 August), when the price would have been £43.51/MWh under a PAR 50 scenario compared to the current live System Price of £25.51/MWh.



4.1 Live prices vs PAR 50 prices: Prices when the System was long

Graph 4.2 compares live System Prices with PAR 50 prices when the system was short. Prices were higher in 36% of short Settlement Periods compared to the PAR 50 scenario; 15% changed by more than £5/MWh and 6.3% by more than £10/MWh. The biggest difference in price from the PAR 50 to the live scenario was £24.70/MWh (Settlement Period 21 on 14 August); the price would have been £39.30/MWh under the PAR 50 scenario, compared to the current live System Price of £64.00/MWh.

There was one Settlement Period that exceeded £100/MWh under the PAR 1 scenario; Settlement Period 17 on 1 August was priced at £110.00/MWh. Under the PAR 50 scenario, this Settlement Period would be priced £12.33 lower at £97.67/MWh, and no Settlement Periods in August would have exceeded £100/MWh.



4.2 Live prices vs PAR 50 prices: Prices when the System was short

5 GLOSSARY

Term	Abbrev.	Definition
Bid		A proposed volume band and price within which the registrant of a BM Unit is willing to reduce generation or increase consumption (i.e. a rate below their FPN).
Bid/Offer Acceptance	**BOA**	A Bid or Offer within a given Settlement Period that was Accepted by the SO. BOAs are used in the Imbalance Price calculation process e.g. to calculate NIV or the System Price.
Offer		A proposed volume band and price within which the registrant of a BM Unit is willing to increase generation or reduce consumption (i.e. a rate above their FPN).
System Price		A price (in £/MWh) calculated by BSC Central Systems that is applied to imbalance volumes of BSC Parties. It is a core component of the balancing and settlement of electricity in GB and is calculated for every Settlement Period. It is subject to change via Standard Settlement Runs.
Replacement Price		A price (in £/MWh) calculated by BSC Central Systems that is applied to volumes that are not priced during the imbalance pricing process (detailed in BSC Section T) It is calculated for every Settlement Period, and is subject to change via Standard Settlement Runs.
Utilisation Price		The price (in £/MWh) sent by the SO in respect of the utilisation of a STOR Action which: (i) in relation to a BM STOR Action shall be the Offer Price; and (ii) in relation to a Non-BM STOR Action shall be the Balancing Services Adjustment Cost.
Market Index Price	**MIP**	The Market Index Price reflects the price of wholesale electricity in the short-term market (in £/MWh). You can find an explanation of how it is calculated and used in the Market Index Definition Statement (MIDS).
Reserve Scarcity Price	**RSVP**	Both accepted BM and non-BM STOR Actions are included in the calculation of System Prices as individual actions, with a price which is the greater of the Utilisation Price for that action or the RSVP. The RSVP function is based on the prevailing system scarcity, and is calculated as the product of two following values: - the Loss of Load Probability (LoLP), which will be calculated by the SO at Gate Closure for each Settlement Period; and - the Value of Lost Load (VoLL), a defined parameter currently set to £6,000/MWh.
Replacement Price Average Reference	**RPAR**	The RPAR volume is a set volume of the most expensive priced actions remaining after NIV tagging, and is currently 1MWh. The volume-weighted average of these actions, known as the Replacement Price, is used to provide a price for any remaining unpriced actions prior to PAR Tagging.
Long		In reference to market length, this means that the volume of Accepted Bids exceeds that of Accepted Offers.
Short		In reference to market length, this means that the volume of Accepted Offers exceeds that of Accepted Bid.
Net Imbalance Volume	**NIV**	The imbalance volume (in MWh) of the total system for a given Settlement Period. It is derived by netting Buy and Sell Actions in the Balancing Mechanism. Where NIV is positive, this means that the system is short and would normally result in the SO accepting Offers to increase generation/decrease consumption. Where NIV is negative, the system is long and the SO would normally accept Bids to reduce generation/ increase consumption. It is subject to change between Standard Settlement Runs.
Price Average Reference	**PAR**	The PAR volume is a set volume of the most expensive priced actions remaining at the end of the System Price calculation, and is currently 1MWh.

APPENDIX 1 – HOW SYSTEM PRICES WERE CALCULATED DURING THE BLACKOUT

In this section Market Advisor Emma Tribe explains how System Prices were calculated during the blackout on 9 August 2019 to incorporate the Demand Control event. This was the first time a Demand Control event was included in the calculation of System Prices.

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At 16:53 on Friday 9 August 2019, electricity was automatically disconnected for 5% of the UK until 17:37 in a Demand Control Event. This was trigged by a lightning storm and the sudden loss of power from an offshore wind farm and a CCGT Unit.

This disconnection represented a total reduction in energy demand of 714MWh on the transmission network.

ELEXON's role is to calculate the System Price, also known as the Imbalance Price or Cash-Out Price. The System Price represents the real time marginal cost of balancing energy on the transmission network in each 30 minute Settlement Period. Since BSC Modification P305, introduced in 2015, Demand Control Events are included in the System Price calculation.

Demand Control Events are costed at £6,000/MWh for the purpose of the calculation, where £6,000/MWh represents the Value of Lost Load (VoLL) to energy consumers. This figure was set by Ofgem, and can be reviewed by ELEXON's Imbalance Settlement Group (ISG).

The 9 August 2019 was the first time that a Demand Control event was included in the System Price calculation. The event was included for three Settlement Periods: 34, 35 and 36.

The effect on System Prices was minimal; including the Demand Control Event caused System Prices to change by only £0.25/MWh in two Settlement Periods. The calculated System Price being £64.50/MWh in Settlement Period 34 and £65/MWh in Settlement Periods 35 and 36.

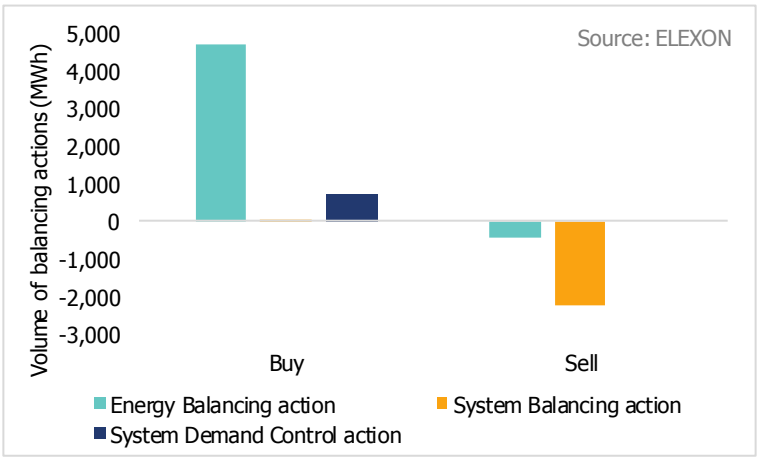
Including Demand Control Events in the System Price could have caused the System Price to rise to £6,000/MWh. This did not happen in these three Settlement Periods because the System Price calculation is designed to remove price distortions, so as not to 'pollute' the System Price signal to the energy market.

Balancing actions taken during the blackout

Graph A1 shows the volume of balancing actions taken in Settlement Periods 34 to 36 on 9 August 2019. A total of 8,158MWh of balancing energy volume was utilised during these three Settlement Periods.

Balancing actions taken in these Settlement Periods have been classed as either:

- Energy balancing, taken to balancing the gross national energy imbalance
- System balancing, taken to manage a system constraint
- System Demand Control, where demand disconnections are taken to manage a system constraint.



A1. Balancing actions utilised

The majority of balancing actions (4,716MWh) were energy balancing, to increase the level of energy on the system and balance an energy deficit.

A further -2,257MWh of system balancing volume was taken to reduce the level of energy on the system in order to resolve system constraints.

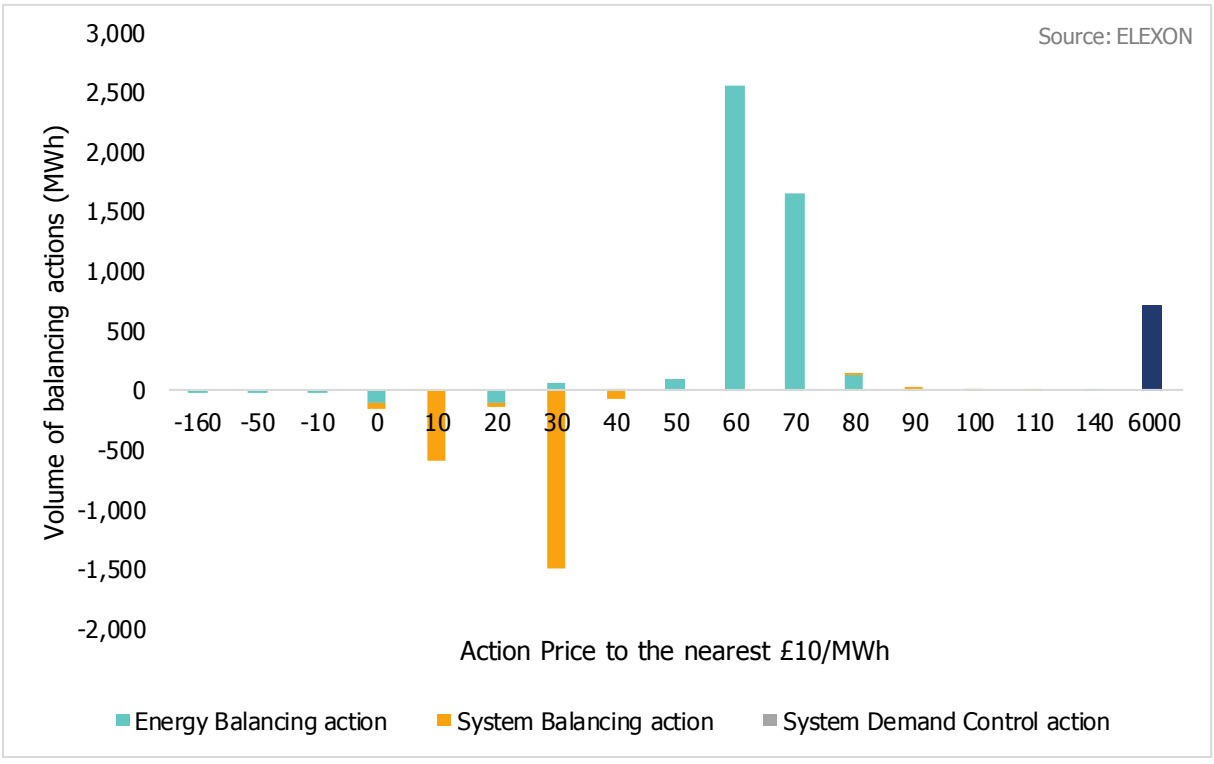
The 714MWh of System Demand Control Volume represents 9% of the total balancing energy utilised during these three Settlement Periods.

How the prices of actions are ranked in merit order

Whether an action is classified as system balancing or energy balancing has an effect on how it is treated in the System Price calculation. For energy balancing, the price of the action should be the cheapest available to fulfil the required energy need. The price of actions taken in order of cheapest to most expensive is called the merit order.

When an action is taken for system balancing reasons, then National Grid as the Electricity System Operator (ESO) will choose the balancing action to fulfil the constraint need. As the constraint need is different from the energy balancing need, the price of these actions may be out of merit order, and therefore not reflect the real time market value of energy.

Graph A2 shows the volumes of balancing energy utilised during Settlement Periods 34 to 36 in merit order, grouped by price to the nearest £10/MWh.



A2. Volume of balancing actions priced in merit order

90% of energy balancing volume was priced between £55/MWh and £75/MWh during these three Settlement Periods. The most expensive price paid for energy balancing volume during these periods was £135/MWh in Settlement Period 34.

The most expensive system action in the buy stack was the £6,000/MWh System Demand Control Volume. When a system balancing action is more expensive than the most expensive energy balancing action, the price is out of

merit order. System balancing actions priced out of merit order are repriced, receiving the same price as the most expensive 1MWh of energy balancing volume in each Settlement Period. This prevents distortion of the System Price.

The Net Imbalance Volume and Price Average Reference

In these Settlement Periods, energy balancing volume was utilised to both increase (positive volume) and decrease (negative volume) the level of energy on the system.

The System Price only considers the price of balancing volume used to reduce the half hourly Net Imbalance Volume (NIV) of the system.

The net of the positive and negative balancing volumes in each Settlement Period by action price is given in **graphs A3.1, A3.2 and A3.3**.

The NIV in each Settlement Period is:

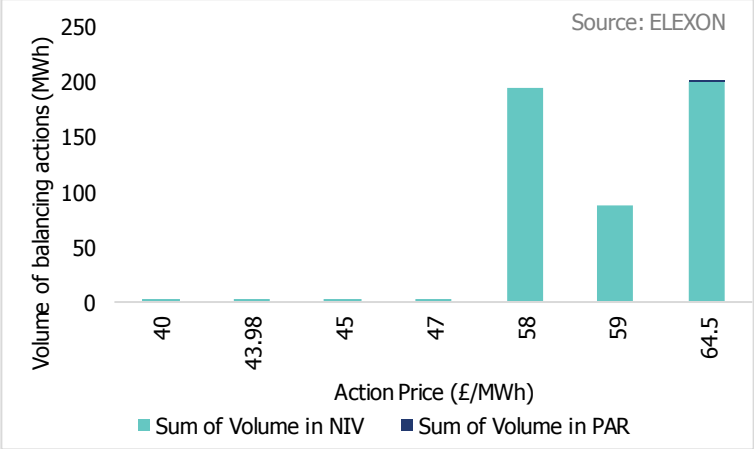
- Settlement Period 34: 486.28MWh,
- Settlement Period 35: 1,282.57MWh,
- Settlement Period 36: 1,055.67MWh

The netting process removes the most expensive actions from the System Price calculation first. In graphs A3.1, A3.2 and A3.3 the most expensive actions, including the Demand Control event, were NIV tagged.

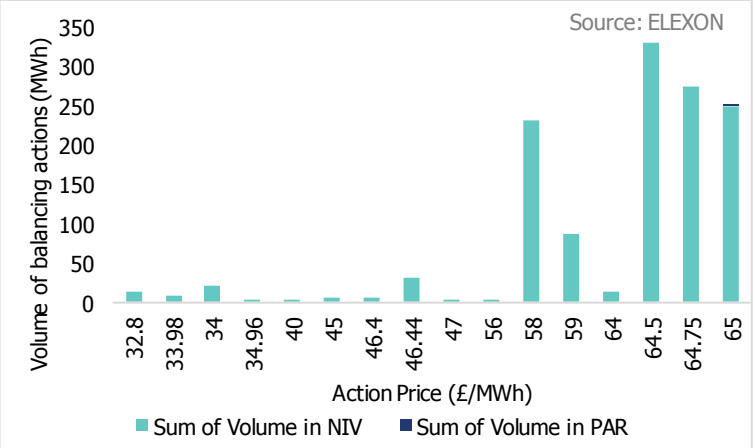
The final System Price is then derived as the average price of the most expensive 1MWh of energy remaining in the NIV; this is referred to as the Price Average Reference (PAR).

The volume of energy in the PAR is shown as a darker blue in the graphs above. As the x axis is ordered from cheapest to most expensive, this 1MWh volume is always in rightmost column of the graphs.

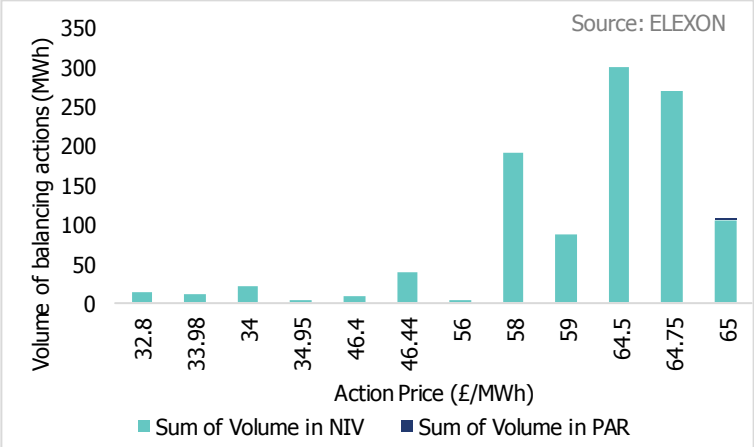
For Settlement Period 34 the price of the volume that set the System Price was £64.50/MWh, for Settlement Periods 35 and 36 it was £65/MWh.



A3.1 Settlement Period 34, volumes of balancing actions in the Net Imbalance Volume (NIV)



A3.2 Settlement Period 35, volumes of balancing actions in the Net Imbalance Volume (NIV)



A3.3 Settlement Period 36, volumes of balancing actions in the Net Imbalance Volume (NIV)

Why the System Price was not higher

The inclusion of the £6,000/MWh Demand Control Volumes had minimal effect on the System Price in these Settlement Periods. As the Demand Control Event was flagged as a System Demand Control Event, the price of these actions were considered as being taken out of merit order and repriced. There were also actions taken to decrease the energy on the system during these Settlement Periods, and this netted out both the Demand Control action and other higher priced actions.

The Demand Control Event was automatically triggered by a Low Frequency Demand Disconnection, and lasted less than an hour. There was no signal to the market that Demand Control balancing volumes might be needed in any of the Loss of Load Probability and De Rated Margin forecasts. These forecasts are published at eight hours, four hours, two hours and one hour ahead of the start of each Settlement Period.

The prices for energy available in the Balancing Mechanism for each Settlement Period are submitted an hour ahead of the start of the Settlement Period (referred to as Gate Closure). As the system was restored to normal operation in less than an hour, the prices of energy in the market did not react to the scarcity.