PUBLIC

P305 POST IMPLEMENTATION REVIEW

Emma Tribe – Market Analyst

V1.1

February 2017

ELEXON

P305 POST IMPLEMENTATION REVIEW

CONTENTS

EXECUTIVE SUMMARY **3**

1. BACKGROUND AND SCOPE OF ANALYSIS **4**

BSC Modification P305 4

Analysis Provided 5

Market Context 6

Change in Market Participants 8

Related Work 9

2. BALANCING BEHAVIOUR **10**

Market balancing as measured by Net Imbalance Volume (NIV) 10

Market balancing as measured by Parties' aggregated Imbalance 13

Party Imbalances by Long and Short 14

Balancing Production and Consumption Energy Accounts 16

3. OVERVIEW OF PRICING TRENDS **18**

Overview of System Prices since the implementation of BSC Modification P305 18

System Prices since BSC Modification P305 implementation compared to previous years 20

Comparison of System Prices using different price scenarios 22

November 2018 scenario 25

BSC Modification P305 and price volatility 28

Bids and Offers affecting number of extreme System Prices 30

4. OVERVIEW OF PARTIES TRADING CHARGES **32**

Historical Imbalance Trading Charges 32

P217 Price scenario 35

November 2018 Price scenario 37

5. PARAMETER ANALYSIS **39**

Reduction in the Price Average Reference Volume (PAR) Value 39

Reduction in the Replacement Price Average Reference Volume (RPAR) 41

De-Rated Margin (DRM), Loss of Load Probability (LoLP) and the Reserve Scarcity Price 41

DRM as an informational tool 44

The impact of including non-BM STOR volumes in the System Price calculation 46

The Buy Price Price Adjuster 47

LIST OF APPENDICES **48**

APPENDIX 1: GLOSSARY **49**

APPENDIX 2: CLASSIFICATION OF PARTY TYPES **51**

APPENDIX 3: SUMMARY OF WORKSHOP VIEWS AND EVIDENCE PROVIDED **55**

P305 POST IMPLEMENTATION REVIEW

EXECUTIVE SUMMARY

This document summarises data and analysis provided by ELEXON to contribute to BSC Parties' understanding of BSC Modification P305 'Electricity Balancing Significant Code Review Developments'.

Using BSC data, the 12 month period from 1 December 2015 to 30 November 2016 has been compared against the same period in previous years. Key observations from this report are:

- Overall, the market was long more frequently than short in 2015/16 – the system was net long in 69% of Settlement Periods (compared to 57% of Settlement Periods in 2014/15);
- Parties' Energy Imbalance Volumes in the 12 month period were the greatest compared to the same period in each of the last four years;
- System Prices have, on average decreased but a greater number of System Prices over £100/MWh have been seen;
- BSC Parties have used the single Imbalance Price to balance Energy Imbalance Volumes between Production and Consumption Energy Accounts;
- The Reserve Scarcity Price (RSP) introduced by P305 has been used to reprice 130 Short Term Operating Reserve (STOR) actions;
- Demand Control actions or Contingency Balancing Reserve actions have not been used since the implementation of P305 and therefore it was not possible to assess the impact of these processes.

If you have any questions or feedback regarding this report, please contact market.analysis@elexon.co.uk.

P305 POST IMPLEMENTATION REVIEW

1. BACKGROUND AND SCOPE OF ANALYSIS

This document summarises data and analysis provided by ELEXON to contribute to BSC Parties' understanding of BSC Modification P305 'Electricity Balancing Significant Code Review Developments'. Our review compiles relevant evidence using Settlement data, but we do not provide an assessment of the Modification.

In this section, we look at:

- Background of BSC Modification P305, and the changes to the pricing calculation
- Analysis on the Market conditions prior to and since the implementation of BSC Modification P305
- Related work that impacts the BSC Modification P305 changes

BSC Modification P305

BSC Modification P305 introduced a number of changes to the calculation of the cash-out price, and was implemented on 5 November 2015. It was raised to progress the conclusions to Ofgem's Electricity Balancing Significant Code Review (EBSCR), which looked at addressing the Authority's concerns with the electricity balancing arrangements.

The System Sell Price (SSP) and System Buy Price (SBP) are the 'cash-out' or 'Energy Imbalance' prices that are used to settle the difference between contracted generation or consumption and the amount that was actually generated or consumed in each half hour trading period. P305 implemented the following changes:

- A reduction in the Price Average Reference (PAR) value to 50MWh and the Replacement PAR (RPAR) value to 1MWh upon implementation, and reduce the PAR value further to 1MWh on 1 November 2018.
- A single imbalance price so that SSP and SBP are equal to each other in each Settlement Period.
- A price for Short Term Operating Reserve (STOR) actions using a Reserve Scarcity Price (RSP) which is determined with reference to a 'static' Loss of Load Probability (LoLP) function upon implementation, before switching to a 'dynamic' function on 1 November 2018.
- Price Demand Control actions at Value of Lost Load (VoLL), currently £3,000/MWh increasing to £6,000/MWh on 1 November 2018, and a process for correcting participants' imbalance volumes following such an event.

National Grid raised P305 on 30 May 2014. The Panel agreed to submit P305 to an Assessment Procedure, during which it was issued for industry Impact Assessment and the Workgroup's Assessment Procedure Consultation. The Workgroup recommended that the Alternative Modification should be approved, and its Assessment Report was presented to the Panel on 12 February 2015.

The Panel initially recommended that both the Proposed and Alternative Modifications should be rejected, and issued P305 for its Report Phase Consultation. The Panel made its final recommendation that both the Proposed and Alternative Modifications should be rejected at its meeting on 12 March 2015.

The Authority approved the P305 Proposed Modification on 2 April 2015 for implementation on 5 November 2015 as part of the November 2015 Release.

The decision to approve BSC Modification P305 was based on defects identified in the calculation of cash-out prices by the Electricity Balancing Significant Code Review (EBSCR). The concerns were:

- Cash-out prices were calculated using the average cost of the actions that the System Operator (SO) takes to balance the system, rather than the marginal action.

- The 'dual price' arrangements created unnecessary imbalance costs for Parties because the price for 'helpful' imbalances did not reflect the savings these imbalances create for the SO.
- They excluded the costs borne by the consumer during disconnection and voltage reduction.
- The method for pricing reserve costs into cash-out did not accurately reflect the real time value of this reserve, and excluded the cost of some reserve products altogether.

The EBSCR Final Policy Decision concluded that these defects could increase the cost of ensuring security of supply to consumers because it could lead to inefficient balancing and dampen incentives for the market to provide flexibility.

Analysis Provided

We have carried out analysis using BSC data[1] focusing on the 12 month period 1 December 2015 to 30 November 2016, comparing what System Prices and Trading Charges have been under P305 and what they would have been if this modification has not been introduced. We also consider what prices will be once 'phase two' of the changes are introduced in November 2018, and make comparison of the same period across different years.

To facilitate the analysis, we compare three pricing scenarios:

1. **Live Prices ("Live")** – this is the price calculation that is used in calculating System Prices since 5 November 2015.
2. **P217A Price Scenario ("P217")** – this is the price calculation that applied before P305 was implemented on 5 November.
3. **November 2018 Price Scenario ("Nov 18")** – this is the 'phase two' price calculation that will apply from 1 November 2018, specifically to calculate imbalance prices with a lower Price Average Reference (PAR) value and a Value of Lost Load (VoLL) of £6,000/MWh.

We also assess the impact of Parties' Trading Charges during the period. To carry out this analysis, we have split different BSC Parties into different Party Types[2]:

- Independent Generator
- Non Physical Trader
- Renewable Generator
- Vertically Integrated Player
- Independent Supplier

There is one important caveat to any analysis, and that is we cannot account for any behavioural change that may have resulted from different System Prices.

[1] The data used is a combination of Settlement Runs using at least 'SF' data.
[2] Note that the Party Grouping is based on our latest information and best understanding of Parties. MVRNs can result in cross roles for a Party. See Appendix 2 for details.

Market Context

System Prices post P305 are as much a function of the market fundamentals as the changes to the calculation that were introduced. This is an important caveat to any historical comparison.

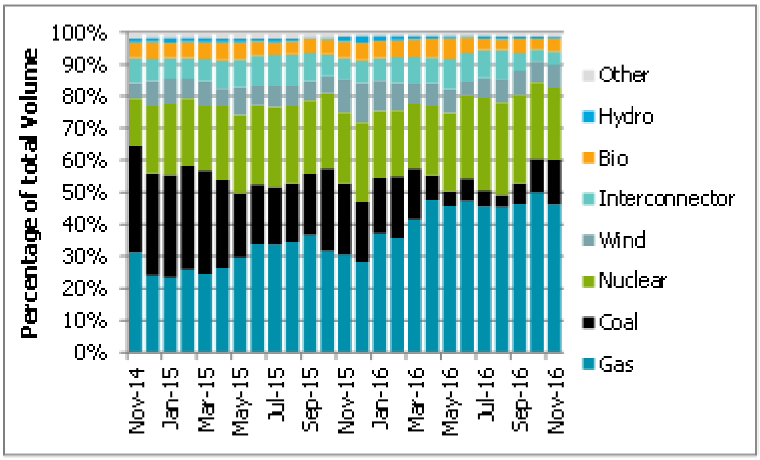
BSC Modification P305 has given frequent strong price signals at times when the generation margin has been low, in particular through October and November 2016.

Graph 1.1 shows the fuel mix between November 2014 and November 2016, and how this has changed each month, using metered output data from generating BMUs (SVA registered embedded generation is not captured).

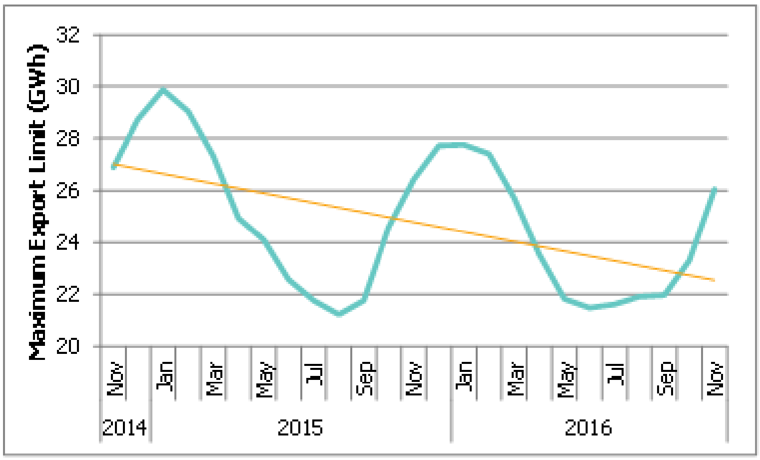
Between December 2015 and November 2016 Gas made up 43% of the fuel mix. For the same period in 2014/15 it was 29%. The increase in Gas generation has coincided with a decrease in Coal generation from 25% of the Fuel Mix in 2014/15 to 11% in 2015/16.

The average available generation per Settlement Period has fallen since Winter 2014/15. This can be seen in **Graph 1.2**, which shows average installed capacity margins over time using Effective Maximum Export Limits. Some of the factors causing this are plant closures, decreasing demand and increasing embedded generation (where MEL is not provided by SVA registered embedded generation). Available capacity shows a seasonal shape, with less capacity available over the summer months, when generators typically perform maintenance.

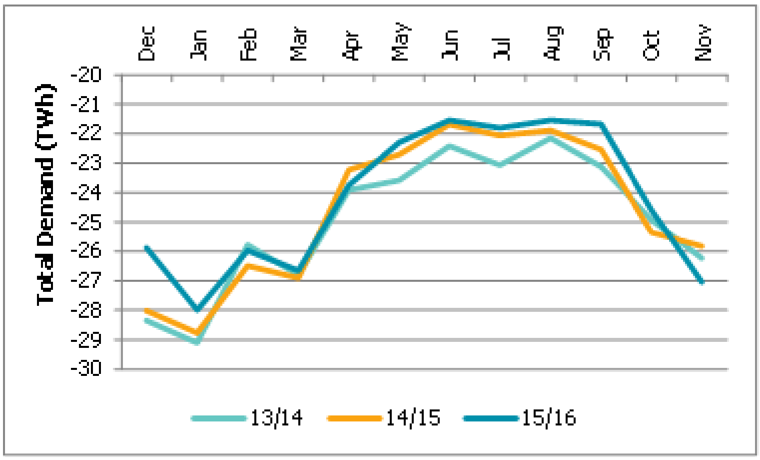
Graph 1.3 shows how, in 2015/16, the monthly total demand has decreased in all months except April and November. The yearly total demand decreased by 1.6% in 2015/16 compared to 2014/16.



Graph 1.1 – Monthly Fuel Mix by type

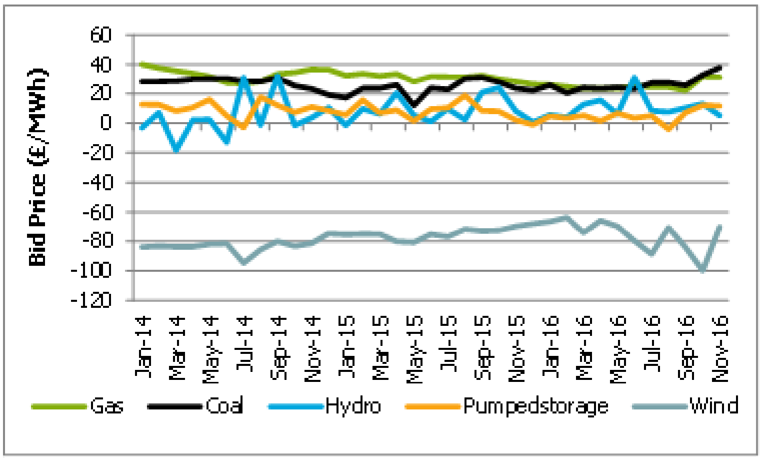


Graph 1.2 - Average installed capacity margins over time using Effective Maximum Exports Limits



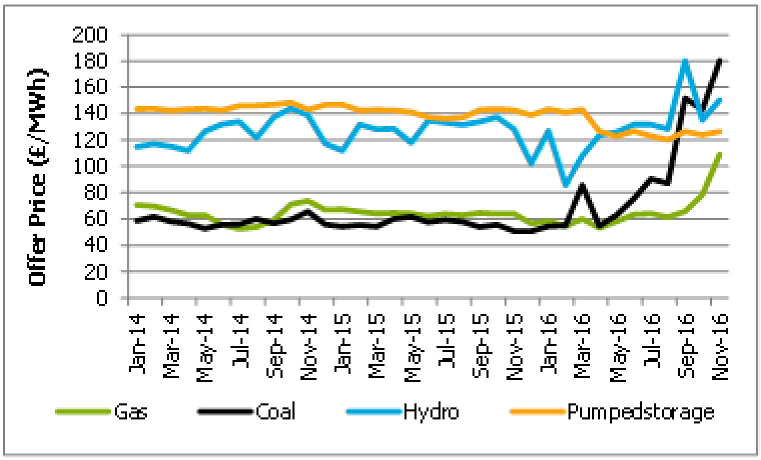
Graph 1.3 - Total electricity demand per month between December 2013 and November 2016

Graph 1.4 shows average accepted Bid Price by fuel type. Wind generators typically submit negatively priced Bids to offset the cost of the Renewable Obligation Certificates that they will not receive if they are not generating.



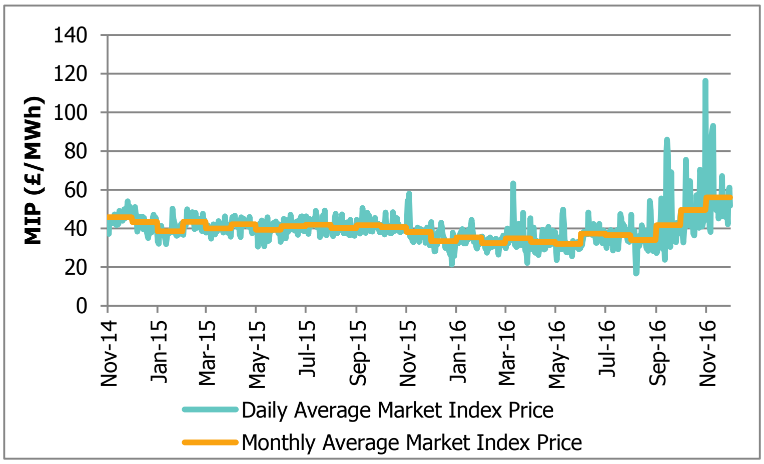
Graph 1.4 - Average accepted Bid Price over time (by fuel)

Graph 1.5 shows average accepted Offer Price by fuel type (wind has been excluded since this fuel type rarely has substantial Offers accepted). In March 2016 Pumped Storage Offers became £20 cheaper on average. For all other fuel types the average Offer price has increased compared to the same month in the previous year. Coal has had the greatest increase, between April 2016 and November 2016 the average accepted Offer Price rose by £126/MWh to £180/MWh.



Graph 1.5 - Average accepted Offer Price over time (by fuel)

Graph 1.6 shows market prices, as measured by the Market Index Price (MIP). The MIP is a price (expressed in £/MWh), calculated for each Settlement Period, to reflect the price of wholesale electricity in the short term or intra-day markets. Prices and volumes for trades that occur within 12 hours of Gate Closure are submitted by the Market Index Data Provider(s) (currently APX and N2EX) and these are used to calculate the Market Index Price[3].



Graph 1.6 - Average Market Index Price

The start of the period since implementation of P305 was a period of falling wholesale prices. That trend changed in June 2016 when the Market Index Price started to increase.

The average Market Index Price was £41/MWh in 2014/15 and £38/MWh in 2015/16. 2015/16 had a greater range of daily average Market Index Prices with a max of £116/MWh and min of £16/MWh compared to a max of £57/MWh and min of £31/MWh in 2014/15.

These conditions have had an impact on the pricing of the underlying balancing actions (such as Bids and Offers in the Balancing Mechanism). These balancing actions are then used to set the System Price.

[3] For full detail of the Market Index Price, see the Market Index Definition statement here: https://www.elexon.co.uk/wp-content/uploads/2012/01/mids_v7.0.pdf

Change in Market Participants

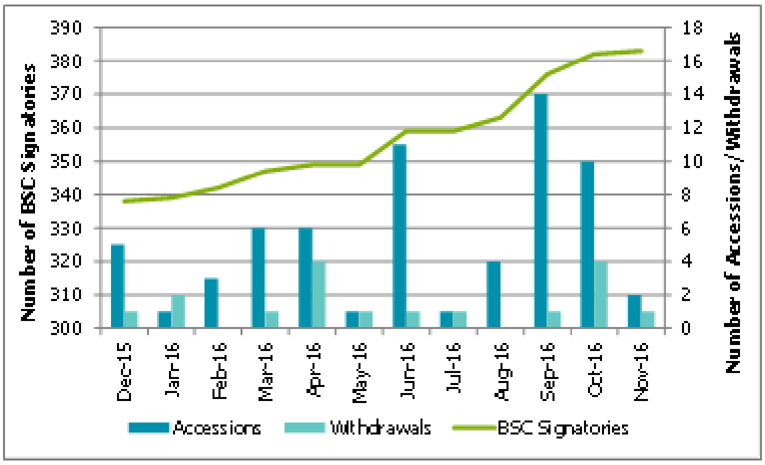
BSC Signatories by month, including accessions and withdrawals, are shown in **Graph 1.7**. Since December 2015 there has been a 13% increase in BSC Signatories, from 338 to 383. The highest number of accessions occurred in September 2016, with 14 new BSC Signatories.

Graph 1.8 shows BSC Signatories split by type, with the increase in suppliers accounting for the majority of growth in the period. Since September the number of BSC Signatories registered as generators has increased by eight.

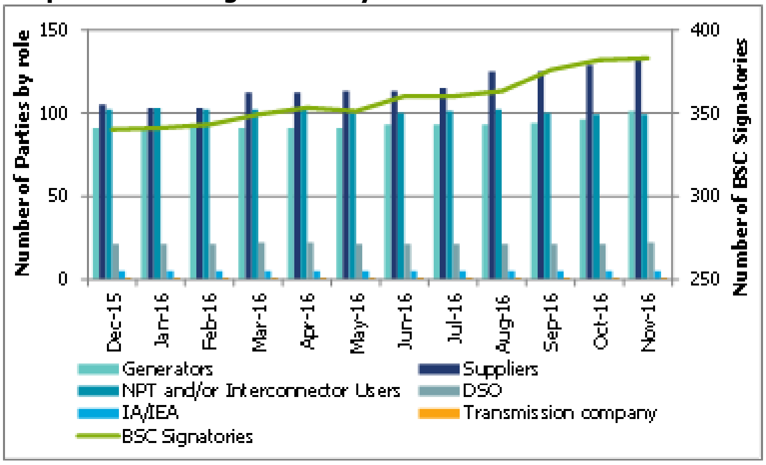
Graph 1.9 shows the number of qualified suppliers split into off the shelf (suppliers taken through qualification with the intention of being sold to third parties) and traditional suppliers (suppliers taken through Qualification led by a consultant or with the assistance of a third party).

The total number of qualified suppliers has grown by 37% since December 2015. The vast majority are off the shelf suppliers, with 38 new participants joining (an increase of 69%). In contrast, only 3 additional traditional suppliers have qualified. Off the shelf suppliers now account for over 61% of total qualified suppliers.

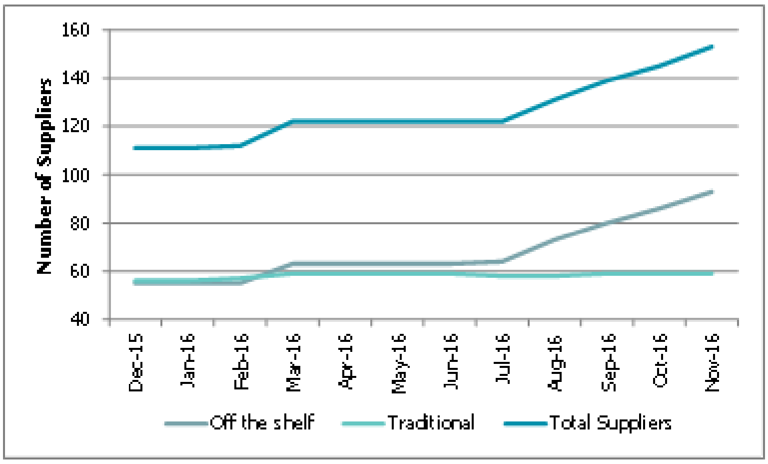
The number of new suppliers may have had an effect on Parties' Energy Imbalance Volumes. Some new suppliers choose to operate with 100% imbalances initially until they secure energy contracts with a third party.



Graph 1.7 - BSC Signatories by month



Graph 1.8 - BSC Signatories by type



Graph 1.9 - Qualified Suppliers by type

Related Work

This review focuses on the impact of the changes introduced as part of P305; other reviews are performed in relation to specific aspects of the arrangements.

Market Index Price Review and Issue Group

The Market Index Definition Statement (MIDS) is the document which contains the methodology for determining the Market Index Price (MIP). Before BSC Modification P305, it was used to set one of the Imbalance Prices in each half hour. Following the implementation of P305, it is only used in defaulting circumstances (e.g. when there are no energy balancing actions taken in a half-hour).

At its October 2015 meeting, the BSC Panel, following the Imbalance Settlement Group's (ISG) recommendations, asked ELEXON to form an Issue Group to look at the use of the MIP in those defaulting situations. Issue Group 64 was formed in Autumn 2016, considered whether the MIDS remains fit for purpose and whether there are other options for setting default prices. After considering the analysis presented by ELEXON, the Issue Group recommended that the current arrangements were fit for purpose. Issue 64 final report was presented to the January 2017 Panel for approval, and closed without change.

Continuous Acceptance Duration Limit (CADL) and De-Minimis Threshold

The Continuous Acceptance Duration Limit (CADL) and the De-Minimis Acceptance Threshold (DMAT) are parameters that are used in the calculation of the Imbalance Price, and they are subject to review every two years. The last review of these parameters was carried out in October 2016. ISG and the Panel agreed to keep both parameters at the same level until the next review, due one year after National Grid's new Electricity Balancing System is implemented (due Q1 2017, with next DMAT review in 2018).

CADL is used to identify short-duration Bid Offer Acceptances (BOAs) that are most likely to be associated with system balancing actions and potentially exclude their cost from the Imbalance Price calculation. It has been set at 15 minutes since its introduction in 2001.

DMAT removes balancing actions smaller than a set value, currently 1MWh, from the Energy Imbalance Price calculation.

Value of Lost Load (VoLL) Process Review

Value of Lost Load (VoLL) is a defined parameter in the BSC, and is currently set to £3,000/MWh. BSC Modification P305 has set the VoLL at this level until 1 November 2018, when the VoLL will be increased to £6,000/MWh. As the VoLL has been planned to be increased on this date, no review has been scheduled.

Loss of Load Probability (LoLP) Calculation Statement review

The Loss of Load Probability Calculation Statement[4] is a document which sets out the methodology for determining the relationship between De-Rated Margin and the probability that there will be loss of load for a given Settlement Period. LoLP is used to determine the Reserve Scarcity Price for a Settlement Period. Section 1.5 of the LoLP Statement specifies that the Panel may review this Statement from time to time and make changes, subject to the Authority's approval, in accordance with BSC Section T 1.6A. This section requires that any suggested changes to be submitted to Industry for consultation and that the Transmission Company, as well as all BSC Parties, to be informed of any change approved by the Authority.

[4] See the Loss of Load Probability Statement here: https://www.elexon.co.uk/wp-content/uploads/2014/10/37_244_11A_LOLP_Calculation_Statement_PUBLIC.pdf

2. BALANCING BEHAVIOUR

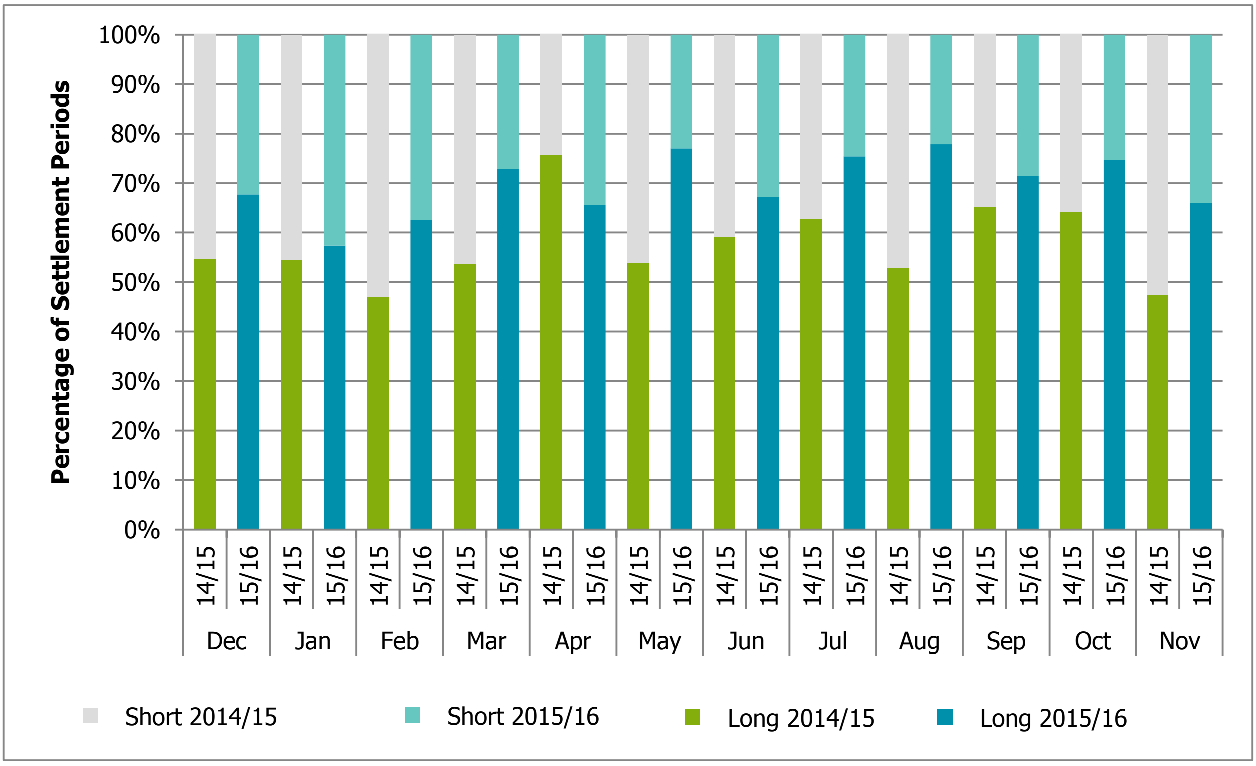
In this section, we present data on:

- The overall imbalance on the system since P305 was introduced, and how this compares to imbalances in the same time period the previous year ("**Net Imbalance Volume**")
- Parties' overall imbalances across the period, how these have changed over time, and how they compare to the same time period in the previous year ("**Parties aggregated Imbalances**")
- Parties' overall imbalances, and how these differ at different times (peak times against all Settlement Periods)
- A measure of volumes of trades in the intra-day forward markets, compared to the same period last year ("**Traded volumes from Market Index Data Providers**")

Market balancing as measured by Net Imbalance Volume (NIV)

There were mixed views about the impact that BSC Modification P305 would have on the market's incentive to balance. Some argued that it would increase incentives to balance efficiently (noting that this would not necessarily mean always having a fully balanced position ahead of Gate Closure), while others argued that it would increase incentives to go long, in response to price volatility or to avoid the consequences of being short.

Net Imbalance Volume (NIV) is the net of all balancing actions taken by the System Operator for a Settlement Period. It indicates whether the system was overall long or short in a Settlement Period, and this can be used as one measure of overall imbalance or length of the system. Positive NIV denotes a short system and vice versa.



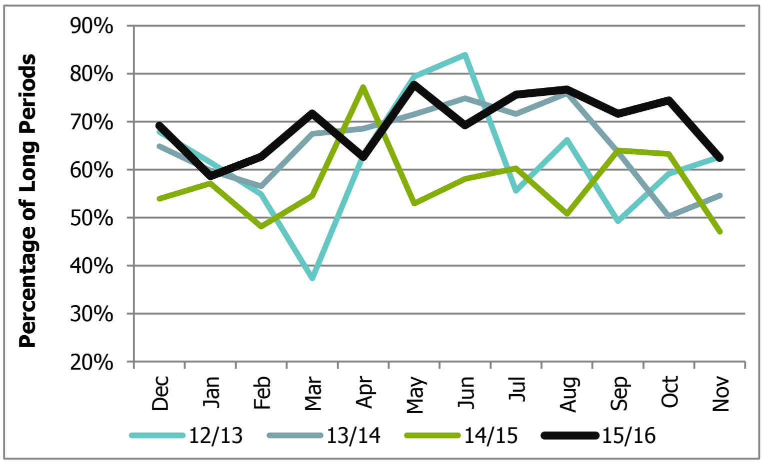
Graph 2.1 - Average system length per Settlement Period by month

Graph 2.1 shows the proportion of Settlement Periods that were long and short and how this compares to the preceding year. Overall, the market has been long more frequently in 2015/16. The net imbalance of the system was long in 69% of Settlement Periods from December 2015 to November 2016, compared to 57% in the same period for the preceding year. However, considering this against the previous four years the trend seems less pronounced.

Graph 2.2 shows the proportion that the system was net long by month in December 2015 to November 2016, and how this compares to the same period across the previous years. In 2013/14 65% of Settlement Periods were long and in 2012/13 62%.

Graph 2.3 shows how long and short the market has been on average across the Settlement Day over 2014/15 (1 December 2014 to 30 November 2015) and **Graph 2.4** shows the same data for the 2015/16 year (1 December 2015 to 30 November 2016). The system length appears to vary more across the day in 2014/15, with the proportion of times the system was short greater over the morning peak (Settlement Periods 13 to 20) and the evening peak (Settlement Periods 35 to 43).

The system was long over 59% of the time for each Settlement Period in 2015/16, whereas 2014/15 has eight Settlement Periods that were short over 50% of the time.

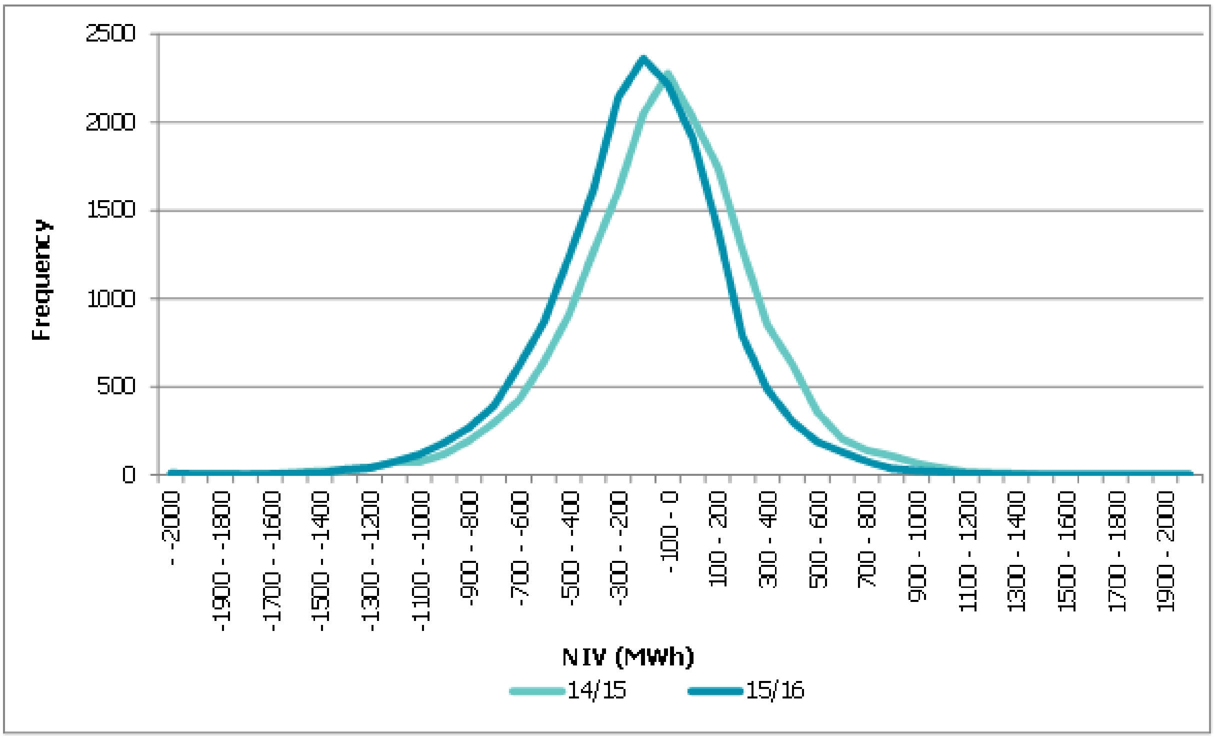


Graph 2.2 - Percentage of Settlement Periods where system was long

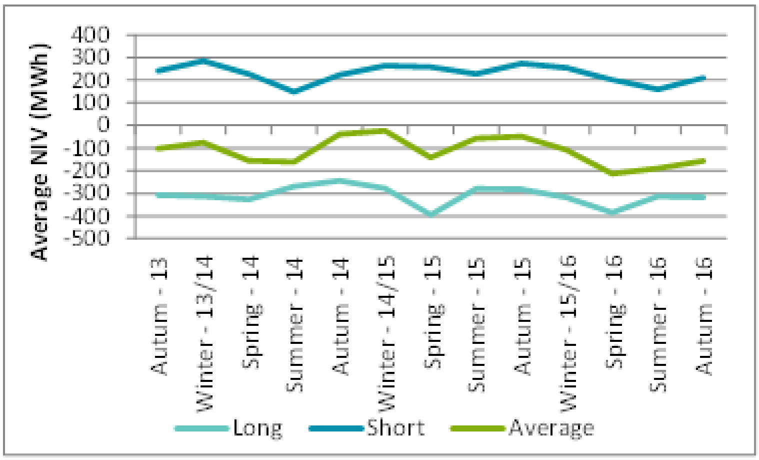
Graph 2.3 - System length per Settlement Period 2014/15

Graph 2.4 - System length per Settlement Period 2015/16

Graph 2.5 shows the frequency distribution of NIVs observed in 2015/16 compared to 2014/15 (positive NIVs denote a short system and negative NIVs denote a long system). The distribution of NIV in 2015/16 has shifted by 100MWh, with a mean NIV of -166MW in 2015/16 compared to mean NIV of -66MWh in 2014/15.



Graph 2.5 - Frequency of Net Imbalance Volumes (NIVs)



Graph 2.6 - Average seasonal Net Imbalance Volume (NIV) compared to the average NIV when the system is long or short

The seasonal average NIV since autumn 2013 is shown in **Graph 2.6**. The average NIV when short or long has changed very little over the period once seasonal variations are taken into account. However, the average NIV regardless of length appears to have become slightly more negative since Winter 2015/16. This could be an effect of a higher proportion of long Settlement Periods.

Market balancing as measured by Parties' aggregated Imbalance

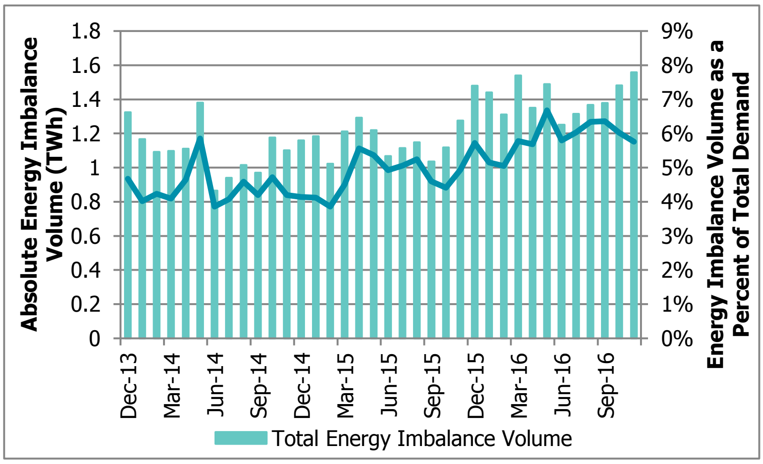
Absolute Imbalances

NIV shows the net length of the system (i.e. it shows whether the system is long or short for a given half-hour), but this hides the long and short Energy Imbalance Volumes faced by market participants in each half hour.

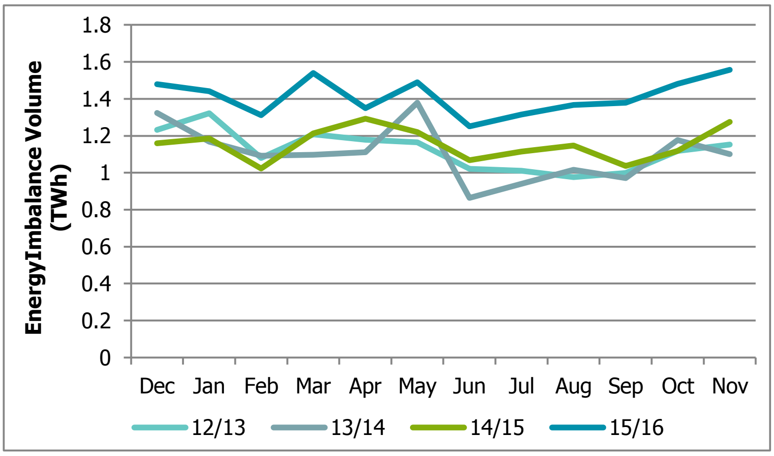
Party Energy Imbalance Volumes are the difference between contracted volumes of energy and physical production and consumption. The imbalance volume for each party has been taken as a net position of their Production and Consumption Accounts. As the introduction of a single System Price removes the need for parties to balance these accounts separately.

Graph 2.7 presents data on Parties' absolute Energy Imbalance Volumes. A second plot shows Energy Imbalance Volumes as a percentage of total demand. There has been an increase in both absolute Energy Imbalance Volumes and Energy Imbalance Volumes as a proportion of total demand over since December 2015. In 2015/16 on average Energy Imbalance Volume was 5.8% of total yearly demand. In 2014/15 this was 4.7% and in 2013/14 it was 4.4%.

Graph 2.8 presents absolute Energy Imbalance Volume data over a year for the past 4 years, aggregated by month. Parties' Energy Imbalance Volumes were higher in 2015/16 for every month. The gap between previous years and 2015/16 has widened since June.



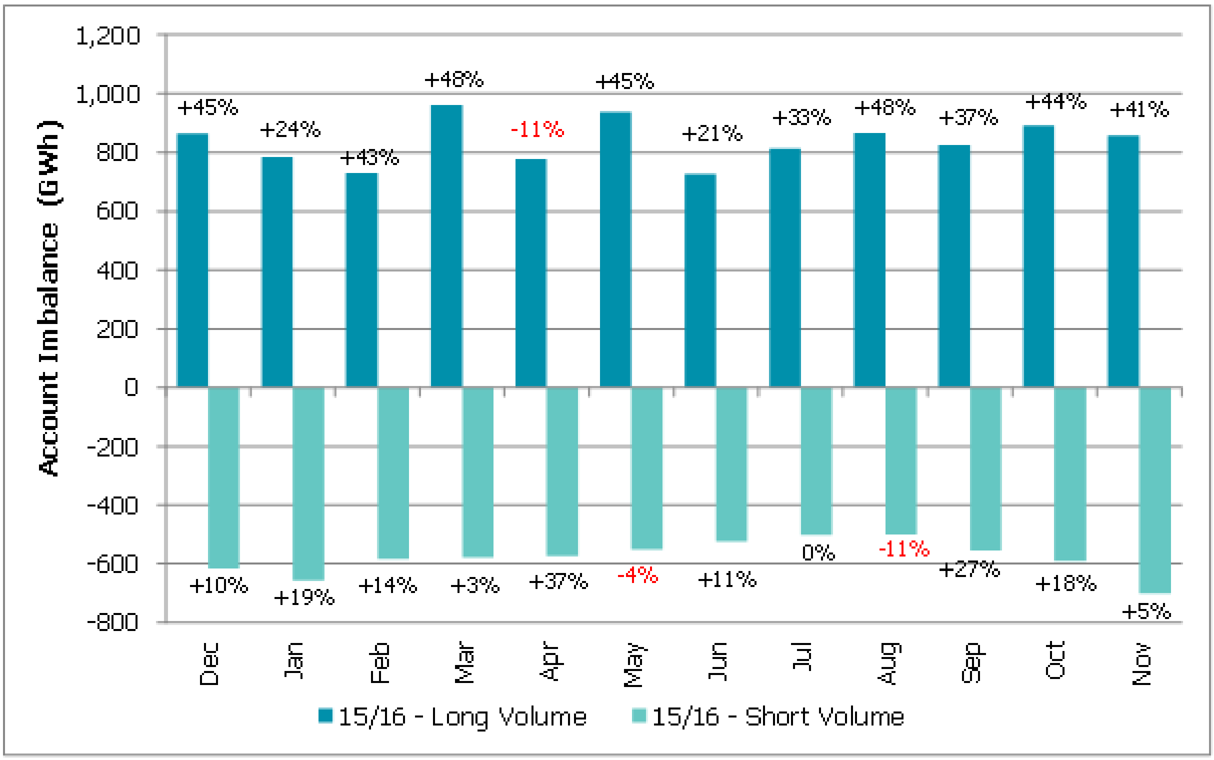
Graph 2.7 - Absolute Energy Imbalance Volumes and as a percentage of total demand by month



Graph 2.8 - Absolute Energy Imbalance Volumes by year

Party Imbalances by Long and Short

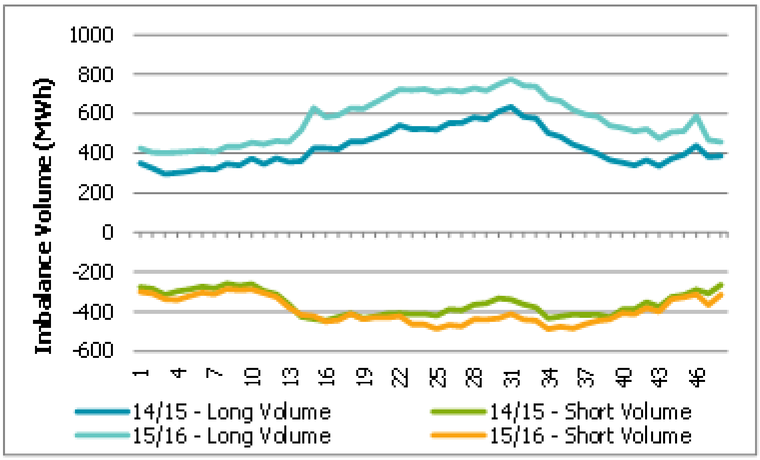
Some stakeholders expressed the view that P305 may create incentives to 'go long' (i.e. purposely contract more, demand less or produce more electricity) particularly over the peak periods, or in response to price volatility. Over the year, Parties long imbalances were 33% greater and short imbalances 10% greater compared to the same period from the previous year.



Graph 2.9 - Aggregated long and short Party imbalances in 2015/16 with percentage change from previous year

Graph 2.9 shows Party imbalances by long and short imbalances per month in 2015/16, and how these compared to the same period from the previous year (long Energy Imbalance Volumes are displayed as positive volumes and short Energy Imbalance Volumes are displayed as negative volumes). Long imbalances were greater in each month in 2015/16, with the exception of April 2016. Short imbalances were greater in every month except May, July and August in 2015/16. March and August had the greatest increase in long volumes, and April the greatest increase in short volumes.

Graph 2.10 shows average Energy Imbalance Volumes by Settlement Period in 2015/16 compared to the same period from the previous year. When a Party is long the absolute Energy Imbalance Volumes are higher in all Settlement Periods in 2015/16. The difference between average Energy Imbalance Volumes for the two years when Parties' are short is less pronounced.



Graph 2.10 - Average imbalance volumes Settlement Period, system length and year

Table 2.1 shows average long and short Energy Imbalance Volumes split by peak[5] and all Settlement Periods for 1 December 2015 until 30 November 2016, and the same period for 2014/15. The average Energy Imbalance Volume was greater (both longer and shorter) in all Settlement Periods in 2015/16. In 2015/16 long Energy Imbalance Volumes over the peak were 19% greater than all long Energy Imbalance Volumes, and short Energy Imbalance Volumes over the peak were 13% greater than all short Energy Imbalance Volumes.

	14/15		15/16	
	Average Long Volume (MWh)	Average Short Volume (MWh)	Average Long Volume (MWh)	Average Short Volume (MWh)
All Settlement Periods	430	-360	572	-396
Peak	508	-402	679	-448

Table 2.1 - Aggregated average long and short Party imbalances comparing peak with all Settlement Periods

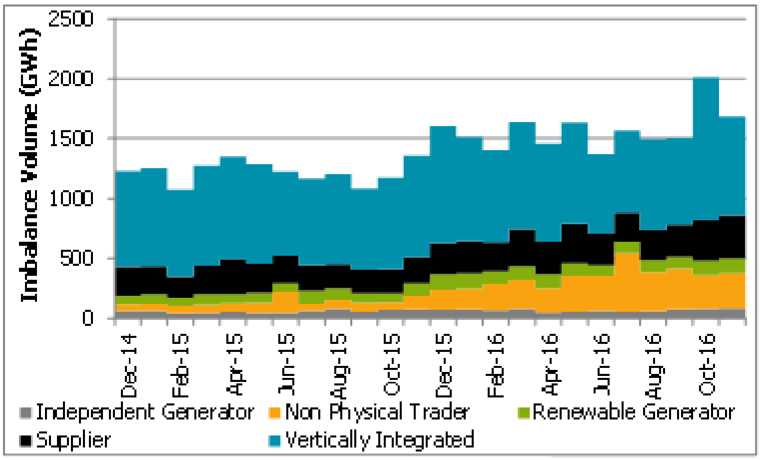
Table 2.2 presents Energy Imbalance Volumes as a percent of Total Demand by different Party type as categorised using BSC Party IDs (see appendix two for classification of Party types for further detail). It can be seen that for all Parties long imbalance percentages increased when comparing 2014/15 to 2015/16. Short imbalances increased for all Parties except Vertically Integrated and Independent Generators. Non Physical Traders have the greatest increase for both short and long imbalances.

Long					
Date	Independent Generator	Non Physical Trader	Renewable Generator	Supplier	Vertically Integrated
14/15	0.085%	0.154%	0.224%	0.590%	1.464%
15/16	0.158%	0.529%	0.321%	0.751%	1.636%

Short					
Date	Independent Generator	Non Physical Trader	Renewable Generator	Supplier	Vertically Integrated
14/15	0.150%	0.114%	0.091%	0.311%	1.444%
15/16	0.119%	0.326%	0.098%	0.411%	1.368%

Table 2.2 - Aggregated Imbalance Volume (MWh) as a percent of Total Demand by Party Type

Graph 2.11 gives the total absolute Energy imbalance by Party type. The increase in Non-Physical Trader imbalances since November 2015 is notable. The increased Energy Imbalance Volume could be a result of speculative trading on the expected Imbalance Prices.



Graph 2.11 - Total Energy Imbalance Volumes split by Party type

[5] Peak periods are defined as Settlement Periods 15 to 38 for the purposes of this analysis.

Balancing Production and Consumption Energy Accounts

Parties have two energy accounts – a Production Account and a Consumption Account. Energy Imbalance Volumes are calculated separately for these. Under a dual cash-out price, long and short imbalances were subject to different System Prices. The difference between the two prices created an incentive for Parties to balance each of their energy Accounts separately.

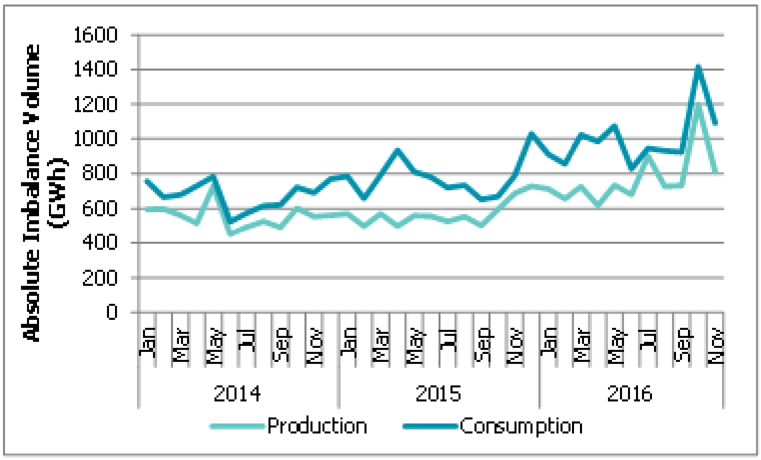
If the Party is solely a generator then they will normally have energy volumes in the Production Account, likewise if a Party is solely a supplier they will normally have energy volumes in the Consumption Account. Vertically Integrated and Non Physical Trading Parties will normally have energy allocated to both accounts. To balance their accounts the Party can trade between their accounts and other Party's accounts using Energy Contract Volume Notifications (ECVNs).

Since the introduction of a single cash-out price as part of BSC Modification P305, any opposing account imbalances will have the same price, so the difference nets off. This has removed the incentive for vertically integrated and non-physical trading Parties to balance their Consumption and Production Accounts. Further, ECVNs incur a charge of £0.0005/MWh; however the benefit of avoiding this charge is unlikely to be material for most Parties.

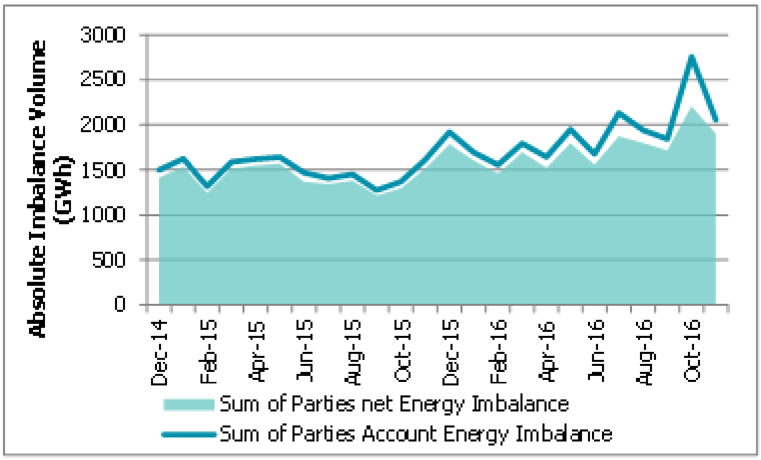
Graph 2.12 shows how monthly absolute Imbalances Volumes have changed over time. Following October 2015, both the Production and Consumption Accounts have been on an upward trajectory, suggesting greater Imbalance Volumes.

Graph 2.13 shows two measures of Energy Imbalance Volumes:

- The 'Sum of Parties net Energy Imbalance' is where for each Trading Party the sum is taken of the absolute net Energy Imbalance Volume of their trading accounts. For example were a Party to have in a Settlement Period an Energy Imbalance Volume of +1MWh in their Consumption Account and -3MWh in their Production Account, the Party's Absolute net Energy Imbalance would be 2MWh.
- The 'Sum of Parties Account Energy Imbalance' sums the absolute imbalances in Parties Production and Consumption Accounts separately. For Example were a Party to have in a Settlement Period an Energy Imbalance Volume of +1MWh in their Consumption Account and -3MWh in their Production Account, the Party's Absolute Account Energy Imbalance would be 4MWh.



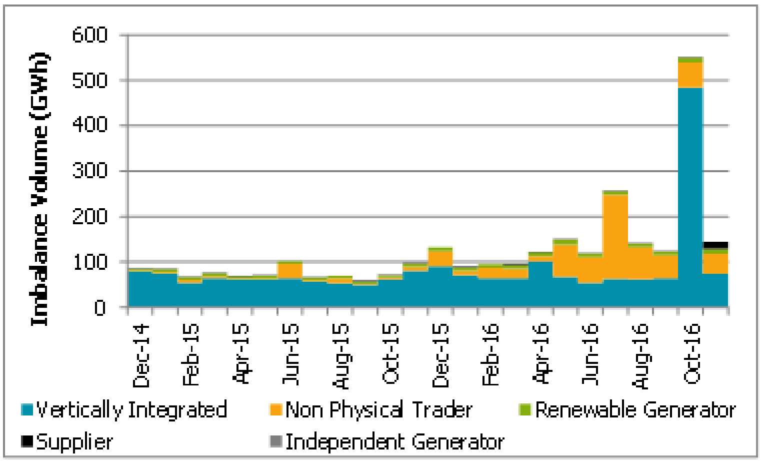
Graph 2.12 - Monthly absolute imbalance volumes for Production and Consumption Accounts



Graph 2.13 - Parties absolute Imbalance Volumes

The difference between these two Absolute Imbalance Volumes has been increasing since December 2015. This suggests that some Parties are no longer balancing their Production and Consumption Accounts. The difference in volumes is split by Party type in **Graph 2.14.**

Graph 2.14 shows the absolute Energy Imbalance volume between the two accounts that can be netted off, by trading Party type. For example, where there are identical Energy Imbalance Volumes in each account, but of differing sign, the net imbalance for that Party would be zero. This graph can therefore be used to determine whether a single Imbalance Price has reduced the incentive to balance the accounts.



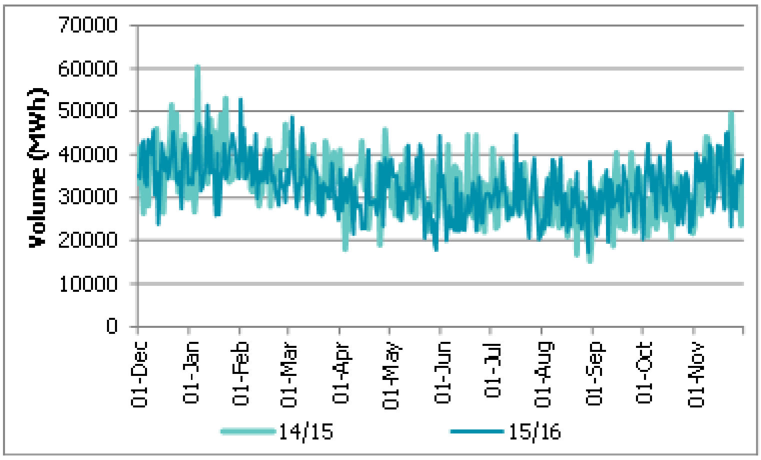
Graph 2.14 - Netted volume between Production and Consumption Accounts

Increases in these volumes suggest that fewer Parties with energy volume allocated to both the Production and Consumption Accounts are balancing these volumes. The Parties with the largest increases are Non-Physical Traders some of whom trade primarily on Interconnectors. It has been observed that some newer interconnector trading Parties do not set up ECVNs to balance between their two Production and Consumption accounts. The spike in October 2016 was caused by a single Vertically Intergrated player that had not balanced the Production and Consumption Accounts at all for a single day.

BSC Modification P305 and intra-day liquidity

The P305 Workshop expressed mixed feelings as to whether P305 would have a beneficial or detrimental impact on liquidity in the wholesale market.

Graph 2.15 shows Market Index Volumes (MIV) as a measure of liquidity in the spot markets from December 2015 to November 2016, compared to the same time period of the preceding year. These are volumes of trades submitted by the Market Index Data Provider(s) and reflect how much trade occurred for the weighted products as defined in the Market Index Definition Statement (MIDS).



Graph 2.15 - Market Index Data Volumes by day

They do not show total market liquidity, but can be used to give an indication of the level of trading before Gate Closure. Using this metric, traded volumes have not changed significantly, with average volumes per day over the 2014/15 period as 37,317 MWh and 37,178 MWh over the 2015/16 period.

3. OVERVIEW OF PRICING TRENDS

This section provides an overview of imbalance prices in the 12 months since the implementation of P305, as well as prices recalculated using two different pricing scenarios:

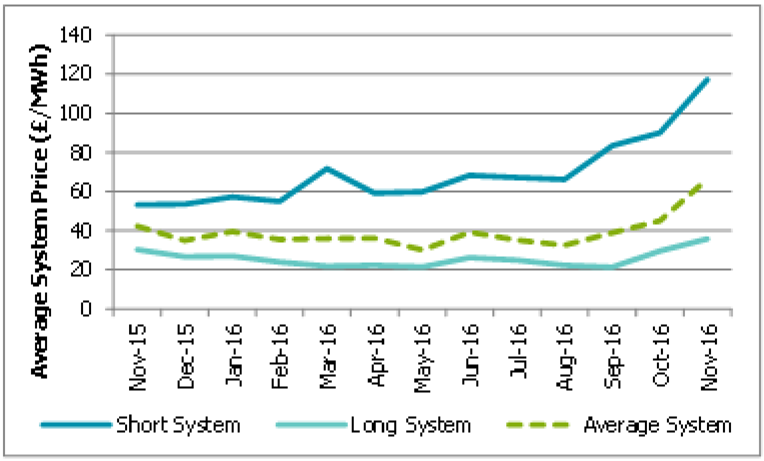
- The **P217 Price Scenario** – the price calculation that was used before BSC Modification P305 was implemented.
- The **November 2018 Price Scenario** – the price calculation that will be used from 1 November 2018

For historic analysis we compare the main price when the System is Long ("**Long System Price**") and Short ("**Short System Price**") to capture the impact of the changes that made the cash-out price 'more marginal.'

Overview of System Prices since the implementation of BSC Modification P305

Graph 3.1 shows the monthly average System Prices since the introduction of BSC Modification P305, and the average prices when the system was long and short. Since the introduction of P305 average short System Prices have increased. Average long System Prices initially decreased, and then increased in October and November 2016. The average System Price had been between approximately £35/MWh and £40/MWh but increased steeply after September to reach £66/MWh in November, due to sharp rises in short System Prices.

Table 3.1 shows an overview of short System Prices since 5 November 2015. The mean short System Price has more than doubled in the year since the introduction of P305. The standard deviation in prices when the market is short has increased by 731%. The increase in peak pricing events when the system is short has pulled up the average System Price for November 2016.



Graph 3.1 – Monthly Average System Prices

Month	Min (£/MWh)	Max (£/MWh)	Mean (£/MWh)	Standard Deviation (£/MWh)
Nov-15	18.43	193.72	53.13	21.87
Dec-15	39.00	140.00	53.53	15.31
Jan-16	33.17	225.00	57.24	27.38
Feb-16	30.00	151.00	54.92	21.65
Mar-16	21.10	517.55	71.66	59.20
Apr-16	30.46	161.19	59.20	30.38
May-16	36.42	480.38	59.82	37.65
Jun-16	27.62	170.00	68.31	30.10
Jul-16	33.03	263.13	67.19	25.58
Aug-16	30.00	151.68	66.19	27.21
Sep-16	34.00	801.77	83.37	69.13
Oct-16	36.96	843.10	90.01	79.67
Nov-16	32.34	1,528.72	117.26	181.68

Table 3.1 – Overview of Monthly Short Prices

Table 3.2 shows the same data for Settlement Periods where the system is long. Unlike for a short system, the standard deviation in long prices has remained consistent over the year.

The lowest System Price occurred in May. Negative prices occur when negative priced Bids are used to calcualte the System Price.

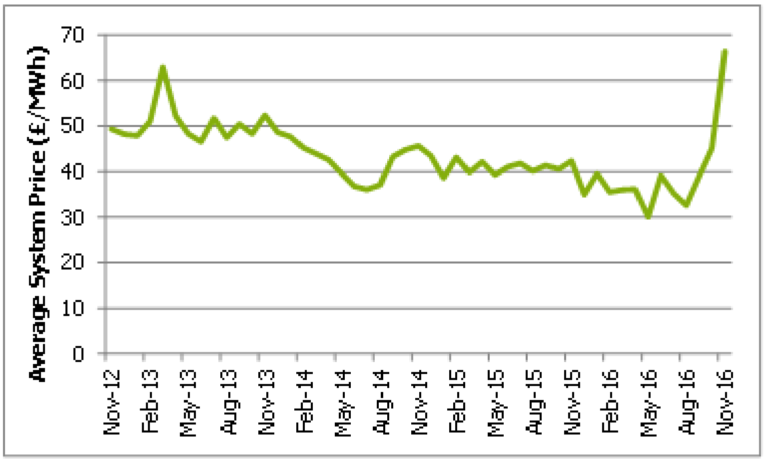
Month	Min (£/MWh)	Max (£/MWh)	Mean (£/MWh)	Standard Deviation (£/MWh)
Nov-15	-39.96	248.65	30.29	16.09
Dec-15	-73.48	42.00	26.67	10.93
Jan-16	-35.00	43.29	27.12	6.77
Feb-16	-59.95	38.00	23.98	6.03
Mar-16	-63.02	39.70	21.92	10.03
Apr-16	-39.19	40.00	22.33	5.54
May-16	-100.00	248.45	21.57	10.92
Jun-16	-12.82	64.40	26.20	5.30
Jul-16	-98.92	79.78	24.90	8.03
Aug-16	-62.50	43.29	22.38	9.22
Sep-16	-73.51	62.36	21.29	10.43
Oct-16	-65.27	49.65	29.62	11.48
Nov-16	-62.55	60.00	35.76	8.78

Table 3.2 – Overview of Monthly Long Prices

System Prices since BSC Modification P305 implementation compared to previous years

This section looks at System Prices since the implementation of BSC Modification P305 and compares these to historic System Prices. The main price has been used for comparison where there was previously dual pricing. Any differences will be a result of a combination of the changes to the cash-out price calculation as well as any changes to market fundamentals.

Graph 3.2 shows the average System Price (using the main price pre-305) from November 2012 to November 2016. The monthly average price of imbalance initially fell since the introduction of BSC Modification P305 from £42.38/MWh in November 2015 to £30.10/MWh in May 2016, the lowest monthly average System Price in the four years compared. This rose steeply from September 2016 to £66.36/MWh in November. The previous high over the four years was when the average monthly System Price was £62.99/MWh in March 2013. Since P305 was introduced there has been the greatest spread in monthly average System Prices.



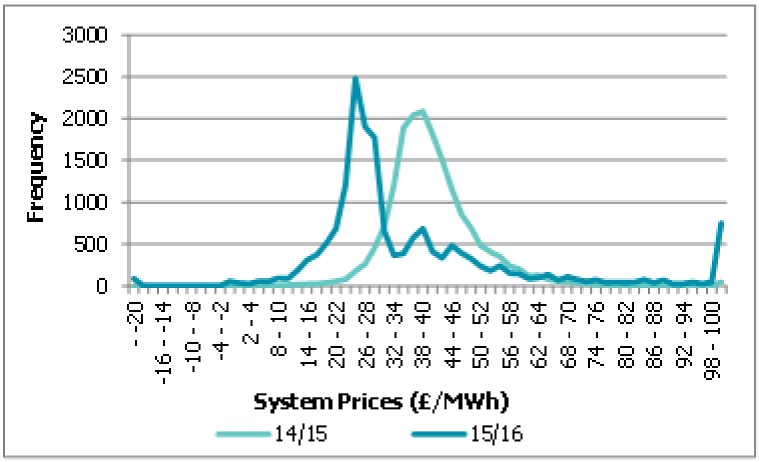
Graph 3.2 - Monthly average System Price regardless of length

Table 3.3 shows the average System Price and spread of prices regardless of length over the last five years. For this analysis a year runs from 1 December to 30 November. Compared to previous years, 2015/16 has the lowest average System Price. There has also been the greatest spread of prices with a range of £1,628.72/MWh in 2015/16 compared to £288.61/MWh in the previous year. This increased spread of prices in reflected in the higher standard deviation.

Year	Min (£/MWh)	Max (£/MWh)	Mean (£/MWh)	Standard Deviation (£/MWh)
12/13	10.60	239.79	50.61	13.63
13/14	5.44	266.11	42.57	11.44
14/15	-39.96	248.65	41.11	10.74
15/16	-100.00	1,528.72	39.09	46.00

Table 3.3 – Average System Price and (2012/13 to 2015/16)

Graph 3.3 shows the frequency of System Prices occurring within £2/MWh price bands in 2014/15 compared to 2015/16. In 2015/16, most System Prices were between £24 and £26/MWh, whereas in 2014/15 prices were more frequently between £38 and £40/MWh. In 2015/16 there were 751 Settlement Periods with prices over £100/MWh whereas in 2014/15 there were 48.

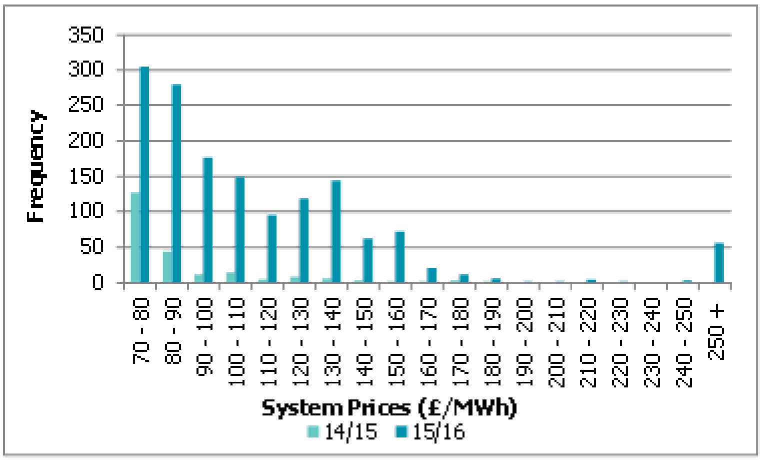


Graph 3.3 – Frequency of System Prices (2014/15 vs. 2015/16)

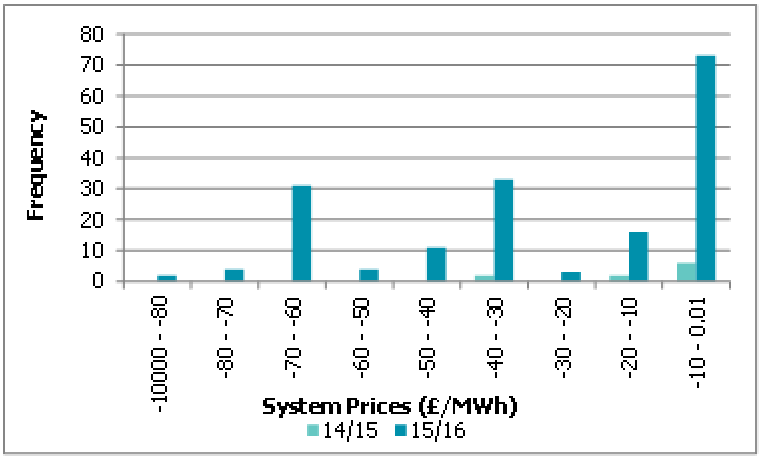
Graphs 3.4 and **3.5** focus on the prices above £70/MWh and below £0/MWh.

56 instances of prices greater than £250/MWh were seen in the 2015/16, compared to none in 2014/15. The highest price in 2014/15 was £248.65/MWh compared to £1,528.72/MWh in 2015/16.

The same trend is seen for the negative prices, with 177 prices less than £0/MWh in 2015/16 (with a lowest price of -£100/MWh) compared to 10 in 2014/15 (with a lowest price of -£39.96/MWh).



Graph 3.4 – System Prices above £70/MWh



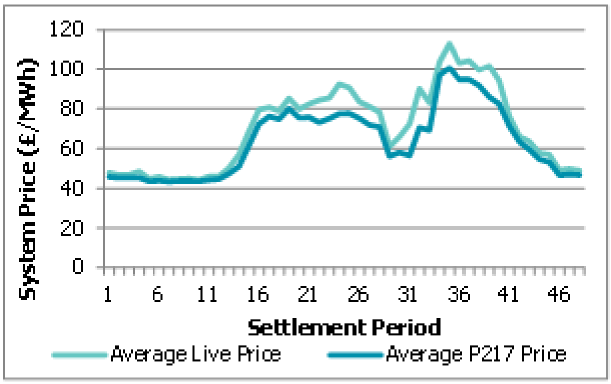
Graph 3.5 – System Prices below £0/MWh

Comparison of System Prices using different price scenarios

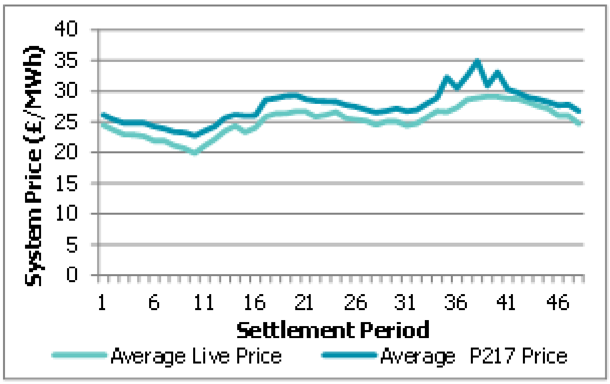
This section compares live prices with two different pricing scenarios. First, we consider what prices would look like with the **P217 (pre-P305) price calculation** to highlight the impact of BSC Modification P305. Before the implementation of P305, the price calculation had:

- Dual pricing, with a reverse price based on the Market Index Price. Note we are only considering the Main Price calculation here;
- A PAR of 500MWh and an RPAR of 100MWh;
- No non-BM STOR volumes or prices included in the price stack;
- No RSP, and instead a Buy Price Price Adjuster (BPA) that recovers STOR availability costs;
- No Demand Control, Demand Side Balancing Reserve (DSBR), or Supplementary Balancing Reserve (SBR) actions priced at VoLL.

Graph 3.6a shows the average System Price, for each scenario, when the system was short by Settlement Period from December 2015 to November 2016, and **Graph 3.6b** shows the same when the system was long.

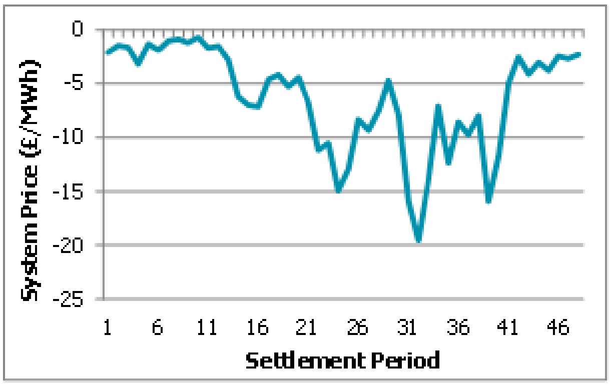


Graph 3.6a – Average Short System Price

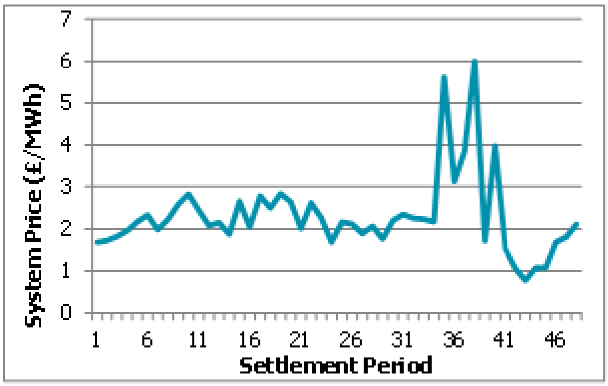


Graph 3.6b – Average Long System Price

Graphs 3.7a and 3.7b show the Settlement Periods where the change in price calculation has had the most effect. In the P217 scenario, System Prices are on average lower when short and higher when long compared to the P305 System Prices. This is expected with the reduction in PAR which strengthens the price signals as BOAs closer to the marginal action are used to set the System Price.



Graph 3.7a - Average difference in P217 and P305 short System Prices

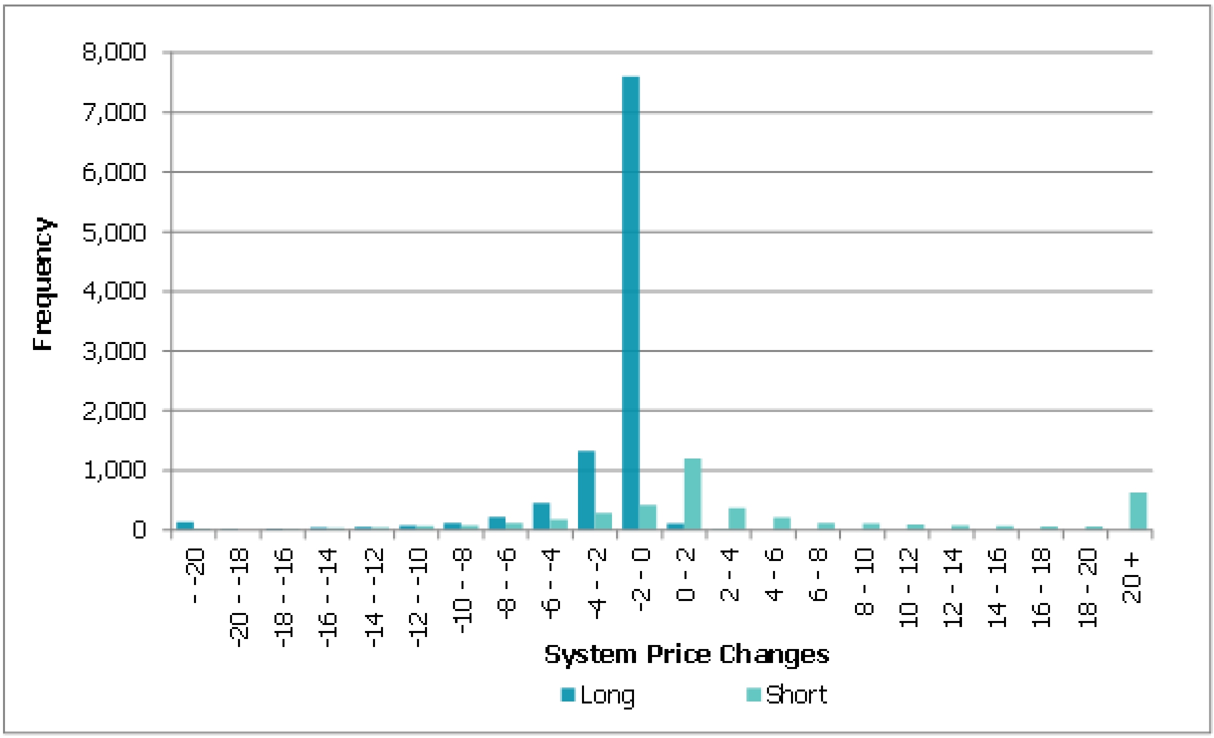


Graph 3.7b - Average difference in P217 and P305 long System Prices

Graph 3.8 shows the frequency distribution of these price changes. 16% of long Settlement Periods had no change and 20% of short Settlement Periods had no change, so these Settlement Periods are not included in the frequency graph.

The majority (83%) of System Prices were lower in the P305 scenario when the system was long. When the system was short 56% of live System Prices were higher than P217 Prices. The change in PAR is largely responsible for this as setting PAR equal to 50MWh has made prices more marginal.

In 24% of short Settlement Periods, live System Prices were lower than P217 prices. In 1% of long Settlement Periods, live System Prices were higher than the P217 prices. These differences were driven by the removal of the portion of the Buy Price Price Adjuster (BPA) that was used to recover STOR availability fees, and the inclusion of non-BM STOR in the price stack.



Graph 3.8 - P217 scenario System Price changes

Case study: Price difference as a result of a change in PAR

In this case study we compare the price stack under the current pricing arrangements with those under the previous 'P217' arrangements.

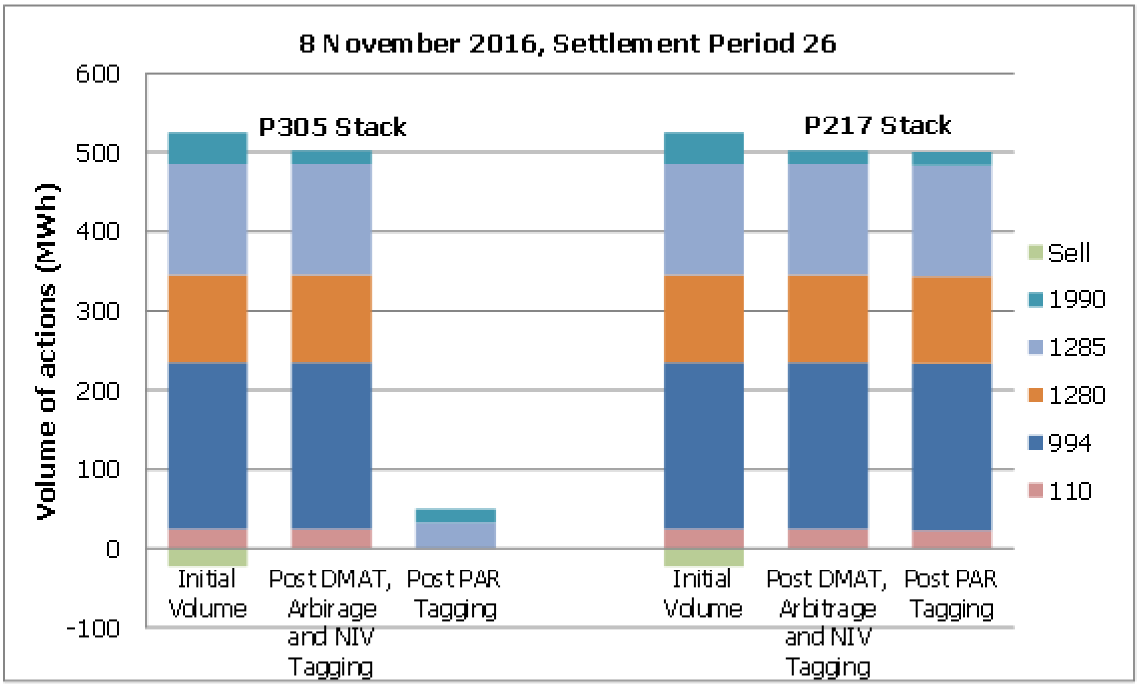
When the market is short, the System Price is set by Buy Actions (including Offers from the Balancing Mechanism). However, we do not include all actions in the price calculation; there are a number of tagging processes to remove some of actions from the volume of actions that are used to set the price (the "Priced Volume"):

- The energy imbalance price is calculated based on the volume-weighted average of a defined volume of the most expensive actions remaining after DMAT, Arbitrage and NIV tagging. This is the **Price Average Reference Volume (PAR)** and before BSC Modification P305 it was 500MWh, P305 reduced the PAR to 50MWh.

The dampening effect of a 500MWh PAR is apparent in Settlement Period 26, 8 November. The live price was £1,523/MWh, but under the old calculation the price would have been £1,133/MWh. The £390/MWh price difference between the scenarios was driven by the difference in PAR, as illustrated in **Graph 3.9** below.

After DMAT, arbitrage and NIV-tagging, there were 502MWh of Buy Actions left in the stack. Under the old price calculation, a weighted average of 500MWh these actions were taken. This volume was made up of Offers from five different BMUs, with prices ranging from £110/MWh to £1,990/MWh. A weighted average of these resulted in a price of £1,133/MWh (including a Buy Price Price Adjuster of £1.92/MWh)[6].

In the live price scenario, however, the reduced PAR of 50MWh meant that only the most expensive 50MWh of actions were averaged to set the price. In this case, this volume came from Offers from two BMUs with prices of £1,990/MWh and £1,285/MWh (there was no Buy Price Price Adjuster in the live scenario). It is worth noting that in the November 2018 scenario, when the PAR reduces to 1MWh, the only price setting action would have been the £1,990MWh Offer.



Graph 3.9 - P305 and P217 pricing stacks on 8 November, Settlement Period 26

[6] This is added onto the price to account for National Grid's option fees. See page 42 for further detail.

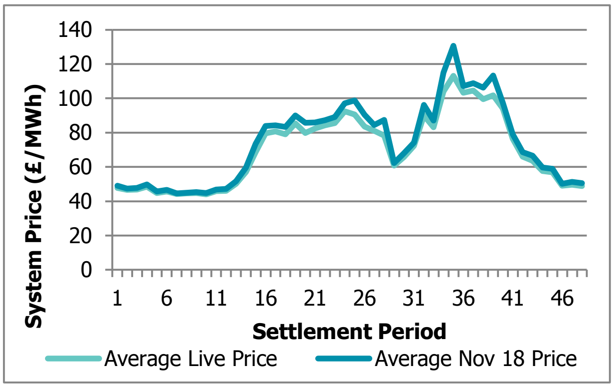
November 2018 scenario

The **November 2018 Scenario** is intended to reflect the changes to the imbalance price parameters that are due to come in on 1 November 2018. These are:

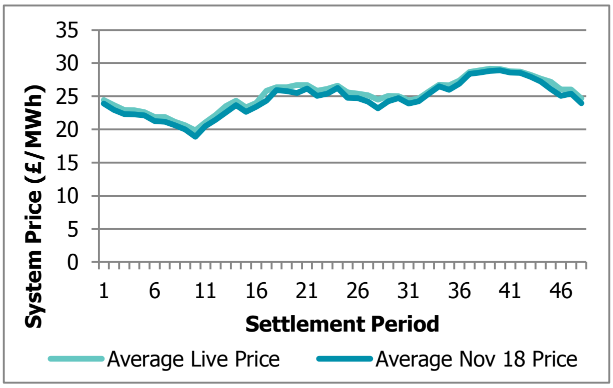
- A reduction in the PAR value to 1MWh (RPAR will remain at 1MWh); and
- An increase in the VoLL to £6,000/MWh, which will apply to all instances of VoLL in arrangements, including the RSP function.

A 'dynamic' LoLP function will also be introduced from November 2018. We are not able to capture the impact of the change in LoLP function in the pricing scenario, and hence the same LoLP values have been used in both scenarios.

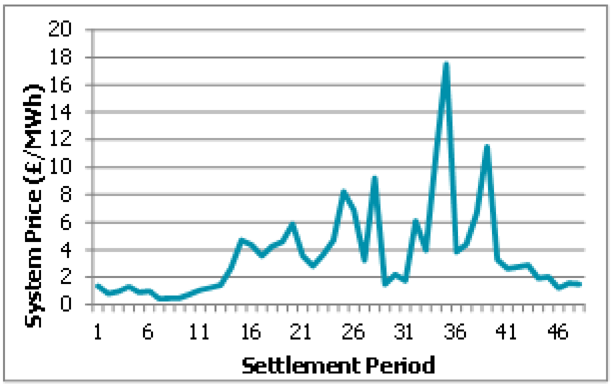
Graphs 3.10a and **3.10b** show System Prices from December 2016 to November 2016 recalculated using the November 2018 scenario. Prices are always lower when the system is long under the November 2018 scenario and higher when the system is shorter. **Graph 3.11a** and **Graph 3.11b** show the average differences between the live scenario and the November 2018 scenario at Settlement Period level.



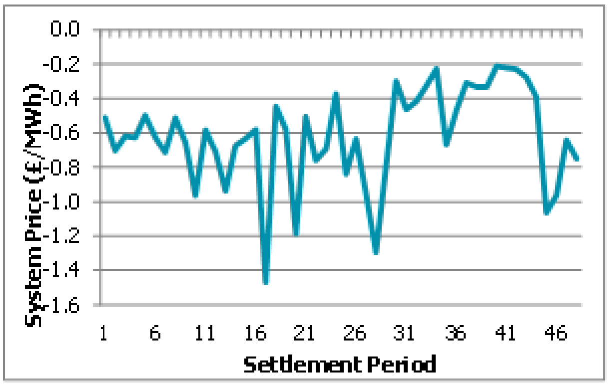
Graph 3.10a – Average Short System Price



Graph 3.10b - Average Long System Price



Graph 3.11a - Average difference in P217 and P305 Short System Prices

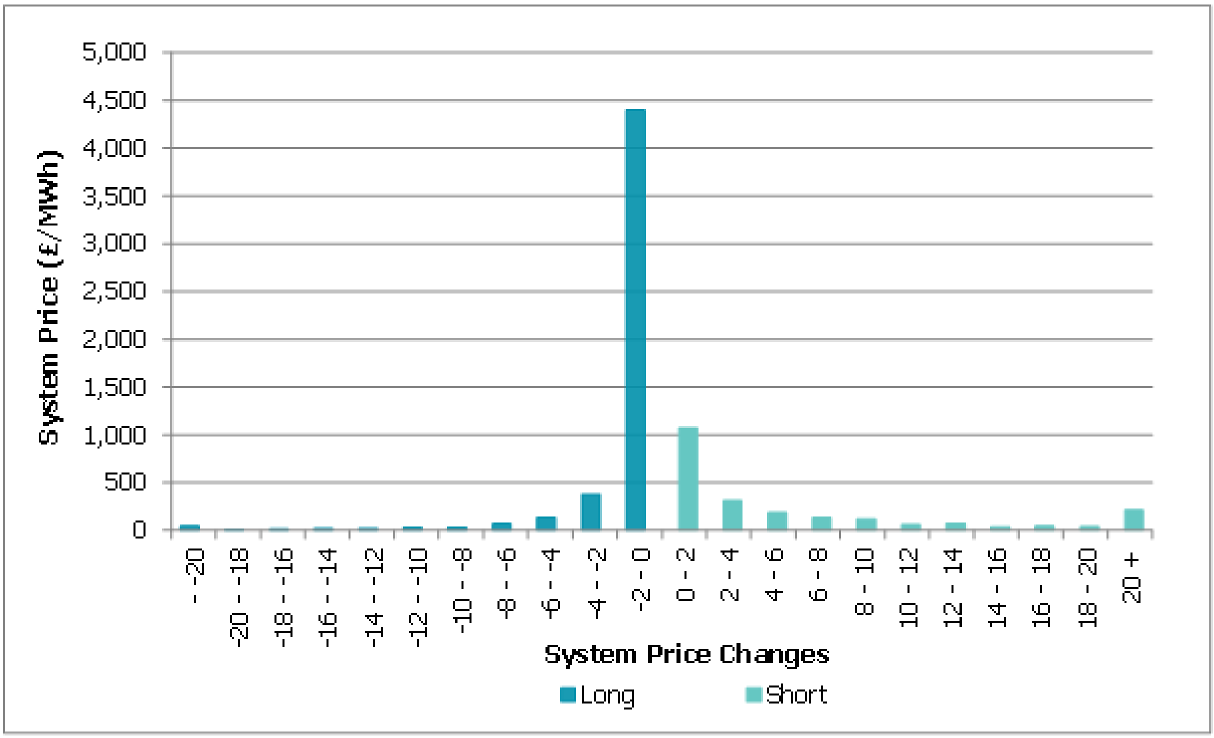


Graph 3.11b - Average difference in P217 and P305 Long System Prices

The November 2018 changes have the biggest impact when the market is short in Settlement Period 35, where the November 2018 price is, on average, £17.50/MWh higher than the live price. When the market is long the biggest average difference between the System Prices occurs in Settlement Period 17 when the November 2018 price is, on average, £1.47/MWh lower than the live price.

Graph 3.12 shows the magnitude of price changes, excluding those Settlement Periods where there were no changes (56% of all Settlement Periods). The average difference in prices when the system was long was £1.38/MWh lower and when the system was short was £3.73/MWh higher.

- There were 212 Settlement Periods where the System Price would have been more than £20/MWh higher when the System was short in the November 2018 scenario.
- The November 2018 calculation would have resulted in 13% more Settlement Periods with negative System Prices.
- There would also have been 16% more Settlement Periods with prices over £100/MWh compared to the live scenario.
- Where there were six Settlement Periods with prices over £1,000/MWh in the live scenario, there would have been 13 Settlement Periods in the November 2018 scenario.
- Under November 2018 pricing scenario the highest System Price would have been £1,990/MWh (live highest £1,529/MWh) and the lowest System Price would have been -£158/MWh (live lowest -£100/MWh).
- The standard deviation of System Prices, regardless of length was 17% higher in the November 2018 scenario.



Graph 3.12 - November 2018 scenario price changes

Case study: Price Difference between the Live and November 2018 scenarios as a result of the increase in VoLL

In this case study, we compare the price stack under the current pricing arrangements with those under the November 2018 arrangements for Settlement Period 39 on 30 September 2016.

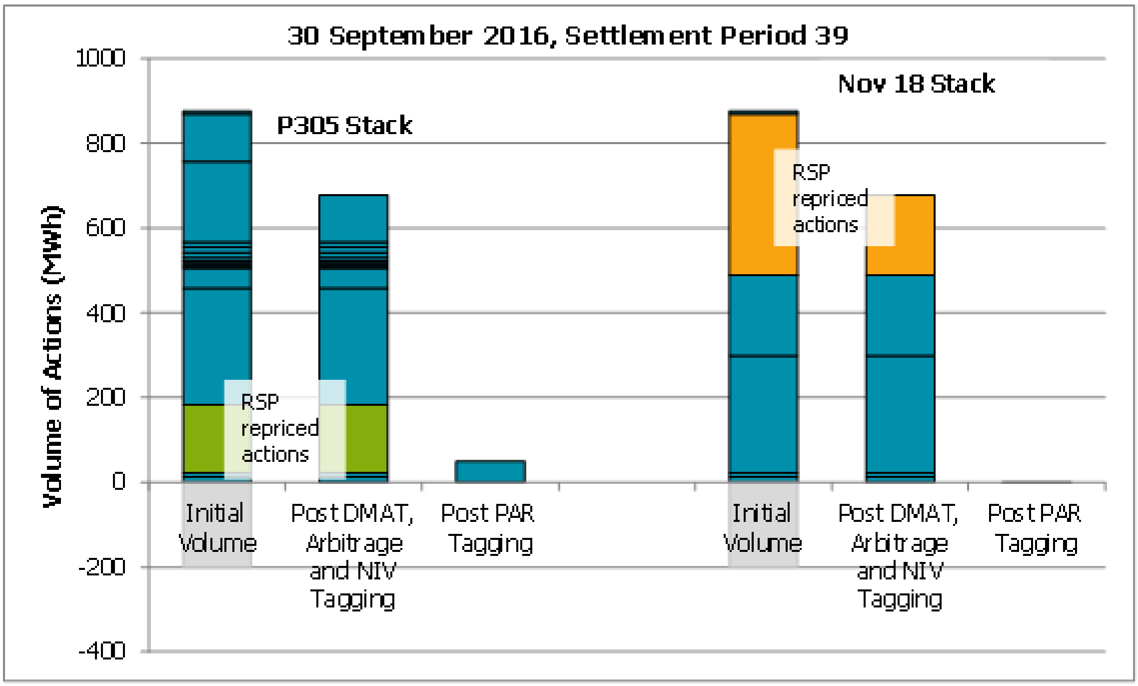
In this Settlement Period, the price difference between the live and November 2018 pricing scenario is due to the **increase in VoLL from £3,000/MWh, to £6,000/MWh in November 2018**.

- The Reserve Scarcity Price (RSP) is calculated by multiplying together the Loss of Load Probability (LoLP) and the Value of Lost Load (VoLL). Where the VoLL is defined as the price at which a customer is theoretically indifferent between paying for their energy and being disconnected. The change in VoLL essentially doubles the RSP for a given Settlement Period, providing the LoLP is constant in both scenarios.
- STOR actions are repriced with the RSP (for the purposes of calculating the imbalance price) when the RSP is greater than the utilisation price.

In Settlement Period 39 on 30 September 2016, the De-Rated Margin (DRM) fell to 1,277MW with a corresponding LoLP of 3.41%. Appling the VoLL gives a live RSP of £102/MWh and a RSP of £204/MWh in the Nov 18 scenario.

Graph 3.13 demonstrates how the lower RSP in the P305 Stack reprices 160MWh of STOR volume. The higher RSP in the Nov 18 Stack reprices 380MWh of STOR volume. The orange RSP repriced actions in the Nov 18 Stack also sit higher up in the stack due to their higher price. The actions repriced by the RSP in the P305 scenario had utilisation prices of between £68/MWh and £98/MWh, whereas the range of repriced actions the Nov 18 stack was £68/MWh to £129/MWh.

After the actions were PAR tagged, in the P305 scenario the RSP repriced STOR are not included in the final 50MWh. The live System Price was calculated to be £143/MWh; the price was set by an Offer Priced at £140/MWh and a £3/MWh BPA. In the Nov 18 stack the RSP repriced STOR actions are at the top of the stack so the System Price is set by the RSP and a BPA of £3/MWh, and hence calculated to be £207/MWh.



Graph 3.13 - P305 and Nov 18 pricing stacks showing RSP repriced actions on 30 September 2016, SP 39

BSC Modification P305 and price volatility

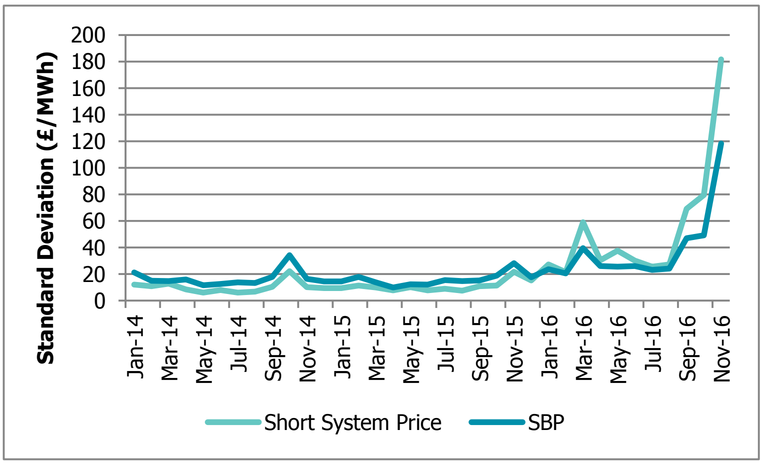
The removal of the dual cash-out price, in combination with the changes to PAR making prices 'more marginal', has impacted the price volatility faced by Parties.

The System Buy Price (SBP) is the price paid by a Party that has a short imbalance position for that Settlement Period. The System Sell Price (SSP) is the price paid to a Party with a long imbalance position for that Settlement Period. Before BSC Modification P305, the Market Index Price (MIP) was paid to or by Parties with imbalances in the opposite direction to the system. This would mean that when the Market was short the SSP would set at the MIP, the SBP, would be calculated by the Main Price Calculation. The opposite would be true if the Market was long.

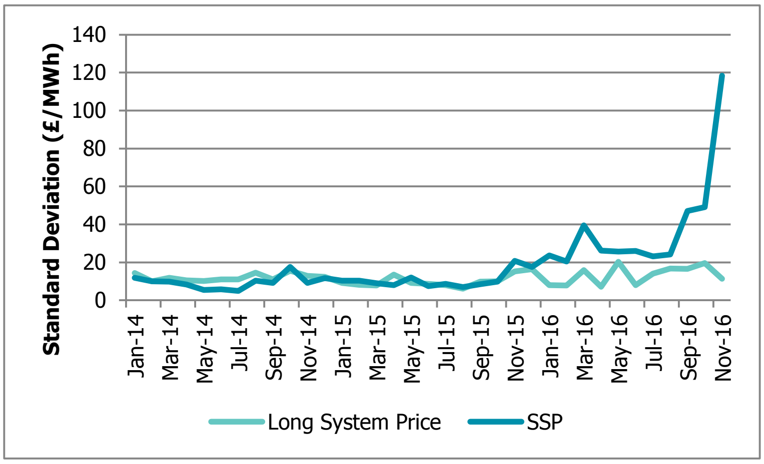
The System Sell price (SSP) and System Buy Price (SBP) are now equal to each other in every Settlement Period as a result of the single System Price calculation. The price calculation reflects the cost of sell actions taken when the system is long, and buy actions taken when the system is short. Because of the difference between the prices of buy and sell actions, there can be a material price change when the system changes direction.

This can be illustrated by looking at the standard deviation of prices. **Graph 3.14** shows the monthly standard deviation of prices that would have been faced by a Party that was always short (System Buy Price or SBP), compared to the standard deviation of prices when the system was short (Short System Price). Both of these have increased since the introduction of P305.

Graph 3.15 shows the standard deviation of prices that would have been faced by a Party that was always long (System Sell Price or SSP), compared to the standard deviation of prices when the system was long (Long System Price). This shows the increased price volatility in prices paid to Parties with long imbalances following the implementation of P305. In contrast the price volatility for a long system has remained largely constant between £7/MWh and £20/MWh.



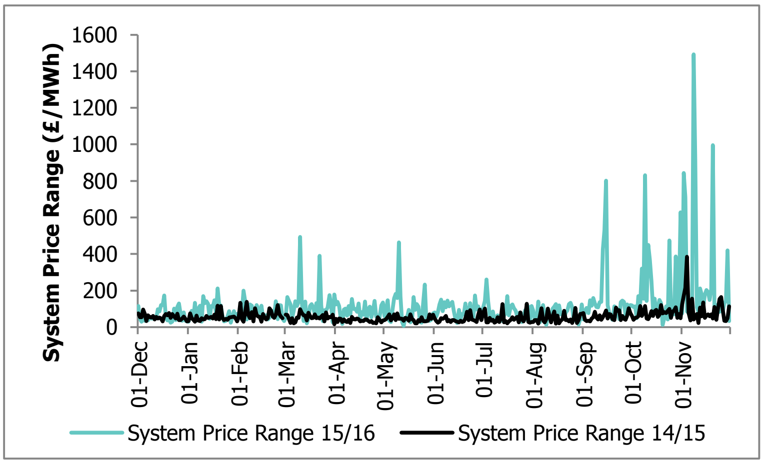
Graph 3.14 - Standard Deviation of System Prices for a Short System and for a Party that is Short - System Buy Price (SBP)



Graph 3.15 - Standard deviation of System Prices for a long system and for a Party that is Long - System Sell Price (SSP)

The removal of dual pricing and more marginal System Price calculation increases the range of prices a Party could have applied to their Energy Imbalance Volumes in a day.

Graph 3.16 gives the range of prices faced each day between December and November in 2014/15 and 2015/16. There are 163 days in 2015/16 with a price range greater than £100/MWh, compared to seven in 2014/15. The increase in the range of System Prices over a day is a consequence of price spikes. This in turn is related to;



Graph 3.16 - Range of System Prices by day

- Decrease in Price Average Reference (PAR) from 500MWh to 50 MWh. Previously an expensive Offer or Bid accepted in one Settlement Period would be volume weighted as part of 500MWh of actions. The reduction to 50MWh reduces the dampening effect of the other actions. Hence, a price spike (positive or negative) is more likely when an expensive Offer or Bid is accepted in a Settlement Period.
- Introduction of Reserve Scarcity Pricing (RSP). This has brought in repricing STOR actions as a function of the De-Rated Margin (DRM). This caused a price spike in October 2016 during a period of tight margins where the most expensive price setting action was priced by the RSP.

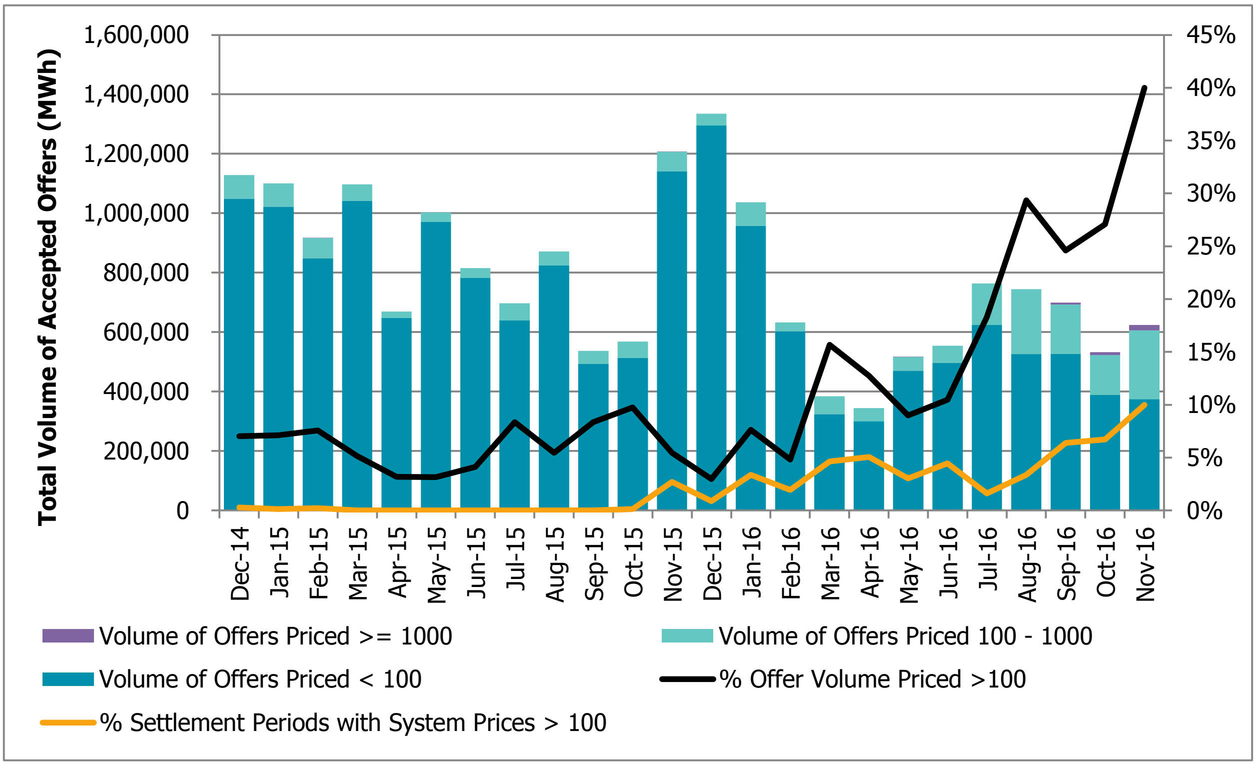
Autumn has days with the greatest range of System Prices, the price range was on average £210/MWh per day in this season.

Bids and Offers affecting number of extreme System Prices

Extreme pricing events refer to Settlement Periods with System Prices over £100/MWh or under £0/MWh. In 2014/15 0.3% of Settlement Periods had System Prices over £100/MWh or under £0/MWh, but in 2015/16 this figure went up to 5%. The increase in these extreme prices can be attributed to:

- Reduction in PAR making prices more marginal
- Introduction of Reverse Scarcity Pricing, STOR actions are priced according to the energy margins for that period
- Increase in the volume of accepted Offers priced over £100/MWh.

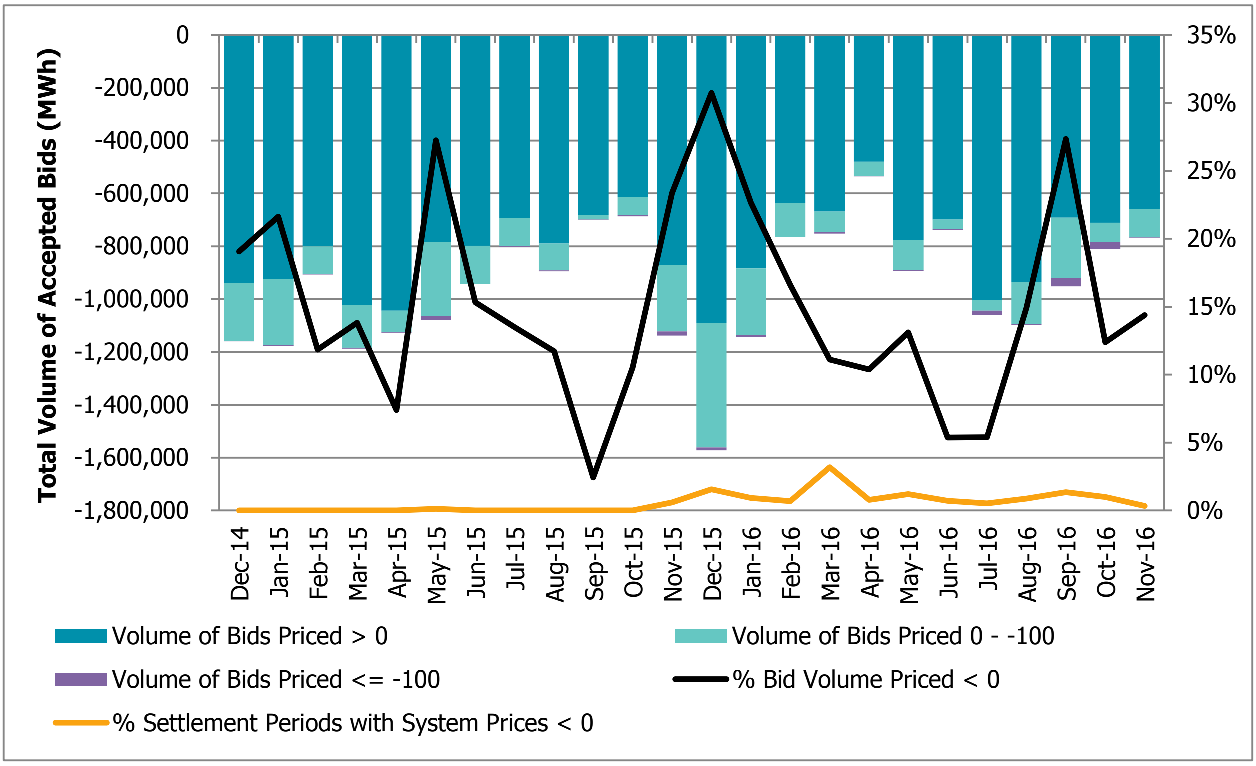
BSC Modification P305 uses the most expensive 50MWh of accepted action volumes after flagging and tagging to calculate a volume weighted price for a given Settlement Period. As a result, the higher priced Offers have more impact on the System Price than when the PAR was larger. **Graph 3.17** shows how the volume of Offers priced over £100/MWh has increased to 40% of all Offer volume in November 2016. Combined with the reduction in PAR this led to 10% of all Settlement Periods in November having System Prices over £100/MWh. 2015/16 has also seen six System Prices over £1,000/MWh in November, there were no prices over £1,000/MWh in the previous four years.



Graph 3.17 - Total volume of accepted Offers split by price (£/MWh), also showing the percentage of Offer volume priced over £100/MWh and the percentage of System Prices priced over £100/MWh

Graph 3.18 shows the change in volumes of negatively priced bids and System Prices. The percentage of negatively priced Bid volume has remained between 31% and 2% of total Bid volume per month. The volume is variable between months and this pattern has not changed since the introduction of P305.

The percentage of all Settlement Periods with negative prices has increased from 0.1% in 2014/15 to 0.8% in 2015/16, largely due to the reduction in PAR. The lowest System Price was -£100/MWh, seen on 19 May 2016, Settlement Period 22.



Graph 3.18 - Total volume of accepted Bids split by price (£/MWh), also showing the percentage of negatively priced Bid Volume and the Percentage of Negatively priced System Prices.

4. OVERVIEW OF PARTIES TRADING CHARGES

This section provides impact analysis on BSC Parties' Trading Charges (specifically, Energy Imbalance charges and Residual Cashflow Reallocation Cashflow) by comparing live prices with the P217A and November 2018 pricing scenarios. Note that the re-calculations do not take into account behavioural changes.

The analysis is broken down by BSC Party types (based on our best knowledge, see appendix two for further information), including vertically integrated players, independent generators, renewable generators, independent suppliers and non-physical traders. This allows us to see how different types of participants are impacted under different pricing scenarios.

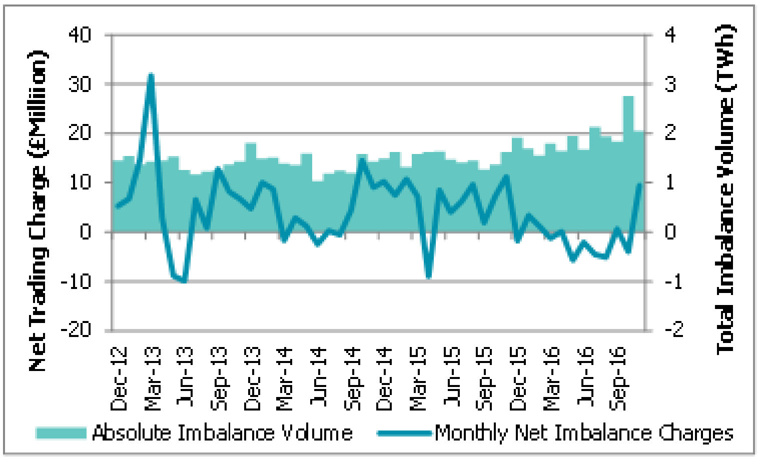
Despite being in the same group, BSC Parties can have very different sizes and trading strategies. Therefore, this analysis is not completely representative of every BSC Party in that group.

Historical Imbalance Trading Charges

This analysis looks at the total net Imbalance Charges faced by Parties from December 2012 to November 2016.

The Energy Imbalance charge is calculated for each half hour as the System Price applied to the Energy Imbalance Volume. Prior to the implementation of BSC Modification P305 on 5 November 2015, there were two imbalance prices for each Settlement Period, the System Buy Price (SBP) and System Sell Price (SSP). The imbalance position of the Party and the length of the system would determine what System Price was applied to calculate a Party's Energy Imbalance charge.

Graph 4.1 shows how the net Energy Imbalance charges have reduced since the implementation of P305, despite increases in Energy Imbalance Volumes. This is expected under a single price mechanism as the market has been long for 69% of Settlement Periods and the prices are lower in this scenario. Further, opposing account imbalance is charged and paid at the same price for Parties using both Production and Consumption Energy Accounts.

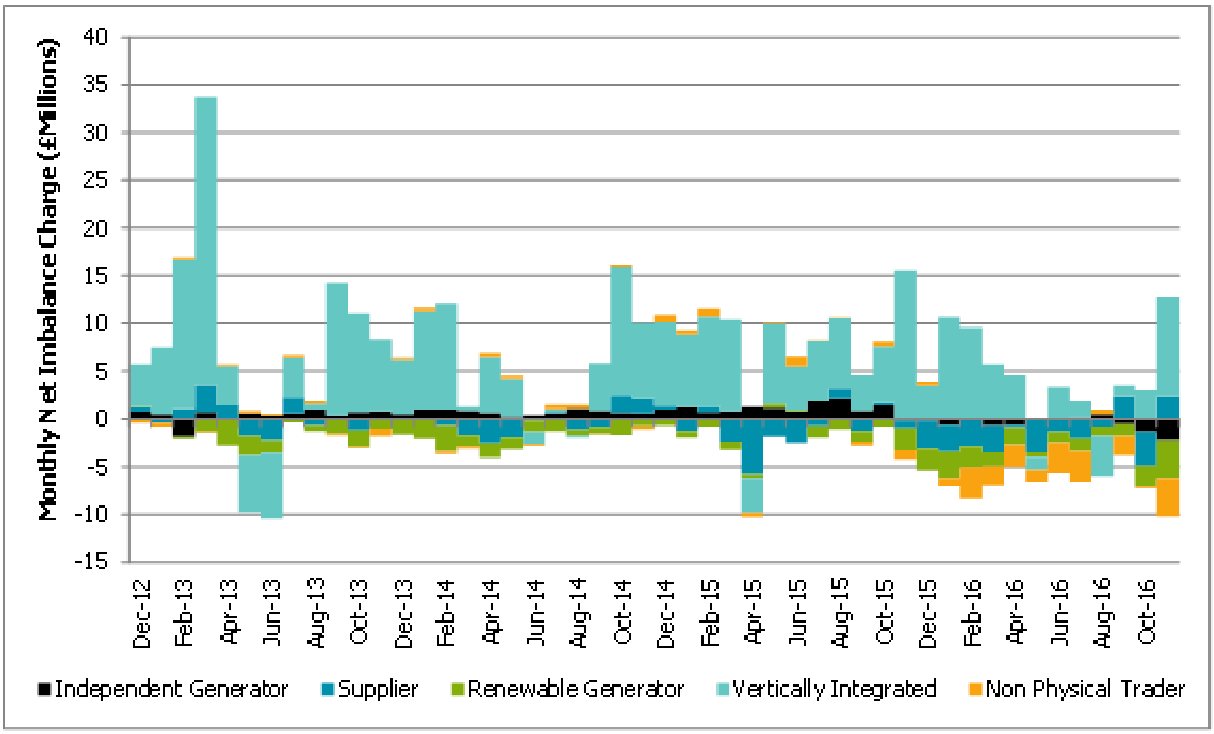


Graph 4.1 - Monthly Net Imbalance Charges and total Imbalance volume.

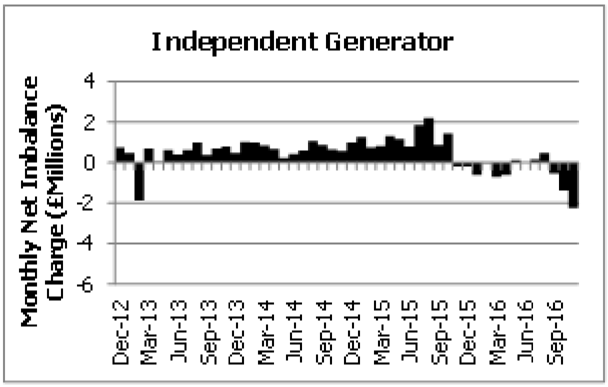
A positive Energy Imbalance charge represents Parties paying out, and a negative imbalance charge represents Parties being paid. Between December 2015 and November 2016 the total net imbalance Charges were -£19 million, in the preceding year these charges were £75 million.

Section 2 covered balancing behaviour in depth, and here we can see a higher percentage of long Settlement Periods occurring since the implementation of BSC Modification P305. Section 3 examined at the average System Price over four years, and here we see the average System Price has decreased since the implementation of BSC Modification P305. These factors have contributed to the decrease in net Energy Imbalance charges since the implementation of P305.

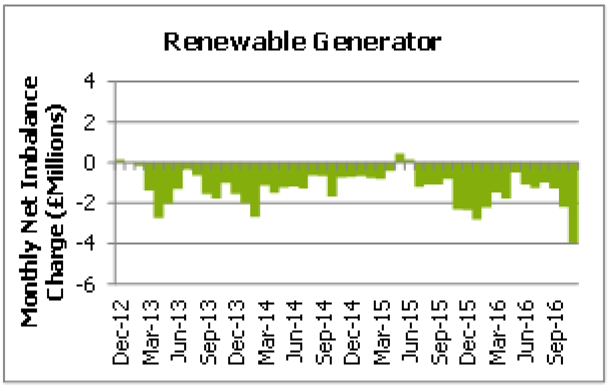
Graph 4.2 shows the split of Trading Charges by Party type over the past four years. Between December 2015 and November 2016 Energy Imbalance charges have decreased (gone more negative) compared to the previous year for all Party Types.



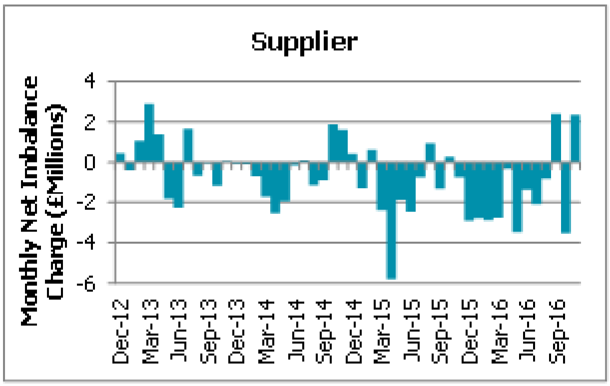
Graph 4.2 - Monthly net Imbalance Charge by Party type



Graph 4.3a – Independent Generator

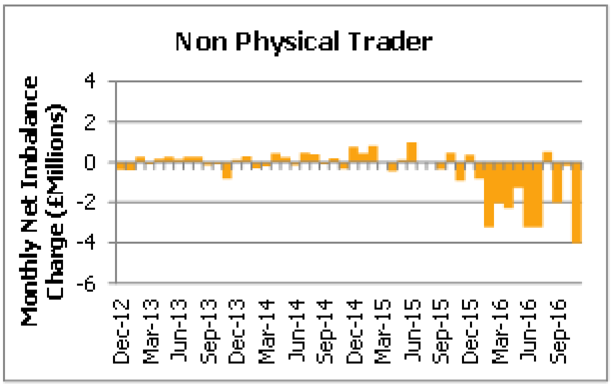


Graph 4.3b – Renewable Generator

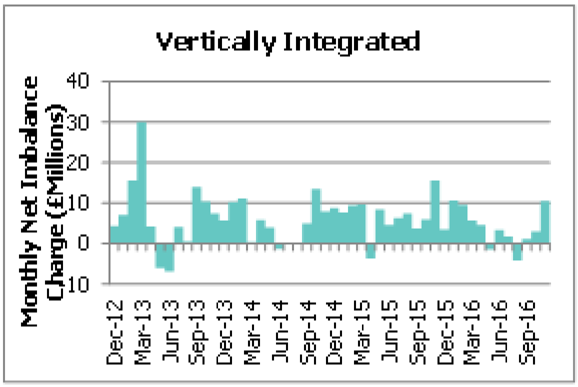


Graph 4.3c - Supplier

Graphs 4.3a to 4.3e inclusive show the monthly net Energy Imbalance Charges for each Party type.



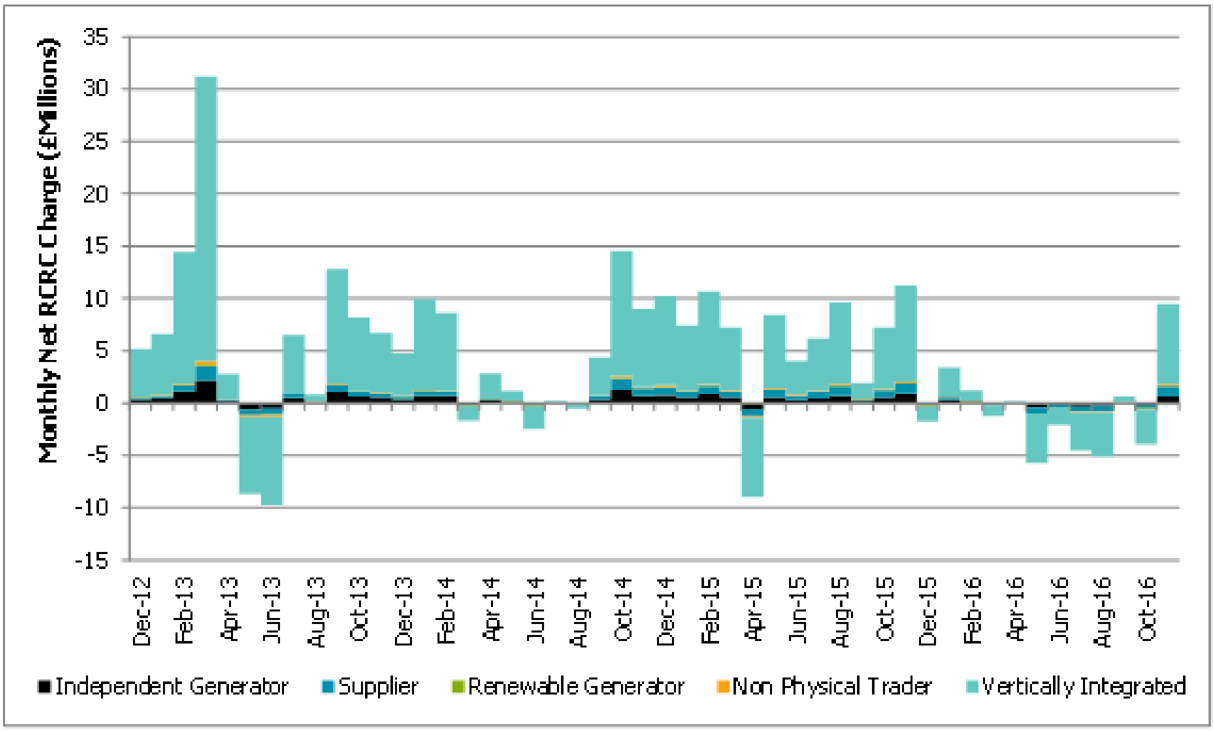
Graph 4.3d – Non-Physical Trader



Graph 4.3e – Vertically Integrated

Non-Physical Traders have had the greatest percentage change in Energy Imbalance charges; they paid a net charge of £1.94 million in 2014/15, which increased to £21.4million in 2015/16. Non-Physical Traders have benefited from the removal of dual pricing, as they no longer need to balance their Production and Consumption Energy Accounts.

Vertically Integrated Parties had the greatest monetary reduction, as net Energy Imbalance charges were reduced by a total of £35.5 million.



Graph 4.4 - Monthly net RCRC by Party Type

Graph 4.4 shows the net RCRC paid each month by Party type. The majority of RCRC are allocated to vertically integrated Parties. This has not changed with the introduction of BSC Modification P305, and was expected given their share of Credited Energy across the market.

P217 Price scenario

BSC Modification P305 was intended to deliver some behavioural change for BSC Parties in the energy market. This makes a comparison of Trading Charges for the same period of time difficult to quantify. There have been new trading Parties, and some old trading Parties have changed their trading strategies since the implementation of P305. Were the live Trading Charges calculated between December 2015 and November 2016 under the P217 pricing scenario, Parties may have used different trading strategies, and therefore incurred different charges. This is important to bear in mind when looking at this analysis.

We consider the impact on two elements of Parties' Trading Charges that will be directly impacted by a change to the System Price calculation:

- **Account Energy Imbalance Cashflow** – this is Energy Imbalance charges made by/to Parties for Energy Imbalance Volumes at the System Price
- **Residual Cashflow Reallocation Cashflow (RCRC)** – Any excess or shortfall in cashflow after all BSC Parties have paid or were paid their Energy Imbalance charges is redistributed amongst BSC Parties pro rata to Credited Energy Volume[7]. Typically, RCRC is paid to Parties, although it can also be a charge.

We have not considered the impact of other elements of Trading Charges which would not have been directly impacted by the P305 changes for example the BM Unit Cashflow, Non-Delivery Charges, System Operator BM Cashflow and Information Imbalance Charge.

The average £/MWh impacts over the year are shown in **Table 4.1**. The impact for each Party is calculated as the net Energy Imbalance charge difference between the two scenarios, between December 2015 and November 2016, divided by the absolute Energy Imbalance Volume when long, short or regardless of length. These impacts are then averaged to give an average impact for a Party type. Positive impacts represent increased charges and negative impacts represent reduced charges under P217 Scenario.

Party Type	Average Energy Imbalance Charge Impact when Party is Short (£/MWh)	Short Standard Deviation (£/MWh)	Average Energy Imbalance Charge Impact when Party is Long (£/MWh)	Long Standard Deviation (£/MWh)	Average Energy Imbalance Charge Impact regardless of length (£/MWh)	Standard Deviation (£/MWh)
Vertically Integrated	4.39	4.65	6.91	10.26	5.51	5.64
Supplier	6.19	3.11	6.94	6.15	6.76	4.53
Non Physical Trader	23.75	62.64	26.14	71.54	23.44	63.97
Independent Generator	4.00	2.75	9.83	14.17	8.82	12.35
Renewable Generator	7.73	5.82	9.16	10.04	8.66	8.59

Table 4.1 - Average impact by Party Type of using Pre-P305 Prices to recalculate Imbalances Charges between December 2015 and November 2016

[7] Credited Energy Volume is the allocation of metered volume from BM Units to Energy Accounts in a Settlement Period, taking account of Transmission Loss Multipliers and applying any Metered Volume Reallocation Notices that are in force

The majority of Parties would have incurred additional Energy Imbalance charges without the implementation of P305. The magnitude of the difference in Energy Imbalance charges was less when the Party was short compared to long. Regardless of length Non Physical Traders have the greatest impact and Vertically Integrated the smallest impact when P305 is compared to P217 Prices.

The larger impact when long and short for Non Physical Traders is driven by behavioural change. The single Imbalance Price removes the need for a Party to balance the Production and Consumption Accounts. Where a Party has equal and opposite Energy Imbalance Volumes in the Production and Consumption accounts the net Energy Imbalance charge for the Party in zero under the P305 scenario. However, under the P217 dual pricing scenario the net charge for the Party is a function of the difference between the System Buy and Sell Price for that Settlement Period.

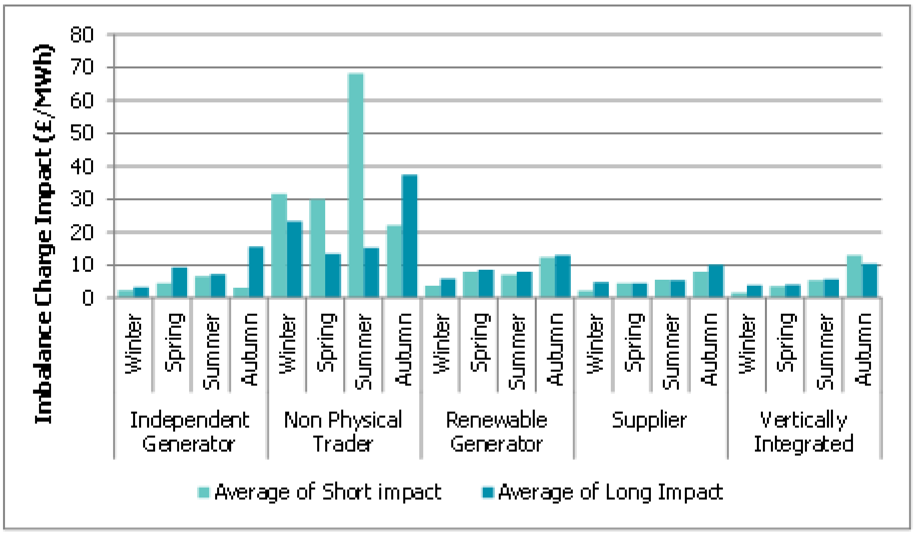
Standard deviation is a measure of how scattered (or varied) the data can be away from its mean value in both directions. The standard deviation of Energy Imbalance charge impact on Non Physical Traders appeared to be the highest amongst all, suggesting more variation in Energy Imbalance charges (in both directions) for these Parties.

Party Type	Average RCRC Impact regardless of length (£/MWh)	Standard Deviation (£/MWh)	Average RCRC + Energy Imbalance Charge Impact regardless of length (£/MWh)	Standard Deviation (£/MWh)
Vertically Integrated	-0.08	0.19	0.38	1.36
Supplier	-0.21	0.23	2.68	4.92
Non Physical Trader	-0.02	0.06	2.55	3.67
Independent Generator	-0.01	0.27	4.30	12.99
Renewable Generator	0.03	0.24	3.90	10.17

Table 4.2 – RCRC impact and combined impact of RCRC and Imbalance Charges

Table 4.2 considers the impact of changes in Residual Cashflow Reallocation Cashflow (RCRC) per MWh of Credited Energy Volume, and looks at the combined impact of RCRC and Energy Imbalance Charges. RCRC are allocated on a Credited Energy Volume basis, hence larger Parties receive the greatest RCRC. There is a large amount of variation in average RCRC + Energy Imbalance charge impacts per MWh of Credited Energy Volume. This is a result of the groupings containing Parties of varying sizes. The average in this case is not representative of the population due to the high standard deviations.

Graph 4.5 considers the average impact on Energy Imbalance charges, by Season and Party type. Non-Physical Traders have the greatest positive impact in all seasons when the market is long or short. On average the greatest impact on long Party charges for all Party types is in autumn. This is due to the high live prices seen in this season, and high prices being less pronounced in the P217 scenario.



Graph 4.5 - Average Long and Short Imbalance Charge Impact per Party by BSC Season, when P217 scenario is compared against Live

November 2018 Price scenario

This analysis compares Parties' charges using live prices against the November 2018 price scenario. The impacts of this on Energy Imbalance charges, over the 12 month period between December 2015 and November 2016 are shown in **Table 4.3**. Note that positive impacts represent increased charges and negative impacts represent reduced charges in the November 2018 scenario when compared against the live charges.

Party Type	Average Energy Imbalance Charge Impact when Party is Short (£/MWh)	Short Standard Deviation (£/MWh)	Average Energy Imbalance Charge Impact when Party is Long (£/MWh)	Long Standard Deviation (£/MWh)	Average Energy Imbalance Charge Impact regardless of length (£/MWh)	Standard Deviation (£/MWh)
Vertically Integrated	1.80	1.88	-2.08	2.63	-0.37	1.40
Supplier	1.96	1.04	-0.80	1.72	0.71	1.87
Non Physical Trader	1.04	1.81	-0.66	1.46	0.15	1.88
Independent Generator	1.46	1.71	-3.61	2.50	-1.72	2.37
Renewable Generator	1.03	0.54	-0.86	1.27	-0.49	0.87

Table 4.3 - Average impact by Party Type of using November 2018 Prices to recalculate Imbalances Charges between December 2015 and November 2016

The November 2018 pricing scenario results in additional Energy Imbalance charges for BSC Parties when the Parties are short, and reduced Energy Imbalance charges when Parties are long. This trend follows regardless of Party type. Standard deviations of Energy Imbalance charge impacts show that Independent Generators have the greatest spread of impacts, regardless of length.

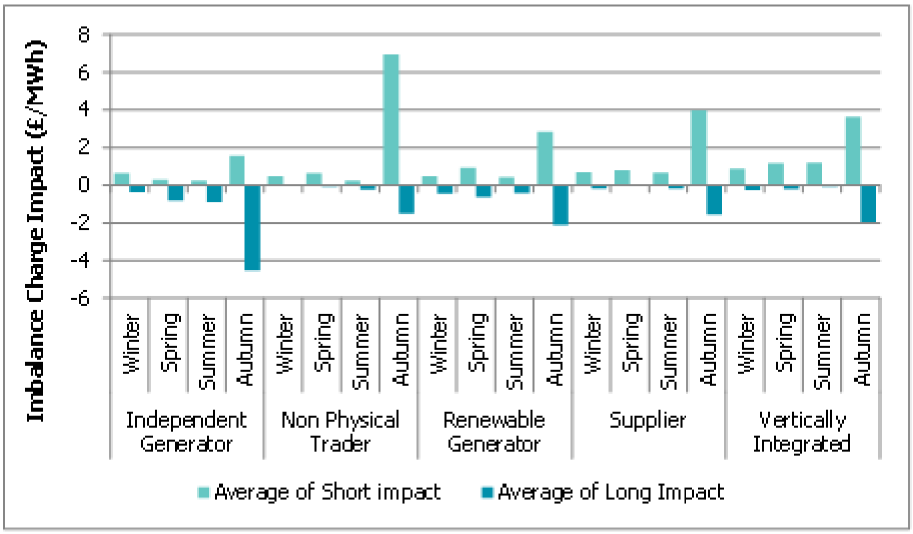
If Energy Imbalance charges were calculated with November 2018 Prices, Suppliers and Non Physical Traders would see an average increase of £0.15/MWh and £0.71/MWh respectively in their Energy Imbalance charges per MWh of Energy Imbalance Volume regardless of length. In contrast, other Party types would see an average reduction.

Table 4.4 examines the average RCRC impact per MWh of Credited Energy Volume. The impact is negligible; Parties RCRC would have largely remained the same in the November 2018 scenario. The average RCRC + Energy Imbalance charge impact per MWh of Credited Energy Volume is greatest for independent Generators. RCRC and Imbalance charges are on average £0.68/MWh less if System Prices were calculated under the November 2018 pricing scenario.

Party Type	Average RCRC Impact regardless of length (£/MWh)	Standard Deviation (£/MWh)	Average RCRC + Energy Imbalance Charge Impact regardless of length (£/MWh)	Standard Deviation (£/MWh)
Vertically Integrated	0.00	0.03	-0.02	0.10
Supplier	-0.01	0.01	0.30	1.71
Non Physical Trader	0.00	0.00	0.03	0.17
Independent Generator	0.00	0.02	-0.68	2.00
Renewable Generator	0.00	0.01	-0.29	0.89

Table 4.4 - RCRC impact and combined impact of RCRC and Imbalance Charges

Graph 4.6 – shows that autumn has the greatest average Energy Imbalance charge impacts for long and short imbalances and all Party types. This is because of the high prices in this season with the November 2018 changes meaning prices become more marginal under this Scenario.



Graph 4.6 - Average Long and Short Imbalance Charge Impact per Party by BSC Season, when November 2018 scenario is compared against live

5. PARAMETER ANALYSIS

This section considers the more detailed aspects of Energy Imbalance Pricing. We consider:

- The impact of moving to a smaller Price Average Reference (PAR), on the number actions setting the price, in the pre-P305, live and November 2018 Scenarios
- Incidents of the **Reserve Scarcity Price** during the period, and how these relate to the Utilisation Prices of **Short Term Operating Reserve** (STOR) balancing capacity
- De-Rated Margins (DRMs) across the period and National Grid's forecasts of these
- The impact of including non-BM STOR volumes in the System Price calculation

Reduction in the Price Average Reference Volume (PAR) Value

The Price Average Reference Volume (PAR) volume is used to tag balancing actions such that a minimum volume of PAR MWh is used to set the Energy Imbalance Price. The value of PAR was reduced to 50MWh, from 500MWh, by BSC Modification P305.

The P305 workgroup noted concerns that a smaller PAR value could amplify any errors or inefficiencies in the current calculation, as there would be a smaller number of actions setting the price. Potential errors or inefficiencies included:

- Incorrect flagging of the prices of system balancing actions by the Transmission Company
- The impact of plant dynamics, leading to a high-priced Offer being accepted in one Settlement Period to resolve an issue at that time. However, because of the BMU's physical abilities, the Offer may have to persist for a longer period, impacting future Settlement Periods where a lower-priced Offer would otherwise have been accepted.

Table 5.1 compares the PAR between December 2015 and November 2016 for the PAR 500MWh (P217) scenario, PAR 50MWh (live) scenario and PAR 1MWh (Nov 18) scenario. The average number of actions in the PAR decreases as the PAR value decreases, as does the percentage of total actions left in the PAR. It also shows that the number of Settlement Periods with only one action setting the price increases as the PAR value decreases.

Note that when determining a small PAR value and multiple actions have the same price, the PAR Tagging will use the actions pro-rata to the action volume. In an example of PAR being 1MWh, several actions at the same price could make up the 1MWh PAR. This would make no difference to the final price compared to using one of the actions, and therefore the average number of actions in PAR will not decrease significantly as PAR gets closer to 1MWh.

	Average number of actions in the PAR	Proportion of SP's with only one action in the PAR	Average % of total actions in the PAR	Max number of actions in the PAR
PAR500 (P217)	13.44	4%	35%	81
PAR50 (live)	6.08	10%	16%	50
PAR1 (Nov-18)	4.05	20%	11%	47

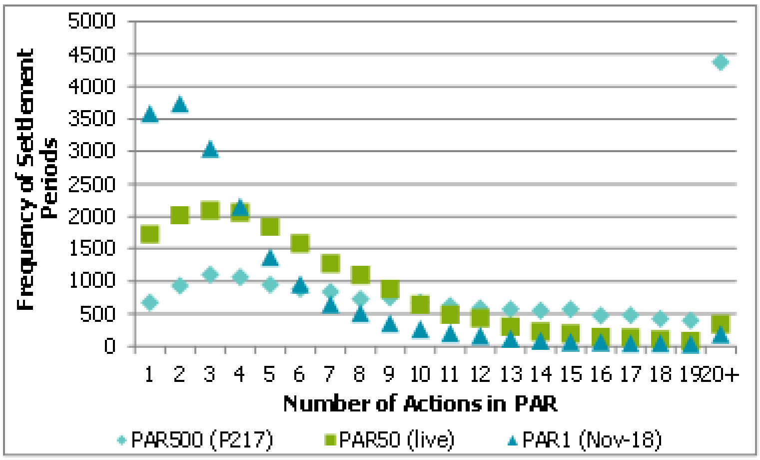
Table 5.1 - Average number of balancing actions left in the PAR

Graph 5.1 shows the frequency of the number of price setting action left in the PAR. In the PAR50 and PAR500 scenarios, the most frequent number of actions setting the price was three, for the PAR1 scenario this was two. In the PAR1 Scenario 79% of Settlement Periods had five or less actions in the PAR, this was 55% of Settlement Periods for PAR50 and 26% for PAR500.

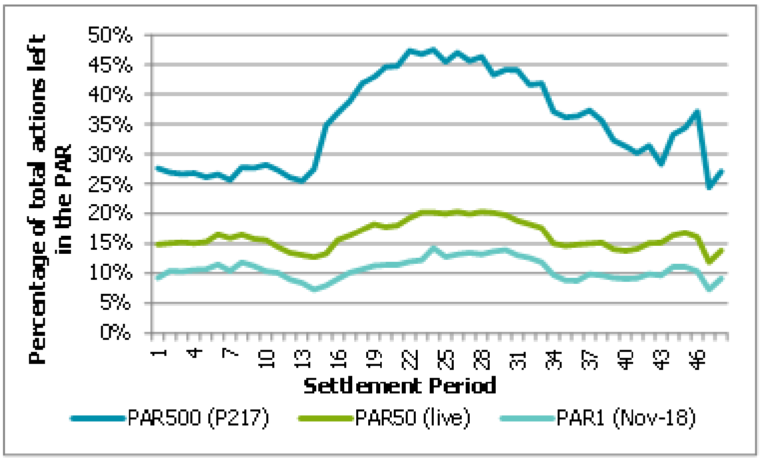
The average percentage of total actions left in each of the scenarios after PAR tagging is shown in **Graph 5.2.** Actions are removed by Arbitrage, NIV and DMAT tagging prior to PAR tagging.

In the PAR1 scenario, an average of 11% of the accepted actions taken remain in the calculation after PAR tagging. There are on average 19% less actions in the PAR50 scenario compared to the PAR500, and 6% less actions in the PAR1 scenario than the PAR50 scenario.

The potential for erroneous system flags was mentioned as a concern during the P305 workgroup. National Grid's system flagging process is the ex-ante identification of BMUs or individual actions which could potentially be classified as system balancing actions (e.g. actions that were taken to resolve locational constraints). The process for this is set out in their System Management Action Flagging Methodology (SMAF) document[8].



Graph 5.1 - Frequency of Settlement Periods by number of actions left in the PAR and size of PAR



Graph 5.2 - Average percentage of actions left in the PAR by Settlement Period

[8] This is one of the Transmission licence C16 statements, and can be found at: http://www2.nationalgrid.com/uk/industry-information/electricity-codes/balancing-framework/transmission-license-c16-statements/

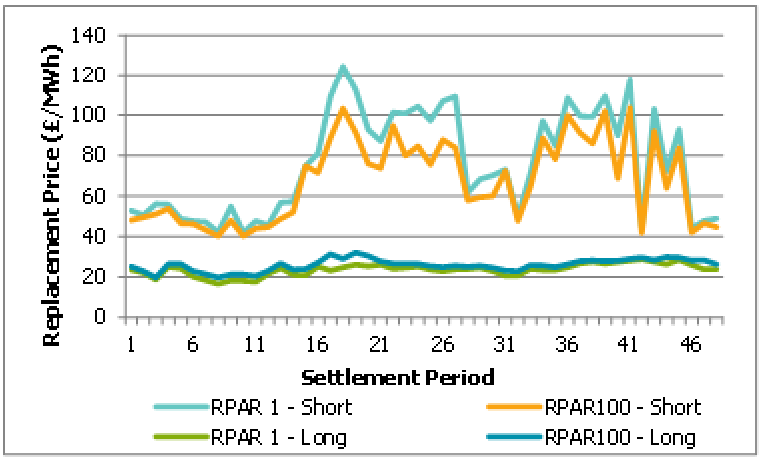
Reduction in the Replacement Price Average Reference Volume (RPAR)

The Replacement Price is the price used for any actions that have become un-priced due to flagging and classification. Flagging is the identification of actions which may have been taken for 'system' management reasons (e.g. locational constraints). If a flagged action is out-of-merit (i.e. an action that is more expensive than the next most expensive unflagged action) it will lose its price, and requires a Replacement Price.

The Replacement Price is set in a similar way as the final Imbalance Price – but only actions with their original price are used, and the weighted average used to set the price is a smaller volume. Before BSC Modification P305 this volume (the Replacement Price Average Reference Volume, RPAR) was the most expensive priced 100MWh ("RPAR100"). P305 reduced the RPAR volume to 1MWh ("RPAR1").

Graph 5.3 shows average Replacement Prices across the day, split by a long and short system, and how the reduced RPAR value has affected them. As expected, Replacement Prices are higher when the system is short as the Replacement Price tends to re-price flagged actions downwards. Actions were priced by an average of £67.43/MWh under RPAR100, and £76.26/MWh under RPAR1.

When the system was long, the Replacement Price was lower under RPAR1 than RPAR100. Under RPAR100, the initial price of actions was re-priced upwards to an average of £25.84/MWh, and under RPAR1 actions were re-priced upwards to an average of £23.59/MWh.



Graph 5.3 - Impact of changing the Replacement Price Average Reference Volume (RPAR)

De-Rated Margin (DRM), Loss of Load Probability (LoLP) and the Reserve Scarcity Price

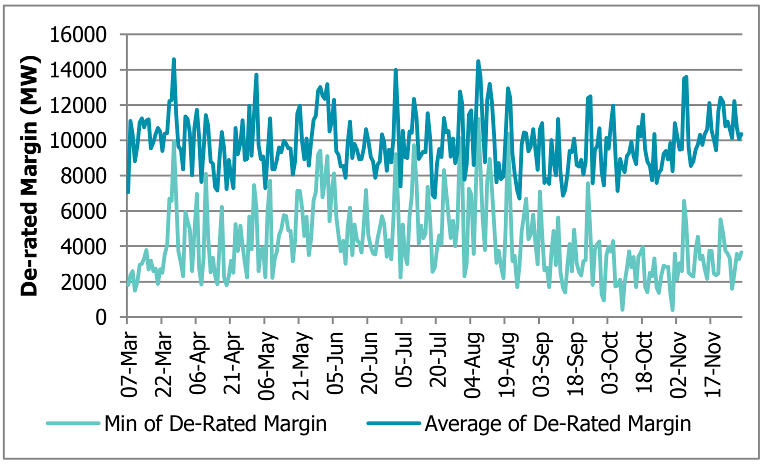
BSC Modification P305 introduced the Reserve Scarcity Price (RSP) which uplifts the prices of STOR balancing capacity when it is higher than the capacity's original Utilisation Price.

The RSP is designed to respond to capacity margins so that it rises as the system gets tighter (i.e. 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, currently set at £3,000/MWh). For each DRM, there is an associated LoLP, which is multiplied by VoLL to determine the RSP[9].

In November 2018 the VoLL will rise to £6,000/MWh and a 'dynamic' LoLP function will also be introduced.

[9] The System Operator has determined a relationship between each DRM and the LoLP which will determine the RSP. The methodology for LoLP is set out in the LoLP Methodology statement: https://www.elexon.co.uk/wp-content/uploads/2014/10/37_244_11A_LOLP_Calculation_Statement_PUBLIC.pdf

Graph 5.4 shows the daily minimum and average De-Rated Margin since data was available (7 March 2016). October had the lowest De-Rated Margins; the average daily minimum over the month was 2,473MW. The RSP is used to re-price STOR actions in the Imbalance Price calculation if it is higher than the original Utilisation Price of the STOR capacity.



Graph 5.4 Daily minimum and average DRMs

Table 5.2 shows the LoLPs and RSPs that the 10 lowest DRMs equated to[10]. The system was long in three of these Settlement Periods, so Offers did not set the System Price.

49 actions were repriced in September 2016 and 81 STOR actions were repriced in October 2016. In all other months the margins were not low enough to reprice actions. Of the repriced actions 125 came from Balancing Services Adjustment Actions (BSAAs) and five from Offers submitted via the Balancing Mechanism. The average increase in price as a result of RSP repricing was £221.51/MWh.

There were two Settlement Periods between March 2016 and November 2016 where the RSP repriced actions set the System Price. These were Settlement Period 39 on 9 October and Settlement Period 35 on 31 October. The final System Price is higher than the RSP as the BPA has been added.

Date	SP	DRM (MW)	LoLP	RSP (£/MWh)	Number of RSP Repriced Actions	System Length	System Price (£/MWh)
31/10/2016	36	387.23	0.2902	**870.54**	2	Long	41.43
09/10/2016	39	414.96	0.2766	**829.92**	27	Short	843.10
31/10/2016	35	553.49	0.2148	**644.29**	2	Short	660.97
01/10/2016	39	932.24	0.0915	**274.57**	27	Short	142.69
31/10/2016	37	1,065.56	0.0639	**191.69**	0	Long	38.51
30/09/2016	39	1,277.17	0.0341	**102.16**	33	Short	143.08
30/10/2016	37	1,321.73	0.0295	**88.42**	0	Short	167.64
25/10/2016	38	1,359.52	0.0260	**78.05**	23	Short	123.17
14/09/2016	41	1,386.69	0.0238	**71.31**	16	Short	164.05
20/10/2016	38	1,407.65	0.0221	**66.42**	0	Long	42.02

Table 5.2 - Ten lowest De-Rated Margins and corresponding Reserve Scarcity Prices

[10] Due to data issues (see appendix 3) DRM, LoLP and RSP data was only operational from Settlement Period 27 on 7 March 2016.

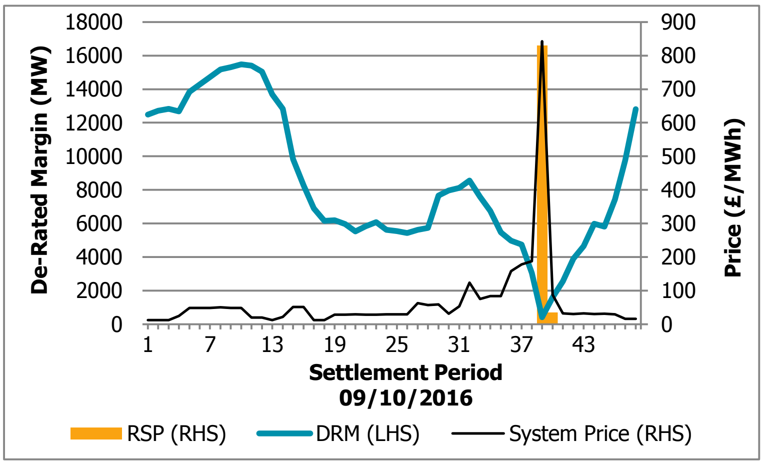
Case study: Reserve Scarcity Price Setting the System Price

This case study looks at 9 October 2016 where the Reserve Scarcity Price Set the System Price in Settlement Period 39.

BSC Modification P305 introduced the Reserve Scarcity Price (RSP). This potentially uplifts the prices of Short Term Operating Reserve (STOR) flagged actions for the purposes of calculating an Imbalance Price. The RSP is a function of the De-Rated Margin (DRM) and the Loss of Load Probability (LoLP), so that as the DRM gets smaller, the RSP rises. This reflects scarcity of available generation on the system. The RSP can rise to a maximum of £3,000/MWh in practice, note that a zero DRM gives a 50% LoLP and hence a £1,500/MWh RSP. (RSP=VoLL*LoLP).

Graph 5.5 shows the DRM on 9 October fell to 414MW in Settlement Period 39, and the corresponding LoLP was 27.66%. This resulted in the **£829.92/MWh** RSP. As this was sufficiently high and during a Short Term Operating Reserve (STOR) Availability Window, actions were re-priced.

In this Settlement Period, three STOR provider Combined Cycle Gas Turbine (CCGT) BM Units and 24 STOR flagged Balancing Service Adjustment Actions (BSAAs) were re-priced at the RSP. This is because the RSP was higher than their Utilisation Price. The Utilisation Price of these actions ranged from £68.49/MWh to £160/MWh.



Graph 5.5 - De-Rated Margin and Reserve Scarcity Price

The Price Average Reference (PAR) is currently 50MWh; the actions in the PAR are all from repriced STOR actions. Hence RSP from these actions combined with a Buy Price Price Adjuster (BPA) of £13.18/MWh set the System Price for this Settlement Period to **£843.10/MWh**.

When the price is recalculated using the pre-P305 scenario the Main Price is **£169.45/MWh**. The £673.65/MWh difference in the P217 and P305 prices can be attributed to all of these changes: RSP repriced STOR, inclusion of STOR provider BSAA, PAR reduction and BPA differences.

DRM as an informational tool

National Grid's one hour forecast of DRM is the value used to set the LoLP and therefore the RSP. Indicative forecasts of DRM and LoLP are also available from eight, four and two hours ahead of the start of each Settlement Period. Values are also calculated at 12.00 each day for all Settlement Periods up to the end of the next Operational Day, defined under the Grid Code as the period from 05.00 on one day to 05.00 on the following day, for which Gate Closure has not yet passed.

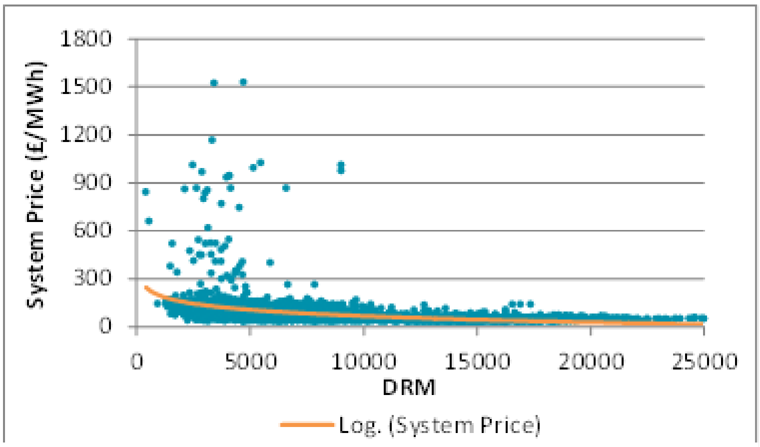
These forecasts act as an informational tool for market participants to drive balancing and prices in the Balancing Mechanism, particularly when margins are low. With the data available, we considered whether DRMs appear to have had an impact on System Prices.

Graph 5.6 shows DRM plotted against System Price for a short System. A weak correlation can be seen. Prices become higher as the DRM becomes lower but there are many other factors affecting the price (e.g. the price of accepted Offers and BSAAs, length of the NIV and the time of day).

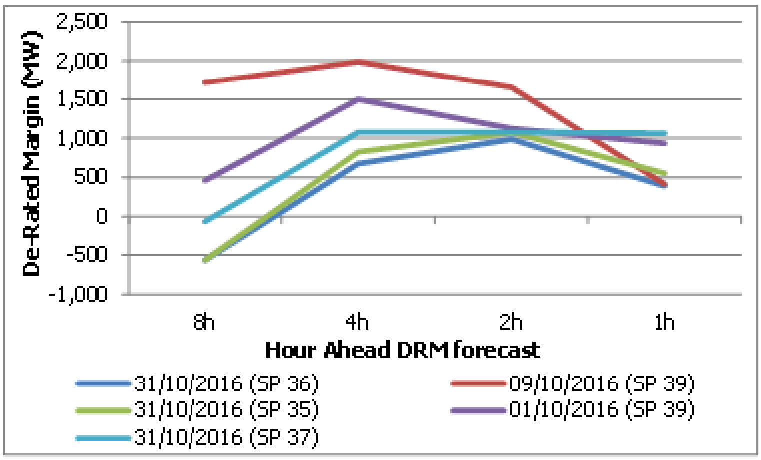
We also considered how the forecasts of the five lowest DRMs evolved across the different forecasts (**Graph 5.7**). In the case of the five lowest 1 Hour Ahead DRM submissions, the difference from the 8 Hour Ahead submissions range from 475MW to 1,571MW.

On 9 October, Settlement Period 39, the 4 hour forecast was 1,571MW above the 1 hour forecast. This difference in DRMs represented a £823.16/MWh difference in RSP.

There was also a large discrepancy between the 8 hour and 1 hour forecast on 31 October, Settlement Period 25, where the eight hour forecast was 1,114MW below the 1 hour forecast. The RSP would have been £2,366/MWh at the 8 hour forecast, but this price reduced to £644/MWh with the 1 hour forecast.



Graph 5.6 - DRM plotted against System Price, where system is short

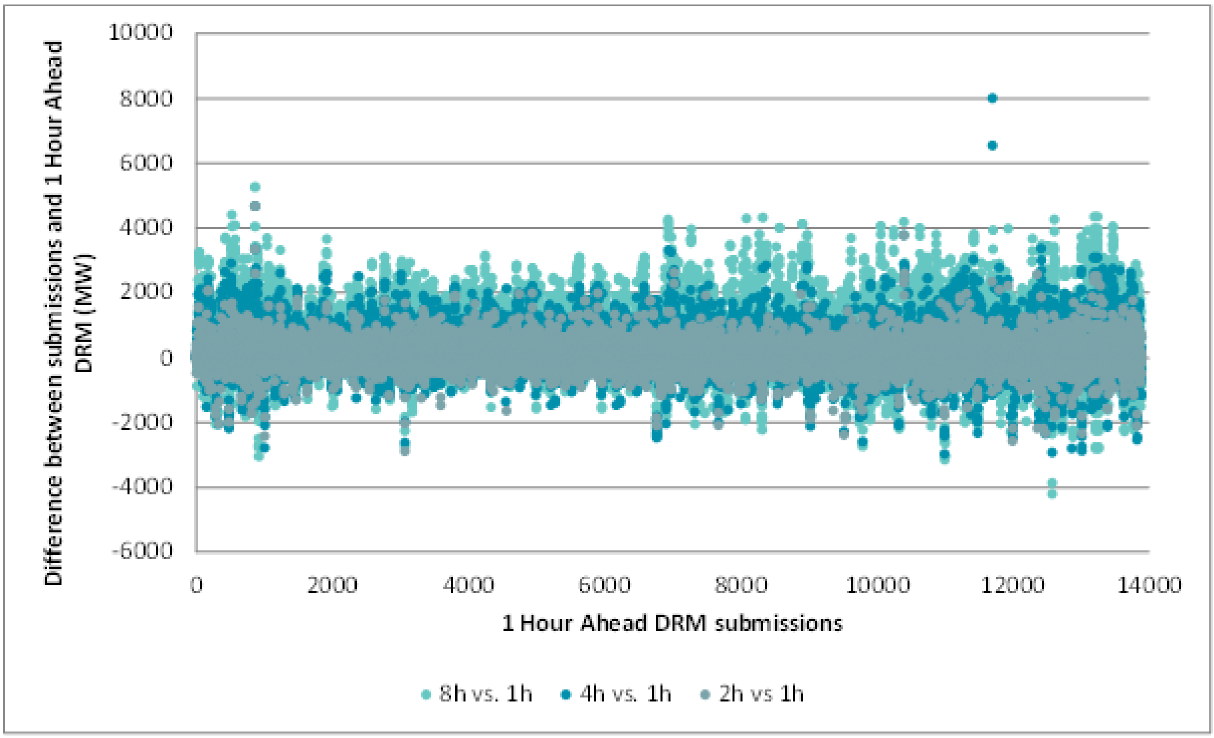


Graph 5.7 - Five lowest DRMs, forecast variations through each submission

Graph 5.8 shows the difference in DRM values between the indicative submissions (8, 4 and 2 Hour Ahead) and the final 1 Hour Ahead submission, which will set the LoLP and the RSP.

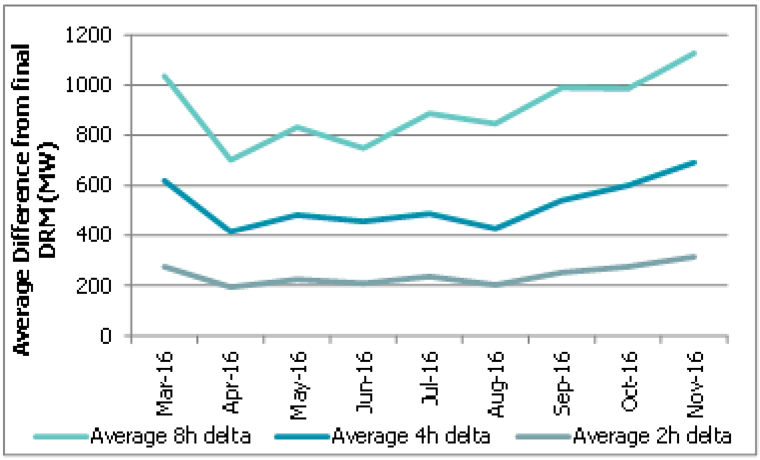
The 8 Hour Ahead is, on average, the furthest from the 1 Hour Ahead submission (an average of 895MW from the final value), whilst the 2 Hour Ahead is, on average, the closest to the final 1 Hour Ahead submission (an average of 240MW from the final value). The graph also indicates that when the final DRM submissions are at their lowest levels (<2000MW), the variation between the 1 Hour Ahead submissions and the 8 Hour Ahead submissions were less than average, with an average difference of 771MW.

In 61% of cases the 1 Hour Ahead submission was less than the 2 Hour Ahead submission, this rises to 70% for the 4 Hour Ahead submission and 76% for the 8 Hour Ahead Submission. Where margins were less than 2000MW at the 8 Hour Ahead submission, 91% of the 1 Hour Ahead submissions were higher. This suggests that Parties are responding to make more generation available when the DRM signals a tight system.



Graph 5.8 - Difference between DRM submissions and their 1 Hour Ahead values

Graph 5.9 shows the seasonal variation in the difference between DRM submissions from the final submission (1 Hour Ahead). April had the smallest change in DRM submissions, and November the largest.

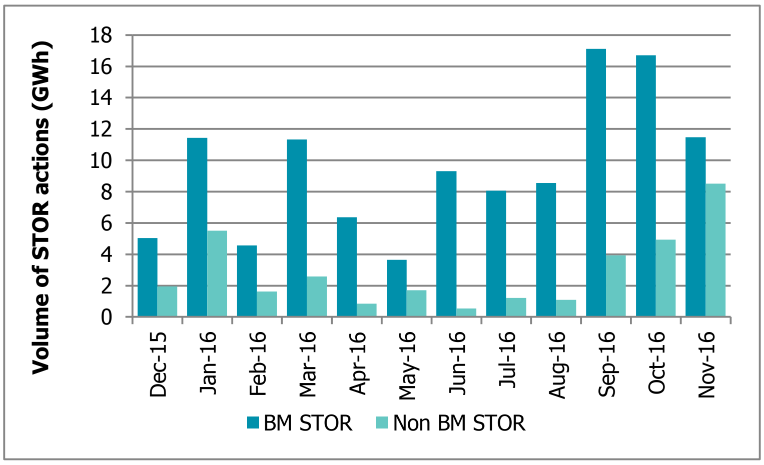


Graph 5.9 - Monthly difference between forecasts and final DRM submission

The impact of including non-BM STOR volumes in the System Price calculation

Non-Balancing Mechanism Short Term Operating Reserve (Non-BM STOR) is reserve capacity that is not dispatched in the Balancing Mechanism (BM). It can be used by the SO to balance the system during STOR Availability Windows. STOR Availability Windows are dependent upon the season and day of the week.

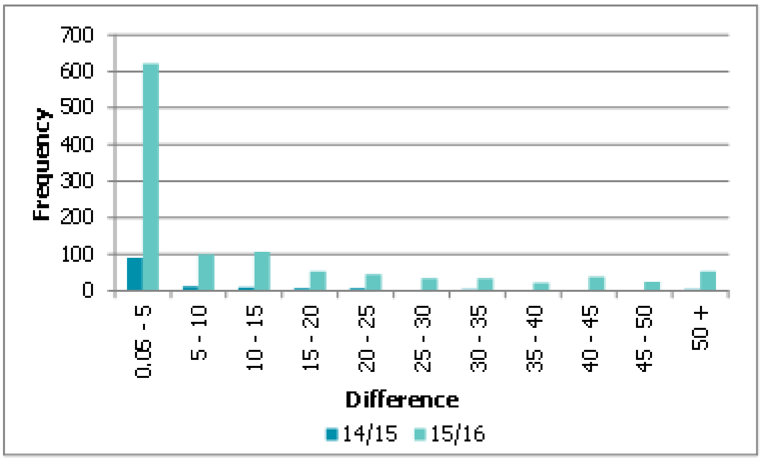
BSC Modification P305 introduced changes to include volumes and prices for non-BM STOR actions in the stack of balancing actions used to determine the Imbalance Price. In addition to this, non-BM STOR may be re-priced using the Reserve Scarcity Price (RSP). 6.1% of total buy balancing actions taken during the assessment period in STOR Availability Windows were STOR actions. Of these, 23% of STOR volume came from non-BM STOR plants (**Graph 5.10**).



Graph 5.10 - BM and non-BM STOR volumes

Including non-BM STOR introduced 34GWh to the System Price calculation between December 2015 and November 2016. These volumes changed the System direction in 195 Settlement Periods; the system would have been long under P217 and is short under P305.

Non-BM STOR volumes and prices can come in later than Bid and Offer data. This means that some Non-BM STOR data is left out of the price calculation on BMRS (Balancing Mechanism Reporting Service). Since BMRS only shows indicative System Prices, this is not updated with subsequent calculation runs. **Graph 5.11** shows the frequency of differences in the latest calculated System Price and what is shown on BMRS. There was no change in 99% of Settlement Periods in 2014/15 and in 93% of Settlement Periods in 2015/16. Where there was a price difference in 2015/16 55% of changes were less than £5/MWh.



Graph 5.11 - Difference between prices shown on BMRS and the prices from the latest calculation run

ELEXON

The Buy Price Price Adjuster

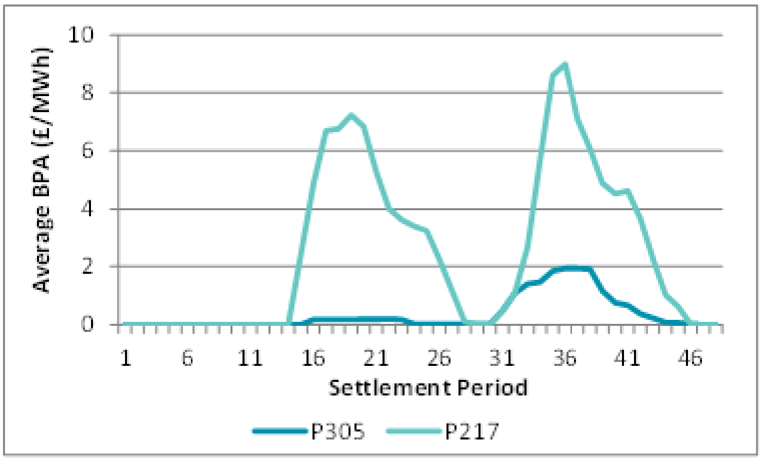
The **Buy Price Price Adjuster (BPA)** is an adjustment made to the System Price to reflect the long-term contracts that the SO enters into to provide balancing services. The BPA is added to the System Price when the net imbalance of the Transmission System is short.

Before P305 was implemented, STOR availability costs were allocated to Settlement Periods using the BPA according to a historic weighted profile. This approach meant that BPAs did not necessarily align with tight margins or STOR usage. BSC Modification P305 introduced the Reserve Scarcity Price as a mechanism for targeting the value of STOR usage, and removed STOR availability costs from the BPA calculation.

National Grid has been recalculating the STOR availability costs that would have been included in the BPA for use within ELEXON's analysis. Using this, we can create a 'P217 BPA' to see the impact that this proportion has had on BPAs and System Prices.

Overall, the BPA is used less frequently – the live BPA applied to 6% of short Settlement Periods, whereas P217 BPAs would have applied 44% of the time.

As the BPA is no longer being used to recover STOR availability costs, BPAs are now lower. **Graph 5.12** shows the average BPA's applied by Settlement Period. The average BPA for any Settlement Period in the live scenario is £0.36/MWh and in the P217 scenario is £2.50/MWh. The Settlement Period with the highest average live BPAs are 36 and 37, for the P217 scenario this is Settlement Period 36. The average BPA is £7.07/MWh lower in Settlement Period 36 for the live scenario.



Graph 5.12 – Average BPAs by Settlement Period

LIST OF APPENDICES

1. Glossary
2. Classification of Party Types
3. Summary of Workshop Views and Evidence Provided

Appendix 1: 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 Energy 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		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	**RSP**	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 RSP. The RSP function is based on the prevailing system scarcity, and is calculated as the product of two following values: · the Loss of Lost Load (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 £3,000/MWh.
Replacement Price Average Reference Volume	**RPAR**	The RPAR is a set volume of the most expensive priced actions remaining at the end of the System Price calculation, 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 via Standard Settlement Runs.

Appendix 2: Classification of Party Types

Party Name	Party Type
Addito Supply Limited	Supplier
APXCOMMODITIES LIMITED	Non Physical Trader
AVRO ENERGY LIMITED	Supplier
Axis Telecom Ltd	Supplier
AXPO	Supplier
Baglan Operations Ltd	Independent Generator
Barbican Power Limited	Supplier
Barclays Bank plc	Non Physical Trader
BARKING POWER LIMITED	Independent Generator
Bayswater Energy Limited	Supplier
BES Commercial Electricity Ltd	Supplier
Bethnal Energy Limited	Supplier
BKW Energie AG	Non Physical Trader
Bluebell Energy Supply Limited	Supplier
BNP Paribas	Non Physical Trader
Bord Gais Energy Limited	Non Physical Trader
BP Gas Marketing Limited	Non Physical Trader
Breeze Energy Supply Ltd	Supplier
British Energy Direct Ltd	Supplier
BritNed Development Ltd	IEA
Bronze Energy Supply Ltd	Supplier
Brookfield Renewable Supply 2	Non Physical Trader
BTG Pactual Commodities	Non Physical Trader
Business Power & Gas Limited	Supplier
Captured Carbon	Non Physical Trader
Cargill PLC	Non Physical Trader
Carrington Power Ltd	Independent Generator
Cenergise Limited	Non Physical Trader

Party Name	Party Type
Centrica	Vertically Integrated
CFP Trading Ltd	Non Physical Trader
Citigroup Global Markets Ltd	Non Physical Trader
Comet Energy Limited	Supplier
Compagnie Nationale du Rhone	Non Physical Trader
ConocoPhillips (UK) Limited	Non Physical Trader
Co-operative Energy Limited	Supplier
Copper Energy Supply Ltd	Supplier
CORBY POWER LIMITED	Renewable Generator
Cornflower Energy Supply Ltd	Supplier
Corona Energy Retail 5 Ltd	Supplier
Coulomb Energy Supply Limited	Supplier
Cour Wind Farm (Scotland) Limited	Renewable Generator
Covent Energy Limited	Supplier
Crystal Rig III Limited	Renewable Generator
Daffodil Energy Supply Limited	Supplier
Daisy Energy Supply Ltd	Supplier
Danske Commodities A/S	Non Physical Trader
DONG Energy Burbo Extension (UK) Ltd	Renewable Generator
Dong Energy Power UK Limited	Vertically Integrated
Donnington Energy Limited	Supplier
Drax Power Ltd	Independent Generator
Dual Energy Direct Limited	Supplier
E.ON	Vertically Integrated
ECC AG	Non Physical Trader
ECC Lux Sarl	Non Physical Trader
Economy Power	Supplier
Edelweiss Energia S.p.A	Non Physical Trader

Party Name	Party Type
EDF Energy PLC	Vertically Integrated
Edgware Energy Limited	Supplier
Effortless Energy Ltd	Supplier
Eggborough Power Limited	Independent Generator
EirGrid Interconnector Limited	IEA
Electrabel SA	Non Physical Trader
Electraphase LTD	Supplier
Electricity Plus Supply Ltd	Supplier
ElectroRoute Energy Trading	Non Physical Trader
ENDESA GENERACION SAU	Non Physical Trader
Eneco Energy Trade	Vertically Integrated
Enel Trade SpA	Non Physical Trader
Energi Danmark A/S	Non Physical Trader
Energy Data Company Limited	Supplier
Energy Supply Solutions LTD	Supplier
Energy24 Limited	Supplier
Energya VM Gestion De Energia	Non Physical Trader
Engie (aka GDF SUEZ)	Vertically Integrated
EPG Energy Limited	Vertically Integrated
Epower Supply Ltd	Supplier
Erova Energy Limited	Non Physical Trader
ESB Independent Energy (NI)	Non Physical Trader
ESBIG Trading Ltd	Non Physical Trader
ESSO Petroleum Company Ltd	Renewable Generator
Exelon Generation Limited	Non Physical Trader
Extra Energie GmbH	Non Physical Trader
Extra Energy Supply Limited	Supplier
F & S Energy Ltd	Supplier
Fallago Rig Wind Farm Limited	Renewable Generator
Farmoor Energy Limited	Supplier

Party Name	Party Type
Farringdon Energy Limited	Supplier
First Hydro Company	Independent Generator
First Utility Limited	Supplier
Flow Energy Ltd	Supplier
Foxglove Energy Supply Ltd	Supplier
Freepoint Commodities Europe	Non Physical Trader
Future Energy Utilities Ltd	Supplier
GAELECTRIC ICT ROI	Non Physical Trader
Gaz de France SA	Non Physical Trader
GAZPROM M &T TLD	Supplier
GB Energy Supply Limited	Supplier
Gen4u Limited	Supplier
GFP Trading Ltd	Renewable Generator
GNERGY Limited	Supplier
Gold Energy Supply Ltd	Supplier
Good Energy Limited	Supplier
Grangemouth CHP Ltd	Independent Generator
Greater Gabbard Offshore Winds	Renewable Generator
Green Energy (UK) Plc	Supplier
Gwynt y Mor Offshore Wind Farm	Renewable Generator
Hanbury Energy	Supplier
HAPPGCO	Non Physical Trader
Haven Power Ltd	Supplier
Holborn Energy Limited	Supplier
Hudson Energy Supply UK Ltd	Supplier
Hyde Park Energy Limited	Supplier
I Supply Energy Limited	Supplier
Iberdrola (ScottishPower)	Vertically Integrated
ICE Clear Europe Limited	Non Physical Trader
Inovyn Chlor Energy LTD	Supplier

Party Name	Party Type
Intergen	Independent Generator
IPM Energy Retail Ltd	Vertically Integrated
Iresa Limited	Supplier
J.Aron & Company	Non Physical Trader
JP Morgan Chase Bank	Non Physical Trader
Kensington Power Limited	Supplier
KOCH SUPPLY & TRADING SARL	Non Physical Trader
Lavender Energy Supply Ltd	Supplier
LDV Harburnhead Ltd	Renewable Generator
Limejump Energy Limited	Supplier
Lincs Wind Farm Ltd	Renewable Generator
LOCO2 Energy Supply Limited	Supplier
London Array Limited	Renewable Generator
MA Energy Limited	Supplier
Macquarie Bank Limited	Non Physical Trader
Marble Power Limited	Supplier
Marigold Energy Supply Ltd	Supplier
Markedskraft ASA	Non Physical Trader
Mercuria Energy Trading SA	Non Physical Trader
Mercury Energy Supply Ltd	Supplier
Merrill Lynch International	Non Physical Trader
Mint Energy Supply Ltd	Supplier
Mistral Energy Supply Limited	Supplier
Monument Energy Limited	Supplier
Morecambe Wind Limited	Renewable Generator
Morgan Stanley	Non Physical Trader
MVV Environment Services Ltd	Renewable Generator
MVV Trading GmbH	Non Physical Trader
Nat Grid Interconnectors Ltd	IEA
NDA	Supplier
NEAS Energy A/S	Non Physical Trader

Party Name	Party Type
NEAS Energy Limited	Supplier
NGET plc	System Operator
Nickel Energy Supply Ltd	Supplier
NIE Energy Ltd	Non Physical Trader
Noble Clean Fuels Limited	Non Physical Trader
Nord Pool Spot AS	Non Physical Trader
Northern Ireland Electricity	Non Physical Trader
Opal Energy Limited	Supplier
Opus Energy Limited	Supplier
Osmium Energy Supply Limited	Supplier
Our Power Energy Supply Ltd	Supplier
OVO Electricity Ltd	Supplier
Paddington Power Limited	Supplier
Palladium Energy Supply Ltd	Supplier
Petroineos Trading Ltd	Non Physical Trader
PFP Energy Supplies Limited	Supplier
Pioneer Energy Limited	Supplier
POWER4ALL Limited	Supplier
PowerQ Ltd	Supplier
PowTra Ltd	Non Physical Trader
Reuben Power Supply Limited	Supplier
Robin Hood Energy Limited	Supplier
RWE Npower	Vertically Integrated
Santiam Energy Limited	Supplier
Scira Offshore Energy Limited	Renewable Generator
SembCorp Utilities (UK) Ltd	Renewable Generator
Shell Energy Europe Limited	Non Physical Trader
Silver Energy Supply Ltd	Supplier
Sinq Power Ltd	Supplier
Smartestenergy Limited	Supplier
Snowdrop Energy Supply Ltd	Supplier

Party Name	Party Type
SONI Ltd	IEA
Spark Energy Supply Limited	Supplier
SSE	Vertically Integrated
Statkraft Markets Gmbh	Renewable Generator
Statoil Gas Trading Ltd	Renewable Generator
Sunflower Energy Supply Limited	Supplier
Switch Business Gas and Power	Supplier
Symbio Energy Ltd	Supplier
Tailwind Energy Supply Limited	Supplier
Team	Supplier
Tempus Energy Supply Limited	Supplier
The Renewable Energy Co Ltd	Supplier
Tonik Energy Limited	Supplier
Tornado Energy Supply Limited	Supplier
Total Gas & Power Ltd	Supplier
Trailstone GMBH	Non Physical Trader
Tulip Energy Supply Ltd	Supplier
UK Power Reserve Limited	Independent Generator
Utilita Energy Limited	Supplier
Vattenfall Energy Trading	Supplier
Vavu Power Limited	Supplier
VAYU LIMITED	Non Physical Trader
VIRIDIAN ENERGY SUPPLY LTD	Non Physical Trader
VITOL SA	Non Physical Trader
VPI Immingham LLP	Independent Generator
Yusupov LTD	Non Physical Trader
Zeven Electricity ltd	Supplier

Appendix 3: Summary of Workshop Views and Evidence Provided

For a full report of the workgroup and the Panel's views on P305, see the Final Modification Report[11]. A summary of views provided against the BSC Objectives is provided below:

Summary of Workgroup Members' Views[12]			
BSC Objectives	**Workgroup members' views**	**Evidence Provided**	**Out of scope**
(a) The efficient discharge by the Transmission Company of the obligations imposed upon it by the Transmission Licence	**Neutral** *(unanimous)*	N/A	N/A
(b) The efficient, economic and co-ordinated operation of the National Electricity Transmission System	**Beneficial** *(minority)* • Strengthens incentive to balance efficiently, particularly in times of tight margin • Potential increase in liquidity which will help participants balance ahead of Gate Closure **Detrimental** *(majority)* • LoLP values could send out false signals and could encourage balancing after Gate Closure if high • Volatile prices may cause participants to take longer positions to avoid the consequences of being short	• Absolute Imbalance Volumes • Party Imbalance Volumes • Market Index Volumes • Aggregated Party Imbalances	• Improvements in cost-reflectivity will encourage investment, driving long run cost savings • Better reflects the value of flexible generation, which may help defer the decommissioning of such plant

[11] The Final Modification Report (FMR) can be found at: https://www.elexon.co.uk/mod-proposal/p305/

[12] This shows a summary the different views expressed by Workgroup members – not all members necessarily agreed with all of these views.

	• More marginal prices increases the risk of balancing actions incorrectly impacting the imbalance price in subsequent Settlement Periods		
(c) Promoting effective competition in the generation and supply of electricity and (so far as consistent therewith) promoting such competition in the sale and purchase of electricity	**Beneficial** *(minority)* • Allows flexible and reliable plant to gain advantage that reflect their value to consumers • Single price removes the inefficient price spread and the net imbalance costs that creates • Incentivises participants to balance positions, increasing liquidity and encouraging investment in flexible capacity • Sharpens the signals of scarcity to the market **Detrimental** *(majority)* • Volatile prices will have a detrimental effect on smaller participants • The distributional effects of P305 are unknown • The reduction in PAR to 50MWh is too large a step and the impacts this will have are unknown • Single price may result in less trading, reducing liquidity	• Party Imbalance Volumes • Market Index Volumes • System Prices	• Improves incentives for flexible and reliable plant to enter the market
(d) Promoting efficiency in the implementation of the balancing and settlement arrangements	**Detrimental** *(minority)* • Introduces complex processes with little proven benefit **Neutral** *(majority)*	N/A	N/A

(e) Compliance with the Electricity Regulation and any relevant legally binding decision of the European Commission and/or the Agency [for the Co-operation of Energy Regulators]	**Neutral** *(unanimous)*	N/A	N/A
(f) Implementing and administrating the arrangements for the operation of contracts for difference and arrangements that facilitate the operation of a capacity market pursuant to EMR legislation	**Neutral** *(unanimous)*	N/A	N/A