ELEXON

Guidance

Imbalance Pricing Guidance

A guide to electricity imbalance pricing in Great Britain

If you need help, or more information, please email: bscservicedesk@cgi.com

Visit our website: www.elexon.co.uk

Contact: **Market Operations**

market.operations@elexon.co.uk

T: 0870 010 6950

This document explains the electricity imbalance pricing (“cash out”) arrangements in the Balancing and Settlement Code (BSC).

Section 1 is a summary of imbalance pricing.

Section 2 introduces the key concepts for imbalance pricing.

Section 3 covers the individual steps for calculating the energy imbalance price.

Section 4 provides a worked example of the price calculation from start to finish.

Section 5 covers the calculation of the Market Price.

Section 6 explains when imbalance charges are billed to Parties.

Section 7 details how imbalance pricing data is published.

Section 8 contains a glossary of terms.

Section 9 Appendix 1 – Reserve Scarcity Price method

Section 10 Appendix 2 – Contingency Balancing Reserve and Demand Control Actions

Section 11 Appendix 3 – The method for calculating the BPA and SPA

Section 12 Appendix 4 – Changes to imbalance prices from 2018

Where a term is first defined it appears in the document in **bold** font.

Throughout the document you will find references to the relevant paragraphs of the BSC, should you wish to use this document to help you interpret the BSC.

Contents

1. Summary

Imbalance pricing (also known as "cash out") is a key part of the wholesale trading arrangements in Great Britain. This document explains why we have imbalance charges, where they fit into the rest of the trading arrangements, how they are calculated and when they are paid. The complete formal rules for imbalance settlement are contained in the **Balancing and Settlement Code (BSC)**.

The wholesale electricity market is set up so that organisations that require electricity for their customers (**Suppliers**) enter into contracts with organisations that produce electricity (**generators**). Together we call these organisations **BSC Parties** or **Parties**.

However, the contracts between Parties do not always cover the generation or demand requirements on the **Transmission System**. This is a problem, as electricity cannot be stored economically in large quantities, and Power Station generation must always balance out consumer demand plus energy lost as heat when electricity is transported (transmission losses). To balance the Transmission System, National Grid acts as the **System Operator (SO)** and takes **balancing actions**. A balancing action is an instruction to a Party, in accordance with agreed rules, to either increase or decrease generation, or increase or decrease demand.

Parties need to submit notifications (**Physical Notifications**) for each half hour trading period (what the BSC calls a **Settlement Period**) so that the SO can understand the overall imbalance of the Transmission System.

Parties must also submit details of their contracts to the BSC Systems. After the end of the Settlement Period, the BSC Systems compare a Party's contracted (traded) volume with its metered volume in order to determine its imbalance. If a Party is in imbalance of its contracted volume then it will be subject to imbalance charges.

Imbalance prices

There are two energy imbalance prices for each Settlement Period. These are:

- **System Buy Price (SBP)**; and
- **System Sell Price (SSP)**.

However there is a single price calculation, so SBP will equal SSP in each Settlement Period. ELEXON apply these prices to Parties' imbalances to determine their imbalance charges. A Party is out of balance when its contracted energy volume does not match its physical production or consumption.

If a Party has under-generated or over-consumed compared to its contracted volume, it will have to buy that shortfall of energy at **SBP**.

If a Party has over-generated or under-consumed compared to its contracted volume, it will have to sell that extra energy at **SSP.**

For most periods the price calculation reflects the costs of balancing the Transmission System for that Settlement Period. These will depend on the system's overall imbalance.

Where the Transmission System is **long** (too much electricity), the price calculation is based on actions taken by the System Operator to reduce generation or increase demand.

Where the Transmission System is **short** (not enough electricity), the price calculation is based on actions taken by the System Operator to increase generation or decrease demand.

However, not all balancing actions are used in the same way by the BSC Systems as the SO does not take all balancing actions for the same reason. Some balancing actions are taken purely to balance the half hour energy imbalance of the Transmission System. These are '**energy balancing**' actions.

And some balancing actions are taken for non-energy, system management reasons. These are '**system balancing**' actions.

Examples of system balancing actions are:

- Actions that are so small in volume they could be the result of rounding errors (**De Minimis Tagging**);
- Actions which have no effect on the energy balancing of the System but lead to an overall financial benefit for the System Operator (**Arbitrage Tagging**);
- Actions taken for locational balancing reasons (**SO-Flagging**); and
- Actions taken to correct short-term increases or decreases in generation/demand (**CADL Flagging**).

We use a number of processes to minimise the price impact of system balancing actions on the energy imbalance price calculation. They can be broadly grouped as:

- **Flagging** – identifying balancing actions that are potentially system balancing. Once identified, we will use the Classification process to decide if they are system or energy balancing;
- **Classification** – assessing the Flagged balancing actions against the Unflagged balancing actions to determine whether they are likely to have been energy balancing or system balancing. If a Flagged Action is more expensive than any Unflagged Action then we consider it to be a system balancing action and remove its price from the calculation; and
- **Tagging** – completely removing both the price and volume of balancing actions so that no part is used in the final calculation.

After completing these processes, we adjust the remaining balancing actions for transmission losses and take a volume-weighted average to calculate the energy imbalance price.

Where an imbalance price cannot be calculated following these steps, we use the **Market Price**. This price reflects the wholesale price of electricity. See section 5 for further details about this price.

Imbalance charges

ELEXON apply these imbalance prices to Parties' imbalances to determine their imbalance charges. Parties are first billed for imbalance charges approximately one month after the Settlement Day for which the charges were incurred. The BSC Systems carry out subsequent Reconciliation Runs over the next 13 months, which update the imbalance charges by replacing any estimated data with actual metered data.

2. Key concepts

The basic starting point

In the wholesale electricity market in Great Britain, organisations that require electricity for their customers (**Suppliers**), enter into contracts with organisations that produce electricity (**generators**), sometimes through intermediaries called **Non Physical Traders**. These types of organisation are called **BSC Parties**, or simply **Parties**.

The basic trading period for electricity is half an hour. Each day is split into 48 half hour units (unless it is a day where the clocks change, which has either 46 or 50 half hours). Each of these half hour units is called a **Settlement Period**. Suppliers will calculate the estimated electricity requirements for their portfolio of customers for each Settlement Period. They will then enter into contracts with generators in order that their customers receive the correct quantity of electricity for each Settlement Period.

The complete formal rules for imbalance settlement are contained in the **Balancing and Settlement Code (BSC)**.

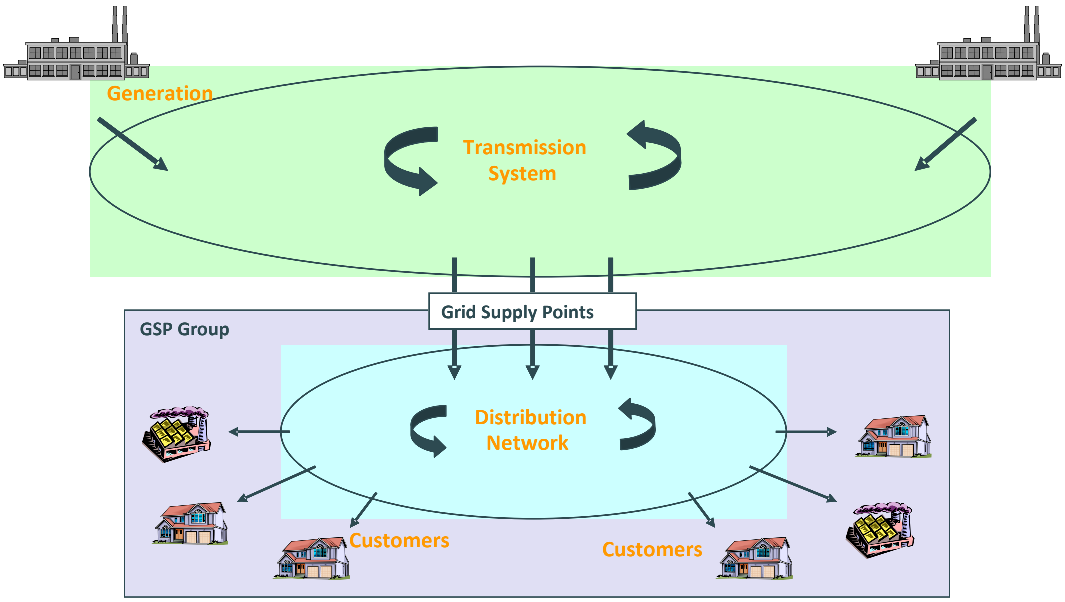
What is a Party?

A BSC Party is an organisation that has signed up to the Balancing and Settlement Code.

All licensed generators, Suppliers and Distributors are required to sign the BSC. Other companies may choose to do so.

What is the Transmission System?

The **Transmission System** is the high voltage network that transports electricity throughout Great Britain. The Transmission System delivers electricity to the lower voltage **Distribution Networks** which in turn supply electricity to customers.



Why does the Transmission System need to be balanced?

Electricity cannot be stored economically in large quantities. This means that generation must always equal demand plus energy lost as heat when electricity is transported (**transmission losses**). If it does not, then the frequency of the Transmission System moves away from the target frequency (50Hz) and the Transmission System becomes unstable.

However, the contracts between generators and Suppliers do not always completely balance the Transmission System. This could be because:

- Suppliers may not always accurately predict demand;
- Generators may not always be able to tightly control their generation (for example intermittent generation or plant tripping off the Transmission System);
- Problems can arise with transmission lines;
- The BSC does not require Parties to meet their contracts (although any Party which does not will be subject to imbalance charges); and
- The market trades in half hour Settlement Periods, but the Transmission System must balance at every instant.

Where the Transmission System is not balanced it is called **imbalance**. National Grid ensures the Transmission System is always balanced. This job is known as system operation, and is managed by National Grid as the **System Operator (SO)**.

What are Balancing Mechanism Units?

Balancing Mechanism Units (BM Units or BMUs) represent the generation or consumption at a particular location. Each Party is assigned BMUs for their power stations or areas of demand. The BSC Systems sum up a Party's BMU volumes and contracts when they carry out the Settlement calculations.

Physical Notifications, Contract Notifications and Gate Closure

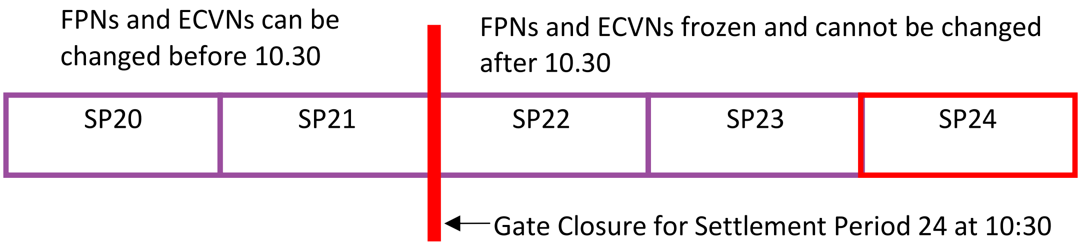
In order to balance the Transmission System, the SO needs to know what generators intend to generate and what Suppliers intend to consume for each Settlement Period. The SO needs this information before the start of the Settlement Period so that it can understand the Transmission System imbalance, plan how to balance it and take balancing actions.

Therefore, generators and Suppliers submit **Physical Notifications (PNs)** for each **Balancing Mechanism Unit (BMU)** (see right) to the SO for each Settlement Period. And **one hour** before each Settlement Period the PNs of Parties are frozen. This is called **Gate Closure**. At this point the PNs become **Final Physical Notifications (FPNs)**. After Gate Closure, Parties must try to adhere to the FPNs submitted to the SO. They should only deviate from their FPN at the instruction of the SO.

Parties also submit **Energy Contract Volume Notifications (ECVNs)** to the BSC Systems for each Settlement Period before Gate Closure. The ECVNs notify the BSC Systems of Parties' contracted volumes. We will use these contracted volumes later on when we calculate Parties' imbalances.

The diagram below shows Gate Closure for Settlement Period 24.

Gate Closure for Settlement Period 24 (SP24)



Transmission System net imbalance

Following Gate Closure, the SO is able to evaluate the net imbalance of the Transmission System. The SO does this by assessing the FPNs of the generators and Suppliers and comparing that assessment to its own forecasts for the Settlement Period. The Transmission System's net imbalance is also called the Transmission System **length**.

A **'long'** Transmission System is one where there is more generation than demand.

A **'short'** Transmission System is one where there is more demand than generation.

How does the System Operator balance the Transmission System?

The SO has a number of ways of balancing the Transmission System. Whatever mechanism the SO uses, it is trying to balance the Transmission System as efficiently as possible. Ideally the SO would choose the cheapest balancing action, then the next cheapest, then the next cheapest, and so on. However, this is not always possible as the SO also considers:

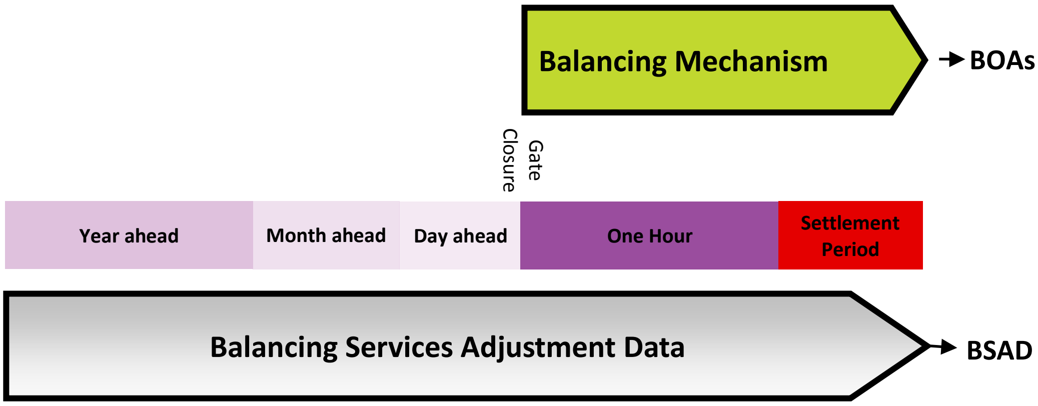
- Technical limitations of the Power Station or demand manager - is it able to increase or decrease generation/demand quickly enough to meet the requirement; and
- Technical limitations of the Transmission System - can the generation/demand be transmitted to the part of the Transmission System where it is needed.

The SO submits balancing actions to the BSC Systems using:

- The **Balancing Mechanism** – for **Bid Offer Acceptances (BOAs)**; and
- **Balancing Services Adjustment Data (BSAD)** – for balancing actions taken outside of the Balancing Mechanism.

The Balancing Mechanism operates after Gate Closure, whereas balancing actions submitted through BSAD can be taken at any point.

Timing of the Balancing Mechanism and BSAD



Ancillary Services and Commercial agreements

In addition to the Balancing Mechanism and BSAD, the SO also uses Ancillary and Commercial Services to balance the Transmission System. Ancillary and Commercial Services cover:

- Reactive Power;
- Frequency Response;
- Black Start; and
- Reserve Services.

We do not normally consider these services when we calculate the energy imbalance prices as they are 'system balancing' services. However, the SO does send data of the volumes involved to the BSC Systems, so that the Parties that provide these services can have their imbalance volumes suitably adjusted. This is called **Applicable Balancing Services Volume Data (ABSVD)**.

The Balancing Mechanism

The Balancing Mechanism operates from Gate Closure to real time and is managed by the SO. It works in a similar way to an auction. Parties submit notices telling the SO how much it would cost for them to deviate from their Final Physical Notification. These notices are called **Bids** and **Offers**.

An **Offer** is a proposal to **increase generation** or **reduce demand**.
A **Bid** is a proposal to **reduce generation** or **increase demand.**

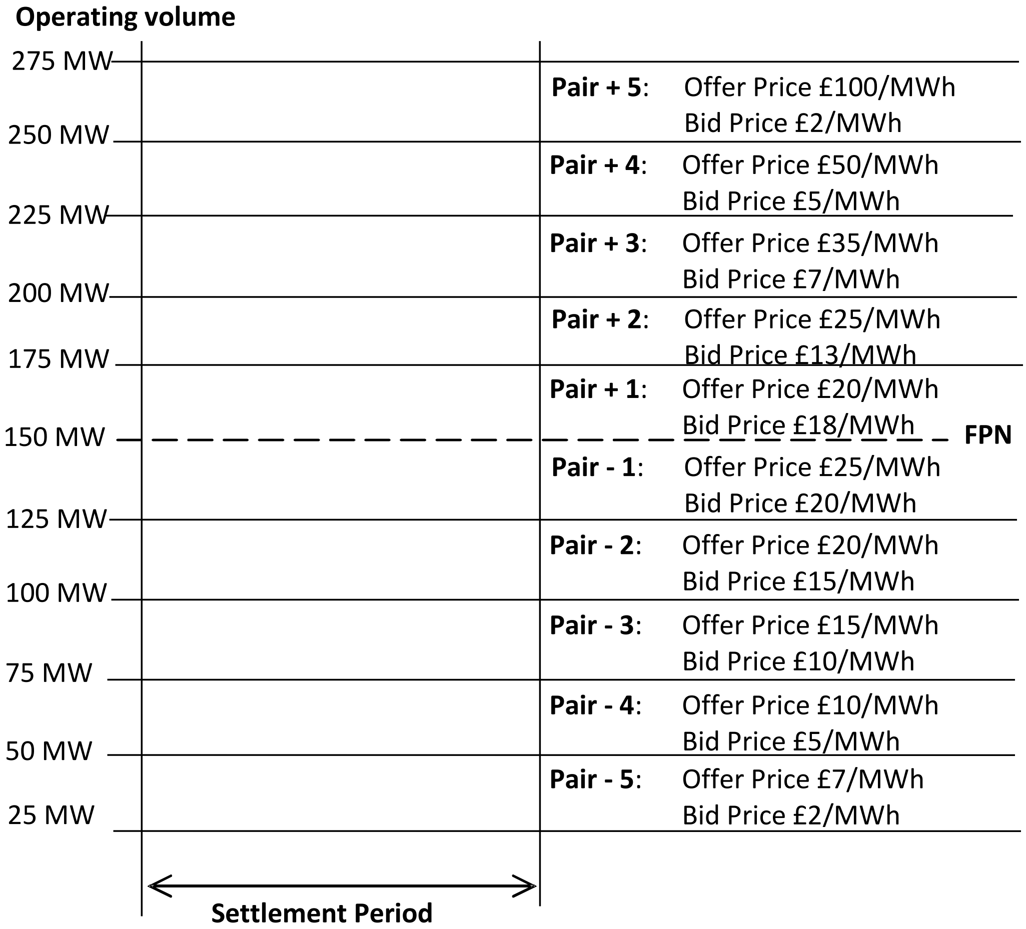
The SO assesses all the Bids and Offers for each Settlement Period and chooses the ones that, alongside the balancing actions submitted through BSAD, best satisfy the balancing requirements of the Transmission System. Participation in the Balancing Mechanism is optional, and Parties that choose to do so must submit Bids and Offers before Gate Closure for each Settlement Period. For each BM Unit, a Party can submit up to ten Bid-Offer Pairs.

Each Bid-Offer Pair includes:

- An Offer Price - the price a Party wants to be paid per MWh for an increase in generation or decrease in demand;
- A Bid Price - the price a Party wants to pay per MWh for a decrease in generation or an increase in demand (although it is possible to submit negatively priced Bids, i.e. a Party is paid to reduce generation);
- The Settlement Period for which the Bid/Offer applies (for example, between 20:00 and 20:30 on 24/07/2009);
- The upper and lower power levels between which the Bid/Offer applies (for example, Bid-Offer +1 applies from FPN to 50MW above the FPN, Bid-Offer +2 applies from 50MW above FPN to 100MW above FPN).

Bids and Offers are submitted in pairs because this provides an undo mechanism for Acceptances. For an Accepted Offer, the paired Bid price is the 'undo' option (and for a Bid the associated Offer price is the 'undo' option). If the SO has already accepted the Offer, this is the price SO will be paid per MWh to undo the acceptance. There's usually a difference between the two, which ensures that if a Party's Bid or Offer is accepted and then undone, they will still receive a payment. Below is an example of ten Bid-Offer Pairs.

Bid-Offer Pairs for a BM Unit



Bid Offer Acceptances (BOAs)

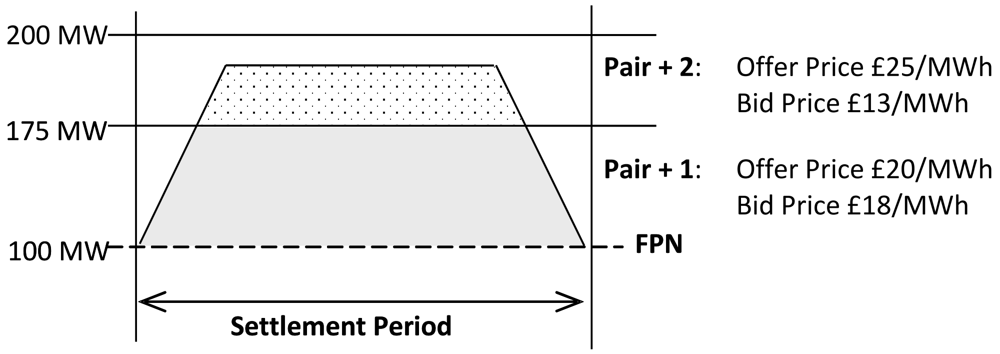
Accepted Bids and Offers are called **Bid Offer Acceptances (BOAs)**. For each BOA, the SO contacts the BM Unit directly and instructs it to deviate from its FPN via a set of 'spot points'. Each spot point represents the change in output away from FPN at a particular time.

For example:

- Spot point 1 = 00:00, 100MW;
- Spot point 2 = 00:05, 195MW;
- Spot point 3 = 00:25, 195MW; and
- Spot point 4 = 00:30, 100MW.

Graphically this looks like this:

An Accepted Offer



Short Term Operating Reserve (STOR)

In addition to balancing actions available in the balancing mechanism, the SO can enter into contracts with providers of balancing capacity to deliver when called upon. These additional sources of power are referred to as **reserve**. Most of the reserve that the SO procures is called **Short Term Operating Reserve (STOR)**.

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

Because the Utilisation Price has been pre-agreed (sometimes many months before it is actually used), and because STOR providers may also receive availability payments, Utilisation Prices may be noticeably different to the price the SO may have paid had it called upon a BM action. Utilisation Prices may therefore not reflect the prevailing market prices at the time of use. To correct this, we use a pricing mechanism to determine a **Reserve Scarcity Price (RSP)** and a process that sets the price for STOR actions to be equal to the greater of its Utilisation Price and the RSP.

Contingency Balancing Reserve and Demand Control

There are some actions that the SO uses only as a last resort to balance the system in the rare event that there is insufficient capacity in the market to meet demand. These include **contingency balancing reserve** and **Demand Control**. If they are used they will be included in the imbalance price calculation at a price of **Value of Lost Load (VoLL)**.

Contingency balancing reserve is a last resort reserve service that the SO procures in addition to Short Term Operating Reserve. It comes in two forms:

- **Supplemental Balancing Reserve (SBR)**, which is provided by generation that would otherwise be unavailable in the market (eg because of closure or mothballing).
- **Demand Side Balancing Reserve (DSBR)**, which is provided by non-domestic customers with the ability to reduce or shift demand when called upon.

If the SO is unable to call on Bids and Offers in the BM or other Balancing Services (including contingency balancing reserve) to meet the current demand, then it can instruct Demand Control as a last resort emergency action to manage the situation. When it issues a **Demand Control Instruction** it will instruct the Distribution Network Operators to reduce demand on their Distribution Systems, either through reducing voltage across the network and/or disconnecting consumers.

What is Value of Lost Load?

Value of Lost Load (VoLL) is a defined parameter in the BSC and is based on an assessment of the average value that electricity consumers attribute to the security of supply. It is currently set at £3,000/MWh.

VoLL and the process for reviewing it are set out in BSC Section T.1.12.

Where in the BSC?

The processes relating to Demand Control Instructions are set out in Section Q.6.9.

Balancing Services Adjustment Data (BSAD)

Balancing actions taken outside of the Balancing Mechanism are submitted to the BSC Systems as **Balancing Services Adjustment Data (BSAD)**. The SO specifies what balancing actions are included in BSAD in the **BSAD Methodology Statement**.

BSAD is split into two components:

- **Balancing Services Adjustment Actions (BSAA); and**
- **Buy Price Price Adjustment (BPA)/Sell Price Price Adjustment (SPA).**

Balancing Services Adjustment Actions

The SO submits an individual Balancing Services Adjustment Action for each of the following Balancing Services:

- Forward Contracts;
  - Energy Related Products;
  - Pre-Gate Closure Balancing Transactions (PGBTs); and
  - System-to-System services,
- Maximum Generation;
- System to Generator Operational Intertripping;
- Emergency de-energisation instructions;
- Demand Side Balancing Reserve; and
- Non-BM STOR.

Buy Price Price Adjustment (BPA)/Sell Price Price Adjustment (SPA)

The other part of BSAD is the Buy Price Price Adjustment (BPA) or the Sell Price Price Adjustment (SPA). The BPA is added when the net imbalance of the Transmission System is short. The SPA is added when the net imbalance of the Transmission System is long.

The BPA/SPA is a reflection of the costs to the SO of regulating reserve and BM start-up. It does not have a volume. It simply adjusts the volume-weighted average price.

In the event that the System Operator has to use **Supplemental Balancing Reserve (SBR)** these actions are not immediately priced at VoLL in the price stack. Due to system constraints, ELEXON cannot simply re-price SBR BOAs equal to VoLL in Central Systems. Instead, ELEXON re-price the action at VoLL ex-post, and re-run the price calculation. The difference in the price is added to the Buy Price Adjuster (BPA). See section 10 for further detail of how this works.

Party imbalances

A Party is in imbalance where its contracted volumes do not match its Metered Volumes (once the BSC Systems have accounted for any BOAs on the Party's BM Units – having a Bid or Offer accepted will not put the Party into imbalance).

Imbalance prices

There are two energy imbalance prices for each Settlement Period. These are:

- **System Buy Price (SBP)**; and
- **System Sell Price (SSP)**.

However there is a **single price calculation** – so SBP will equal SSP in each settlement period.

ELEXON apply these prices to Parties' imbalances to determine their imbalance charges. A Party is out of balance when its contracted energy volume does not match its physical production or consumption.

If a Party has under-generated or over-consumed compared to its contracted volume, it will have to buy that shortfall of energy at **SBP**.

If a Party has over-generated or under-consumed compared to its contracted volume, it will have to sell that extra energy at **SSP**

For most periods the price calculation reflects the costs of balancing the Transmission System for that Settlement Period. These will depend on the system's overall imbalance.

Where the Transmission System is **long** (too much electricity), the price calculation is based on actions taken by the System Operator to reduce generation or increase demand.

Where the Transmission System is **short** (not enough electricity), the price calculation is based on actions taken by the System Operator to increase generation or decrease demand.

Section 3 explains how we calculate the energy imbalance price. Section 4 provides an example of the energy imbalance price calculation based on a theoretical set of balancing actions.

There is a different calculation for prices in the event that there are no actions left following these steps. This is called the **Market Price** and reflects the wholesale price for electricity. See section 5 for further details of this.

3. How does pricing work?

What do we use to calculate the energy imbalance price?

The BSC Systems calculate the energy imbalance price using balancing actions accepted by the SO for that Settlement Period.

There are three types of balancing action:

- **Bid Offer Acceptances (BOAs)**;
- **Balancing Services Adjustment Actions (BSAAs)**; and
- **Demand Control Actions**.

Balancing actions either increase the energy or decrease the demand for energy on the Transmission System (Offers, Buy Balancing Services Adjustment Actions and Demand Control Actions); or decrease the energy on the Transmission System (Bids and Sell Balancing Services Adjustment Actions).

Which balancing actions to use?

We do not use all balancing actions in the same way, as the SO does not take all balancing actions for the same reason. Some balancing actions are taken purely to balance the half hourly energy imbalance of the Transmission System. These are '**energy' balancing** actions.

However, some balancing actions are taken for non-energy, system-management reasons. These are '**system' balancing** actions.

Examples of system balancing actions are:

- Actions that are so small in volume they could be the result of rounding errors (**De Minimis tagging**);
- Actions which have no effect on the energy balancing of the System but lead to an overall financial benefit for the SO (**Arbitrage tagging**);
- Actions taken for locational balancing reasons (**SO-Flagging**); and
- Actions taken to correct short-term increases or decreases in generation/demand (**CADL Flagging**).

There are a number of actions which may be re-priced for the purposes of calculating the imbalance price. These are:

- BOAs or BSAAs from **STOR plant** taken during **STOR availability windows**, in the event that their Utilisation Payment is less than the Reserve Scarcity Price; and
- **Demand Control** and **Contingency Balancing Reserve** volumes, in the event that the SO has to use them to balance the system.

We use a number of processes to minimise the price impact of system balancing actions on the energy imbalance price calculation. They can be broadly grouped as:

Balancing actions or System Actions?

In the BSC balancing actions are called 'System Actions'. This is because they are actions which balance the Transmission System.

- **Flagging** – identifying balancing actions that are potentially system balancing. Once identified, we will use the Classification process to decide if they are system or energy balancing;
- **Classification** – assessing the Flagged balancing Actions against the Unflagged Actions to determine whether they are energy balancing or system balancing. If Flagged Actions are more expensive than any Unflagged Action then we remove its price; and
- **Tagging** – completely removing both the price and volume of balancing actions so that no part is used in the final calculation.

This section describes the processes that remove the price impact of system balancing actions, along with other processes that we use when calculating the energy imbalance price. These are:

1. **Submitting balancing actions**
2. **Determining the STOR action price**
3. **System Operator Flagging (SO-Flagging)**
4. **Emergency Instruction Flagging**
5. **Continuous Acceptance Duration Limit (CADL) Flagging**
6. **Ranked Sets**
7. **De Minimis Tagging**
8. **Arbitrage Tagging**
9. **Classification**
10. **NIV Tagging**
11. **Replacement Price**
12. **PAR Tagging**
13. **BPA/SPA**
14. **Transmission Loss Multiplier**
15. **Final energy imbalance price calculation**
16. **Default rules**
17. **Actions not included in the calculation of the energy imbalance price**

How are balancing actions submitted to the BSC Systems?

Each Settlement Period, the SO sends the following balancing data to the BSC Systems:

- The Final Physical Notifications (FPN) submitted by Parties for their BM Units;
- The Bid–Offer Data submitted by Parties for their BM Units;
- Bid–Offer Acceptance data;
- Balancing Services Adjustment Data (BSAD); and
- Demand Control Instructions.

Balancing Services Adjustment Actions

Balancing actions taken outside of the Balancing Mechanism are submitted to the BSC Systems using Balancing Services Adjustment Data (BSAD). The SO calculates BSAD in accordance with the BSAD Methodology Statement which is required under its Transmission Licence.

BSAD is made up of two parts:

- Balancing Services Adjustment Actions (disaggregated BSAD); and
- Buy Price Price Adjustment (BPA) / Sell Price Price Adjustment (SPA).

The BPA/SPA is used at the end of the process.

Explanation

Where the SO takes a balancing action outside the Balancing Mechanism, it submits it to the BSC Systems as a Balancing Services Adjustment Action.

Each Balancing Services Adjustment Action has a:

- **Balancing Services Adjustment Cost** – value in £ (can be a NULL cost);
- **Balancing Services Adjustment Volume** – value in MWh;
- **SO-Flag** - either set to True/False; and
- **STOR Provider Flag** – either set to True/False.

Once the BSC Systems receive the Balancing Services Adjustment Action, they convert the Balancing Services Adjustment Cost to a Balancing Services Adjustment Price by dividing the Balancing Services Adjustment Cost by the Balancing Services Adjustment Volume:

$$\text{Price}(\pounds/\text{MWh}) = \frac{\text{Cost}(\pounds)}{\text{Volume}(\text{MWh})}$$

Where in the BSC?

The structure of Balancing Services Adjustment Actions is described in Section Q6.3.2.

The BSC Systems calculation for converting the Balancing Services Adjustment Cost to the Balancing Services Adjustment Price is in Section Q6.3.2A. Balancing Services Adjustment Actions are referred to throughout Section T Annex T-1, as they undergo all but one of the calculation processes.

Determining STOR Action Prices

Explanation

There are times when the use of STOR plant to balance the system can have a dampening effect on imbalance prices. This is because of how it is procured and paid for. See Appendix 1 for further detail.

To correct this, we use a pricing mechanism to calculate the **Reserve Scarcity Price (RSP).** The RSP is designed to respond to capacity margins so that it rises as the system gets tighter (the gap between available and required generation narrows). It is calculated using a measure of system reliability called **Loss of Load Probability (LOLP).** LOLP is a value between 0 and 1, and represents a measure of scarcity in available generation capacity, as calculated by the System Operator at Gate Closure. The RSP is determined by multiplying the LOLP by the price of disconnections, **Value of Lost Load (VoLL).**

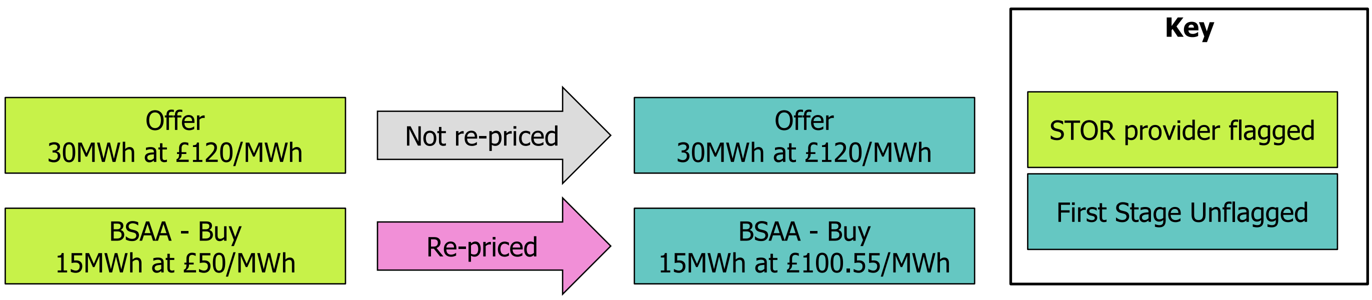
All actions from STOR providers are included in the calculation of Imbalance Prices but whether a STOR action is re-priced depends firstly on whether the STOR action was taken during a **STOR Availability Window.** A STOR Availability Window is the window of time when STOR plant are required to make their capacity available to the SO. Whether an action is re-priced will also depend on the level of its Utilisation Payment compared to the RSP for that half-hour. STOR actions taken during STOR Availability windows are included in the calculation of imbalance prices as individual actions, with a price which is the **greater** of:

- The **Utilisation Price** for the action – ie the price that STOR capacity is paid when it is called upon; and
- The **Reserve Scarcity Price (RSP)**.

Re-priced STOR actions are then treated like other BOAs for the next steps of price calculation (ranking, tagging, etc). Actions from STOR plant outside the STOR Availability Windows are not re-priced.

Example

In the following example, the De-Rated Margin at Gate Closure is 1238MW. This corresponds to a LOLP of 0.0334, as determined by the Loss of Load Probability Calculation Statement. This produces an RSP of £100.55/MWh (0.0334 * £3,000). As these actions took place during a STOR Availability Window, they are re-priced where the RSP is greater than their Utilisation Prices.



What is LOLP?

Loss of Load Probability (LOLP) is a measure of system reliability, calculated by The System Operator for each Settlement Period.

The System Operator's methodology is set out in the **Loss of Load Probability Calculation Statement.**

Where in the BSC?

The process for re-pricing STOR actions is set out in Section T.3.14, and the process for determining the RSP is set out in section T.3.13.

NULL priced Balancing Services Adjustment Actions

Balancing Services Adjustment Actions that result from intertrips are submitted with a NULL cost (and therefore a NULL Price). This is because intertrip-related Balancing Services Adjustment Actions do not have a cost/price available in the required timescales. NULL priced Balancing Services Adjustment Actions are always classified as **Second Stage Flagged balancing actions** and are unpriced. However, if NULL priced Balancing Services Adjustment Actions enter the **Net Imbalance Volume** they will be subject to a **Replacement Price**.

What is an intertrip?

An intertrip is a circuit-breaker that, when activated, disconnects a generator or demand from the Transmission System. This might be to relieve localised network overloads, maintain system stability, manage system voltages and/or ensure quick restoration of the Transmission System.

System Operator Flagging

Explanation

System Operator Flagging (SO-Flagging) is the process that identifies BOAs and Balancing Services Adjustment Actions that are potentially taken for system balancing reasons. The SO-Flagging process is documented in the **System Management Action Flagging Methodology Statement** which is required under National Grid's Transmission Licence.

Where in the BSC?

The SO-Flagging process is described in Section T Annex T-1 paragraph 3.

For BOAs, the SO flags when it believes the BOA may be impacted by a transmission constraint.

For Balancing Services Adjustment Actions, the SO also flags when it believes the balancing action was impacted by a transmission constraint. It also has two additional reasons for flagging a Balancing Services Adjustment Action:

- Any system-to-system balancing service over an Interconnector which is used to avoid adverse effects arising on the GB Transmission System from significant load profile changes; and
- Any system-to-system balancing service over an Interconnector which is used by another country's Transmission System Operator (TSO) for the purposes of resolving a system operation issue.

For the purposes of the Classification process, an SO-Flagged balancing action is a **First Stage Flagged balancing action**.

What is a transmission constraint?

A **transmission constraint** is any limit on the ability of the Transmission System, or any part of it, to transmit power to a location which demands it.

Transmission constraints arise from:

- The need not to exceed the thermal rating of any asset forming part of the Transmission System (preventing the lines getting too hot);
- The need to maintain voltages on the Transmission System; and/or
- The need to maintain the transient and dynamic stability of electricity plant, equipment and systems directly or indirectly connected to the Transmission System.

Emergency Flagging

Explanation

The SO issues Emergency Instructions to Power Stations (and potentially customers) in circumstances when there is a specific requirement to isolate a Generating Unit, Power Station or customer demand from the Transmission System. For example, an emergency could occur if there was a fire or breakdown of a piece of Transmission System equipment, or if there were a major incident that affected part of the Transmission System.

Emergency Instructions are inserted into the energy imbalance price calculation as BOAs. The SO is able to flag or not flag Emergency Instructions, depending on whether they were issued for system balancing reasons.

A flagged Emergency Instruction is called '**Emergency Flagged**'. Emergency Flagged actions are treated in an identical way to SO-Flagged BOAs and are First Stage Flagged balancing actions.

An unflagged Emergency instruction is called an '**Emergency Acceptance**'. Emergency Acceptances are treated in an identical way to unflagged BOAs and are First Stage Unflagged balancing actions.

Where in the BSC?

Emergency Instructions are defined in Section Q5.1.3(b), Q5.3.1(d) and Q5.3.1(e).

The use of Emergency Flagged actions and Emergency Acceptances in the energy imbalance price calculation is described in Section T Annex T-1 paragraph 5.

Continuous Acceptance Duration Limit (CADL) Flagging

Explanation

The SO may need to accept short-duration actions to cater for a sudden increase/decrease in generation or demand. We consider these actions to be potentially system balancing. This is because they are taken in order to balance the Transmission System in real time and may not be required to balance the energy on the Transmission System over the half hour Settlement Period.

In order to distinguish between such short-duration actions we apply a rule called the **Continuous Acceptance Duration Limit (CADL)**. It is a time limit for BOAs. If a BOA is part of a series of acceptances on the same BM Unit which is less than the CADL it will be flagged. A **CADL Flagged** BOA is a First Stage Flagged action.

The current CADL is set at **15 minutes** and may be altered by the BSC Panel (with Ofgem's approval) from time to time after consultation with the SO and Parties.

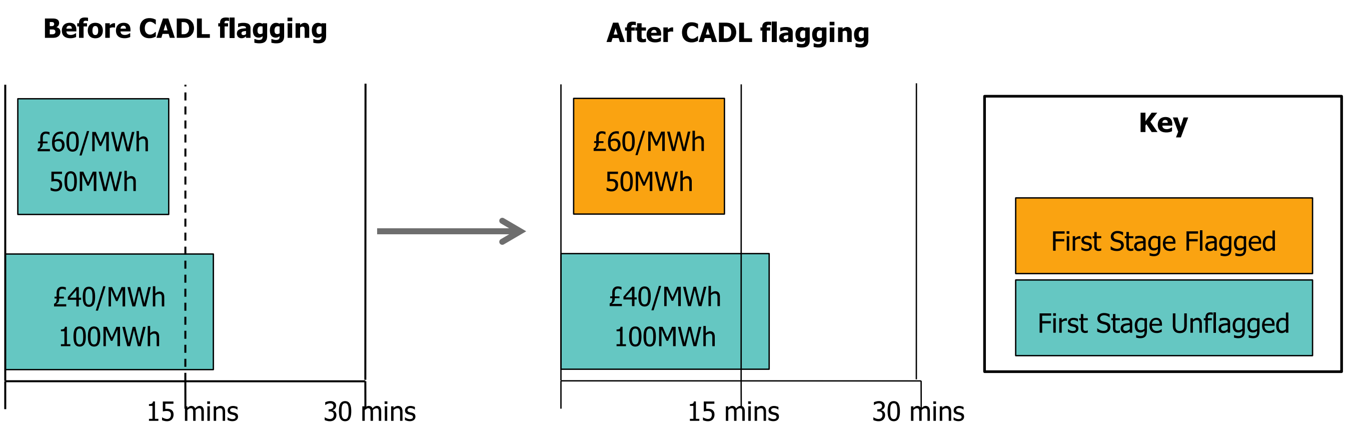
Below is an example of CADL Flagging with two BOAs for different BM Units, one less than 15 minutes and one more than 15 minutes.

Where in the BSC?

The Continuous Acceptance Duration Limit is defined in Section T paragraph 1.9.

The CADL Flagging process is described in Section T Annex T-1 paragraphs 3 and 12.

CADL Flagging example



In the example above, the BOA which is less than 15 minutes in length becomes Flagged.

Ranked Sets

Once the BSC Systems have received all the balancing actions, they are ranked in price order in two separate **Ranked Sets**:

- The **Sell Ranked Set** includes all the **sell balancing actions** which reduce generation on the Transmission System or increase demand; and
- The **Buy Ranked Set** includes all the **buy balancing actions** which increase generation on the Transmission System or reduce demand.

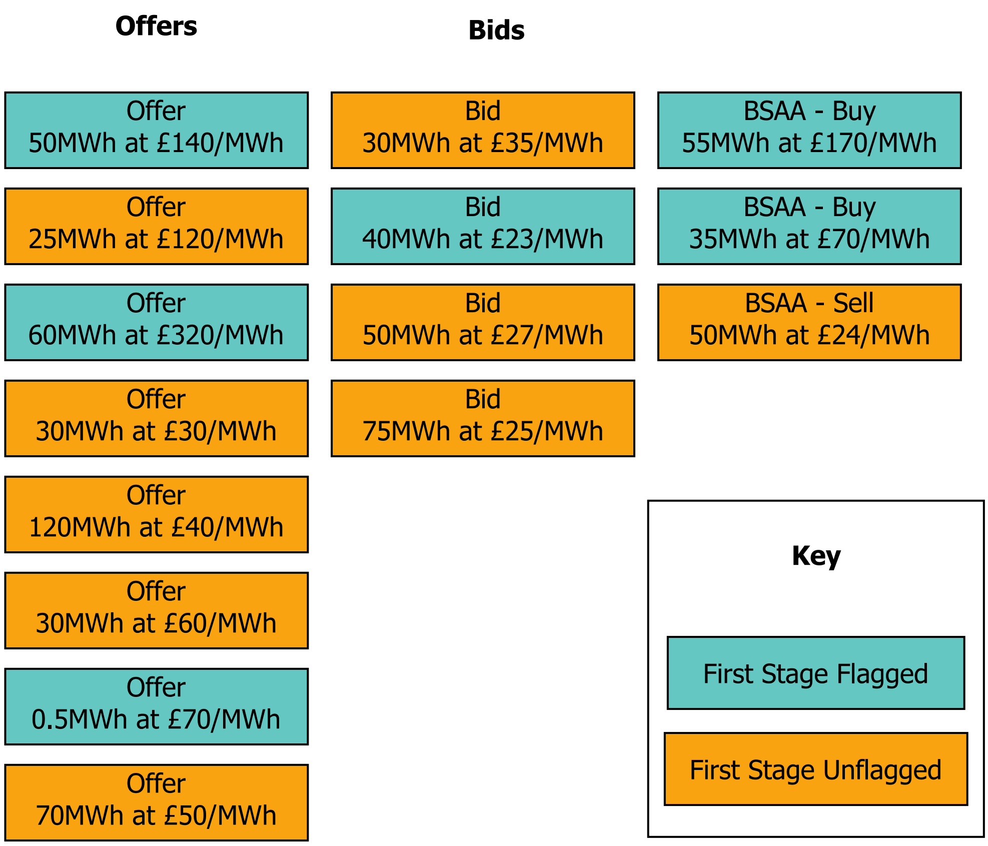
When ranking in price order, we always consider how expensive a balancing action is to the Transmission System. The cheapest balancing action is ranked first and the most expensive balancing action is ranked last.

For a buy balancing action, the higher the price the more expensive the action. So a £10/MWh buy balancing action will be ranked before a £20/MWh buy balancing action.

For a sell balancing action, the lower the price the more expensive the action. This is because the price is what a Party will pay per MWh to reduce their generation or increase demand. So a £20/MWh sell balancing action will be ranked before a £10/MWh sell balancing action.

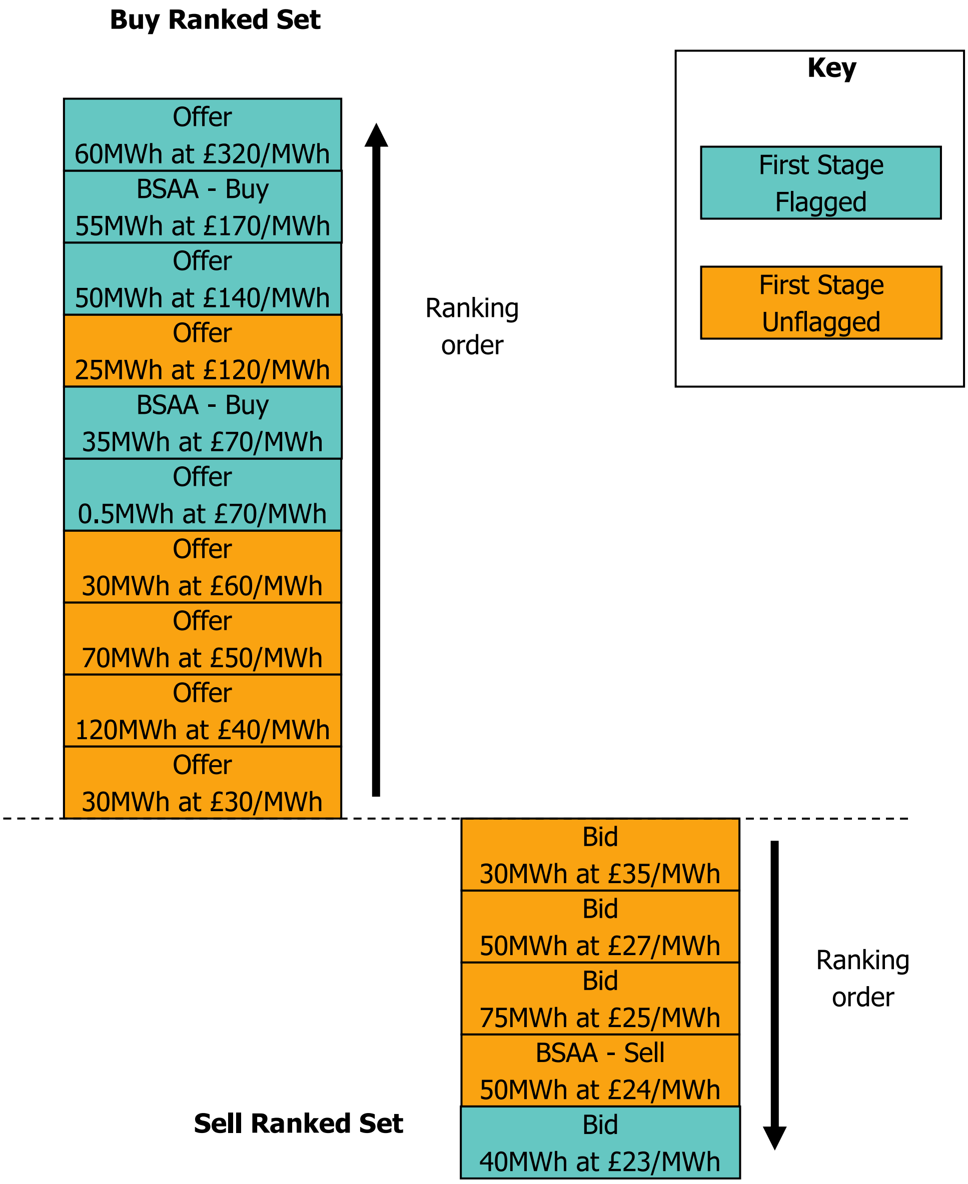
Below is an example of actions being separated out into the Buy Ranked Set and the Sell Ranked Set.

Unranked balancing actions



The above diagram is unranked. The next diagram shows how balancing actions have been ranked into a Buy Ranked Set and a Sell Ranked Set. We show the ranking orders in opposite directions.

Ranked balancing actions



De Minimis Tagging

Explanation

De Minimis Tagging removes all balancing actions (BOAs and Balancing Services Adjustment Actions) with a volume less than the **De Minimis Acceptance Threshold** (**DMAT**). This volume is currently set at **1MWh**. The Panel can alter the DMAT (with Ofgem's approval) following consultation with the SO and Parties.

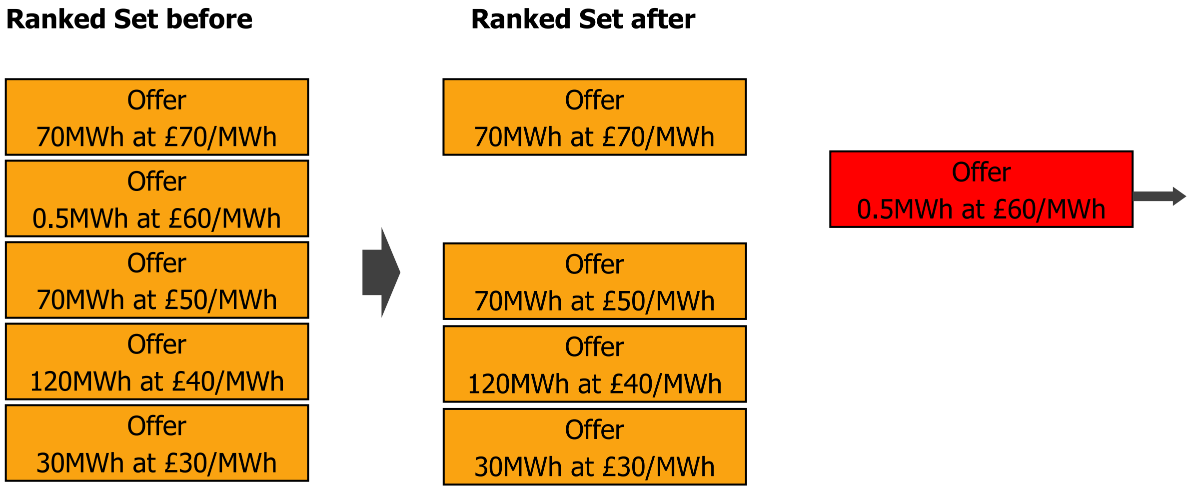
De Minimis Tagging removes potentially 'false' actions created due to the finite accuracy of the systems used to calculate Bid and Offer Volumes. All balancing actions less than 1MWh are completely removed from the calculation of the energy imbalance price, i.e. both the price and volume of a De Minimis tagged BOA are excluded.

Where in the BSC?

BSC Section T1.8 defines the DMAT and the Panel revision process.

The De Minimis tagging process is described in Annex T-1 paragraph 6.

Example of a De Minimis Tagged Offer



In this example the 0.5MWh at £60/MWh Offer is removed by De Minimis Tagging.

Arbitrage Tagging

Explanation

Arbitrage occurs when the price of a buy balancing action (an accepted Offer or a buy Balancing Services Adjustment Action) is either the same or lower than the price of a sell balancing action (an accepted Bid or a sell Balancing Services Adjustment Action). It is considered arbitrage because the SO can 'purchase' the buy balancing action in the same instant as it 'sells' the sell balancing action, and makes an immediate profit for no net change of energy on the Transmission System.

In cases of arbitrage, equivalent volumes of sell balancing actions and buy balancing actions are excluded from the energy imbalance price calculation.

An example of a Bid and an Offer which would be subject to arbitrage is shown below:

Where in the BSC?

The Arbitrage Tagging process is described in Annex T-1 paragraphs 7 and 13.

Example of BOAs which would be Arbitrage Tagged

Offer 30MWh at £10/MWh	Bid 30MWh at £15/MWh

Here a generator is willing to increase generation by 30MWh for just £10/MWh, whilst there is another generator who is willing to pay £15/MWh to decrease generation by 30MWh. It is considered that, in an efficient market, these two generators would have traded with each other ahead of Gate Closure. Therefore the equal volumes (30MWh) are removed from the Buy and Sell Ranked Sets.

Classification

Explanation

Classification determines which first stage flagged balancing actions retain their price and which become unpriced. It is the main way that the BSC Systems decide if a balancing action is an energy balancing action or a system balancing action.

Classification occurs independently for the Buy Ranked Set and the Sell Ranked Set. Before Classification, a balancing action will be either a:

- **First Stage Unflagged balancing action** – an energy balancing action; or
- **First Stage Flagged balancing action** – a potentially system balancing action (SO-Flagged, Emergency Flagged or CADL Flagged).

During Classification, each First Stage Flagged balancing action is compared to the most expensive First Stage Unflagged balancing action in the respective Ranked Set (Buy or Sell).

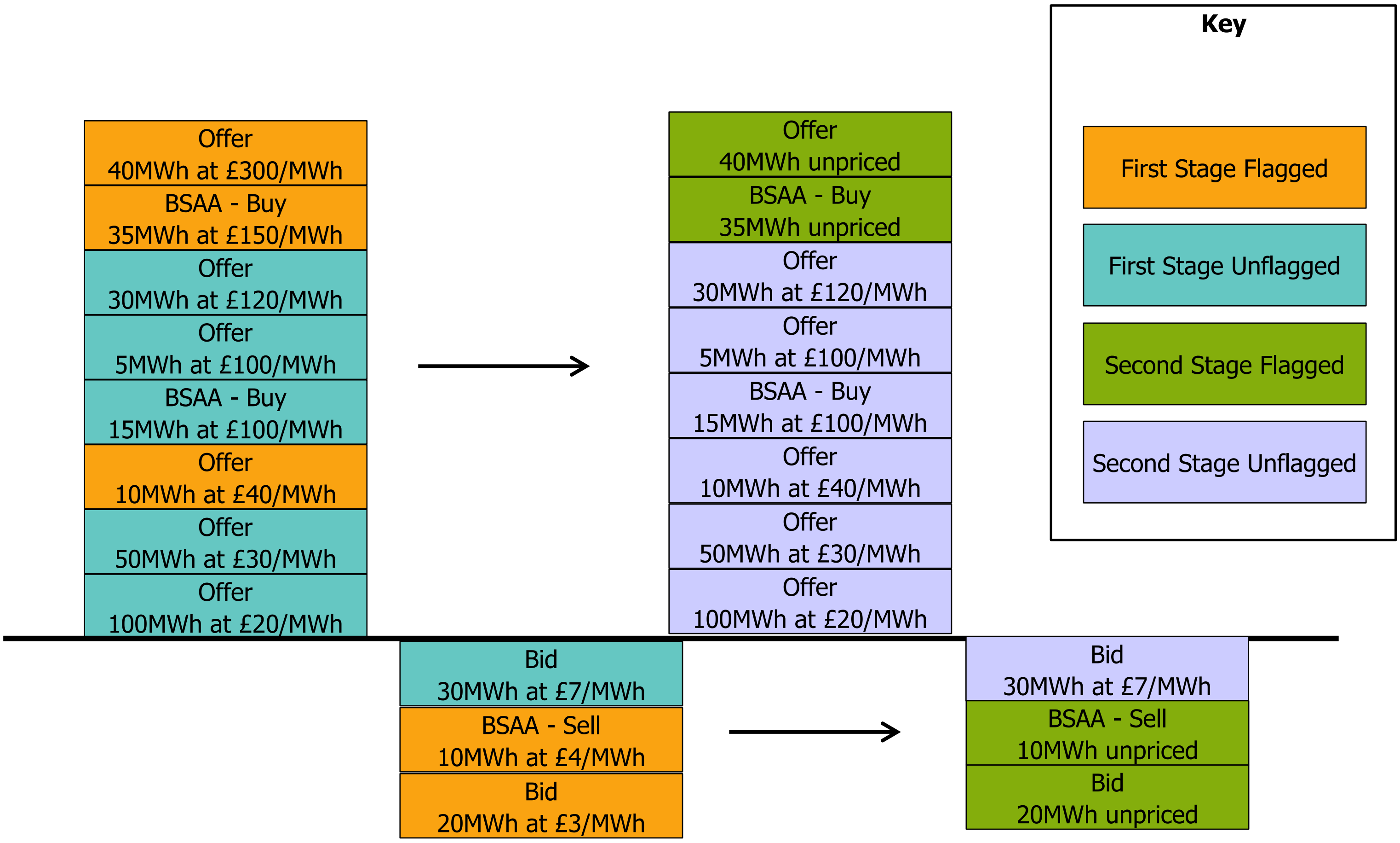
Where in the BSC?

Section T Annex T-1 paragraph 8 describes the Classification process.

If a First Stage Flagged balancing action has a **more expensive price** than the most expensive First Stage Unflagged balancing action it is considered a system balancing action and so becomes **unpriced**.

If a First Stage Flagged balancing action has a **less expensive price** than the most expensive First Stage Unflagged balancing action it is considered an energy balancing action and stays **priced**.

The example below shows Classification at work.



In the example above, the 10MWh buy balancing action retains its price of £40/MWh as it is less expensive than the most expensive Unflagged balancing action (the £120/MWh balancing action). The 30MWh sell action priced at £7/MWh also retains its price. All other First Stage Flagged balancing actions become unpriced as they are more expensive than the most expensive Unflagged balancing action.

Following the Classification process, a balancing action will either be a:

- **Second Stage Unflagged balancing action** – An energy balancing action which keeps its original price; or
- **Second Stage Flagged balancing action** – A system balancing action which becomes unpriced.

Other Classification rules

- Upon Classification, any First Stage Unflagged balancing actions are automatically classified as **Second Stage Unflagged balancing actions**.
- If there are no First Stage Unflagged balancing actions in a Ranked Set, all balancing actions are classified as **Second Stage Flagged balancing actions**.
- A NULL-priced Balancing Services Adjustment Action is always classified as a **Second Stage Flagged balancing action.**

NIV Tagging

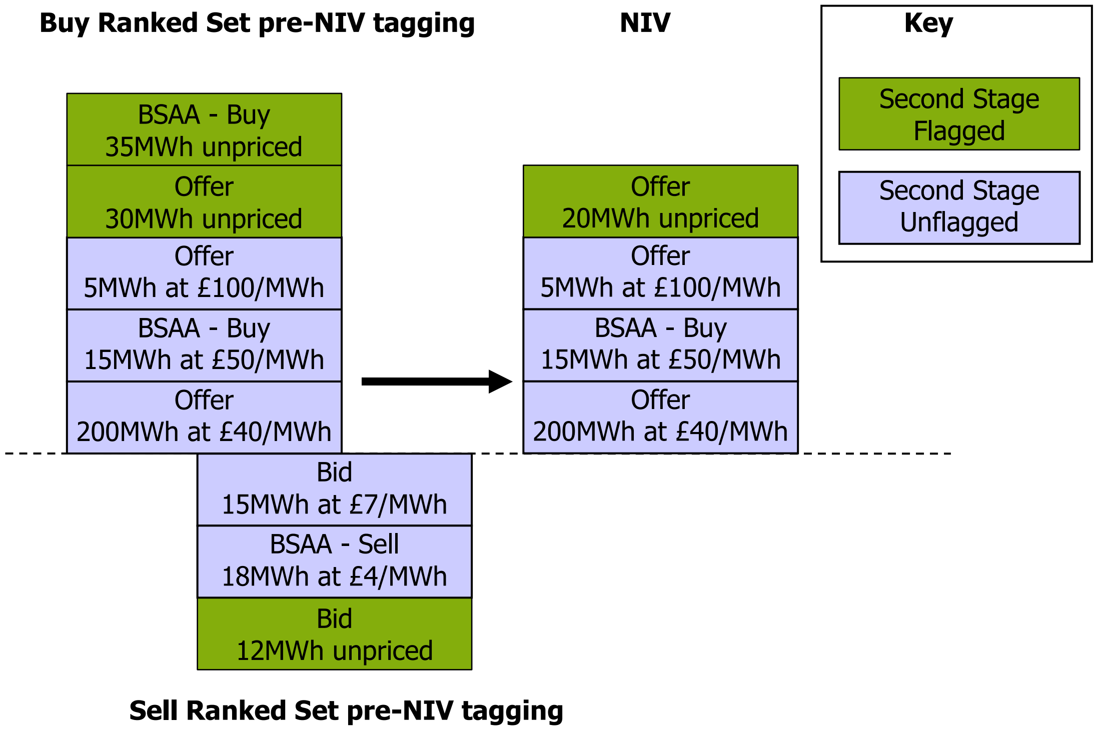
Explanation

Net Imbalance Volume (NIV) Tagging occurs following Classification and works by netting off the Buy and Sell Ranked Sets. The most expensive balancing actions are netted off first and are referred to as NIV Tagged. The NIV Tagging will leave either a net volume of Buy balancing actions, or Sell balancing actions. This is the NIV for a Settlement Period.

Where in the BSC?

NIV Tagging is described in Section T Annex T-1 paragraph 9 and 14.

Example of NIV Tagging



In the example the Sell Ranked Set is NIV Tagged along with the unpriced 35MWh Balancing Services Adjustment Action (BSAA) and 10MWh of the unpriced 30MWh Offer.

When the Transmission System is **short**, and the SO balances the system by accepting a greater volume of buy balancing actions than sell balancing actions, the **NIV will be positive**.

When the Transmission System is **long**, and the SO balances the system by accepting a greater volume of sell balancing actions than buy balancing actions, the **NIV will be negative**.

Replacement Price

Explanation

There are situations where not all of the volume of the NIV is priced. This may occur if there is a large amount of unpriced volume (that has been classified as Second Stage Flagged) in a particular Settlement Period. Where unpriced volume exists in the NIV it must be assigned a Replacement Price. The Replacement Price is calculated from a volume-weighted average of the **most expensively priced 1MWh of unflagged (and therefore priced) actions**. This parameter is the **Replacement Price Average Reference Volume (RPAR)**.

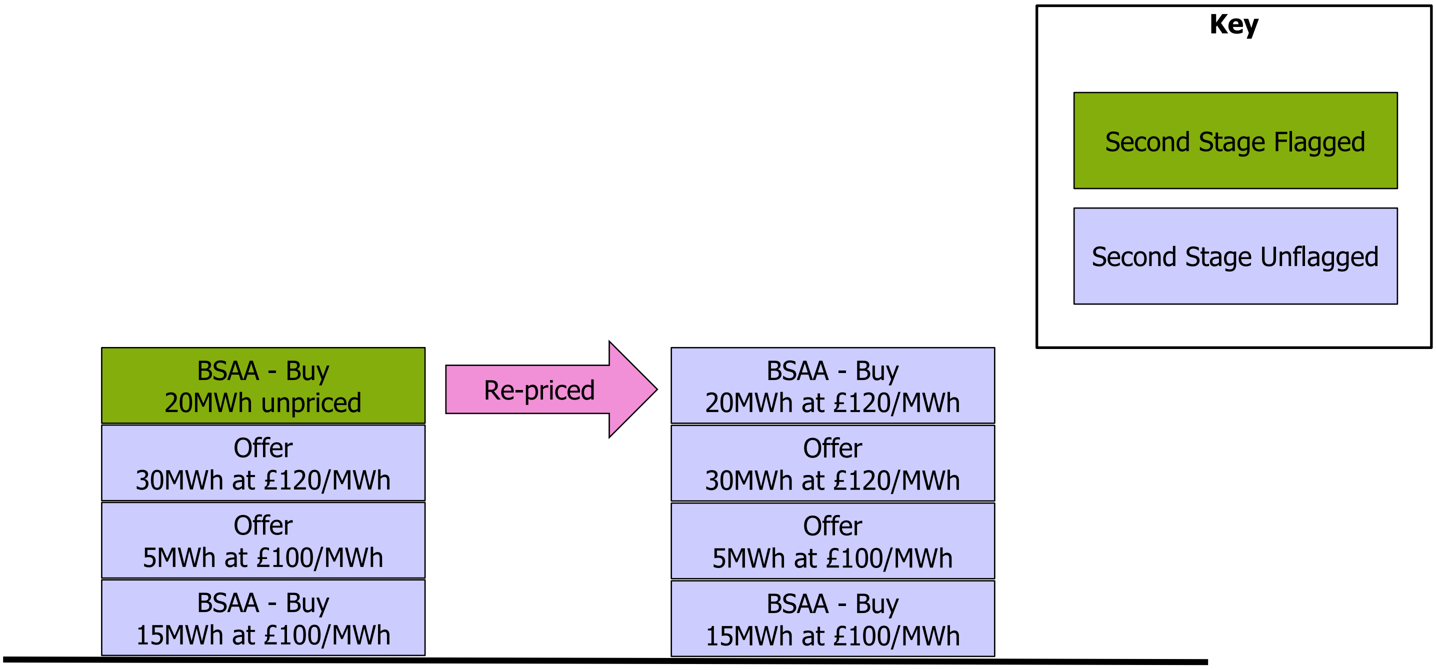
Where in the BSC?

RPAR is defined in Section T1.11.

The Replacement Price Process is described in Section T Annex T-1 paragraphs 10 and 15.

An example of the Replacement Price process is shown below. In the example, the unpriced 20MWh Offer requires a Replacement Price. To calculate the Replacement Price we use the most expensive 1MWh of priced balancing actions. In the example below the Replacement Price is £120/MWh (the price of the most expensive priced 1MWh) and this is applied to the unpriced volume.

Example of a Replacement Price situation



Once the Replacement Price has been assigned to the previously unpriced volume, the NIV stack may have to be re-ranked to keep the actions in the price order.

PAR Tagging

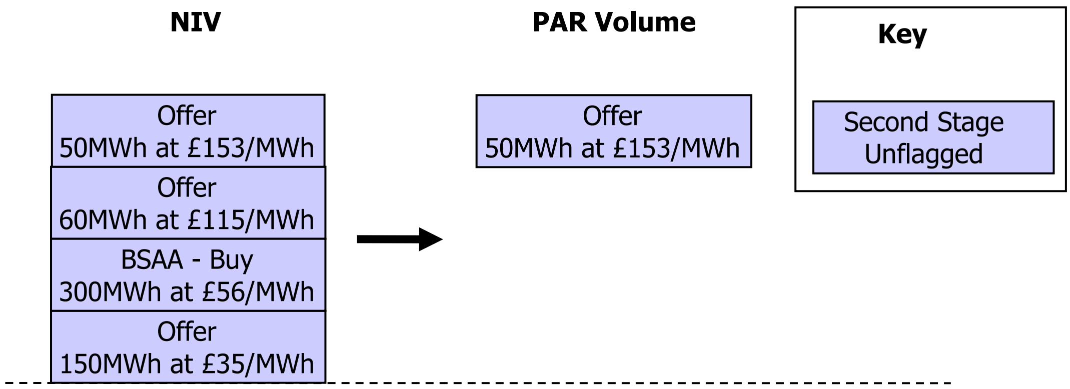
Explanation

The last tagging process is Price Average Reference (PAR) Tagging. The energy imbalance price is calculated based on the volume-weighted average of a defined volume of the most expensive actions remaining. This defined volume is the **Price Average Reference Volume (PAR)** and is **50 MWh**. PAR Tagging is applied such that:

- Where the System is short, the imbalance price is calculated as a volume-weighted average of not more than 50 MWh of the most expensive actions in the NIV (i.e. up to 50 MWh of highest priced buy balancing actions); and
- Where the System is long, the imbalance price is calculated as a volume-weighted average of not more than 50 MWh of the most expensive actions in the NIV (i.e. up to 50 MWh of lowest priced sell balancing actions).

The purpose of the PAR Tagging mechanism is to more closely align the energy imbalance price with the price of the marginal energy balancing action (i.e. the most expensive action taken by the SO to balance total energy supply and demand).

Example of PAR Tagging



Where in the BSC?

PAR is defined in Section T1.10.

The PAR process is described in Section T Annex T-1 paragraphs 11 and 16.

Buy Price Price Adjustment (BPA)/Sell Price Price Adjustment (SPA)

Explanation

The other part of BSAD used for the energy imbalance price calculation is the BPA/SPA. Only one is used for each Settlement Period. The BPA is used when the Transmission System is short (and the NIV is positive), and the SPA is used when the Transmission System is long (and the NIV is negative).

The BPA is a reflection of the costs to the SO of regulating reserve and BM start-up. In the event that the System Operator has to use Supplemental Balancing Reserve (SBR) ELEXON re-price the action at VoLL ex-post, and re-run the price calculation. The difference in the price is added to the Buy Price Adjuster (BPA). See Appendix 3.

The SPA is made up of option fees for negative reserve and forward contracts. For further details of the BPA/SPA, see Appendix 3 or the BSAD Methodology Statement.

Where in the BSC?

The requirement for the Transmission Company to send BPA/SPA in BSAD is in Section Q6.3.2.

The BPA/SPA is then used in the final calculation in Section T4.4.2(a) and T4.4.3(a).

For example:

Volume-weighted average for a short Settlement Period X on an example day = £30/MWh

Buy Price Adjustment for Settlement Period X on example day = £6.50/MWh

System Buy Price = 30 + 6.50 = £36.50/MWh

Transmission Loss Multipliers (TLMs)

Once PAR Tagging has been completed, the balancing actions still remaining will be used in the final calculation. At this stage they need to be adjusted for transmission losses.

What are transmission losses?

When electricity is transmitted over the Transmission System some energy is 'lost' (eg as heat). The energy lost from the Transmission System is commonly referred to as 'transmission losses'.

The total losses are the total energy lost from the Transmission System at any given time, which equates to the difference between total metered generation and total metered consumption.

How are transmission losses allocated?

Transmission losses are allocated to all Parties (with the exception of Interconnector Users) on the basis of their metered energy in each half hour.

A Transmission Loss Multiplier (TLM) is used to scale each non-Interconnector BM Unit's Metered Volumes in Settlement. The TLM is calculated for each non-Interconnector BM Unit for each Settlement Period.

The result is uniform adjustment of the total transmission losses for the Settlement Period such that:

- 45% of losses are allocated across all non-Interconnector BM Units in net 'delivering' (exporting) Trading Units; and
- 55% of losses are allocated across all non-Interconnector BM Units in net 'offtaking' (importing) Trading Units.

The Metered Volumes of Interconnector BM Units are not scaled for transmission losses.

Where do we use transmission losses in imbalance pricing?

The BOAs used to calculate the energy imbalance price are adjusted for transmission losses. This is done in the final calculation (see below). Balancing Services Adjustment Actions are adjusted by the SO before they are sent to the BSC Systems.

Where in the BSC?

The transmission losses calculations are defined in Section T2. The TLM is then used in the final calculation in Section T4.4.2(a) and T4.4.3(a).

Final energy imbalance price calculation

For the final energy imbalance price calculation we take a volume-weighted average of the balancing actions, adjust them for transmission losses and add on the BPA/SPA. Section 4 describes an example of how we do this.

Default rules – what happens when there is not enough priced volume?

There are a number of default rules which apply when the data needed to carry out the pricing method is not available.

Replacement Price

In the situation where there is no priced volume in the RPAR volume, the Replacement Price will be calculated using the Market Price for that Settlement Period. See Section 5 for an explanation of the Market Price pricing method.

NIV and PAR

Where there are no actions left in the NIV, the energy imbalance price will be set to equal the Market Price.

In the situation where the volume of priced (and re-priced from the Replacement Price) balancing actions is less than the PAR volume, the energy imbalance price will be a volume-weighted average of the priced system actions (whatever their volume).

In the situation where the Market Price is zero and the NIV is made up of 100% unpriced actions, the energy imbalance price will be also be zero.

LOLP and the Reserve Scarcity Price

If the SO doesn't have a Gate Closure De-rated Margin Value to produce a Final LoLP Value, then it uses the next available De-rated Margin value (eg the two hours ahead forecast) to calculate a Final LoLP Value. Where no De-rated Margin Value is available to produce a Final LoLP Value, then LoLP will be null. This means that RSP will be nil.

Actions not included in the calculation of the energy imbalance price

Applicable Balancing Services Volume Adjustment Data (ABSVD)

Applicable Balancing Services Volume Adjustment Data (ABSVD) are volume adjustments to BM Units that are instructed by the SO to provide automatic frequency response and other non-BM balancing actions which are not accounted for elsewhere (and therefore these BM Units are in imbalance of their notified position). These volumes are identified post-event by the SO using a set of matrices of frequency response for each individual BM Unit that provides the service. The volume calculated is removed from the Party's Energy Account and entered into the SO account. ABSVD is not included in the calculation of the energy imbalance price, as it is currently not possible to calculate the volume adjustments within the timescales for reporting the energy imbalance price (15 minutes after the end of the Settlement Period).

4. Pricing calculation example

This section provides an example of the energy imbalance price calculation based on a theoretical set of balancing actions.

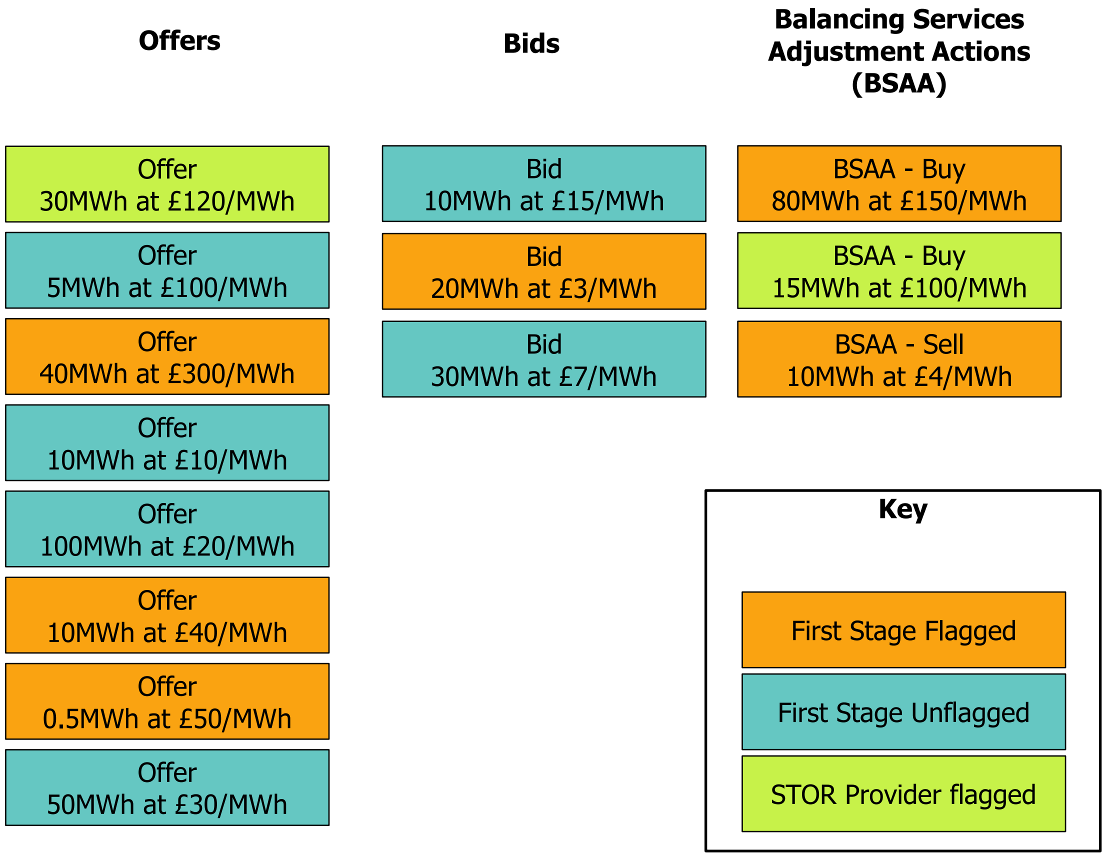
Energy imbalance price calculation processes

This example will, step by step, go through the following nine stages of the calculation:

1. Receive Balancing Services Adjustment Actions and BOAs (Includes SO-Flagging, CADL Flagging, Emergency Flagging);
2. Determine STOR action price;
3. Rank Buy Ranked Set and Sell Ranked Set;
4. De Minimis Tagging and Arbitrage Tagging;
5. Classification;
6. Net Imbalance Volume (NIV) Tagging;
7. Replacement Price;
8. Price Average Reference Volume (PAR) Tagging;
9. Buy Price Price Adjustment (BPA) / Sell Price Price Adjustment (SPA); and
10. Transmission Loss Multiplier and the energy imbalance price calculation.

1. Receive Balancing Services Adjustment Actions and BOAs (Includes SO-Flagging, CADL Flagged, Emergency Flagged)

For each Settlement Period, the SO matches demand to generation in real time by using balancing actions (BOAs and Balancing Services Adjustment Actions). The SO flags balancing actions potentially impacted by system balancing issues (SO Flagging), as well as actions which have come from STOR providers (STOR Provider Flags). The BSC Systems flag actions which have duration less than CADL (15 minutes). SO-Flagged and CADL Flagged actions are collectively called First Stage Flagged balancing actions. In the example below, First Stage Flagged balancing actions are shown in blue stripes and First Stage Unflagged actions are shown in orange. STOR Provider Flagged actions are shown in green. For simplicity the volumes are not shown to scale.



2. Determine STOR action price

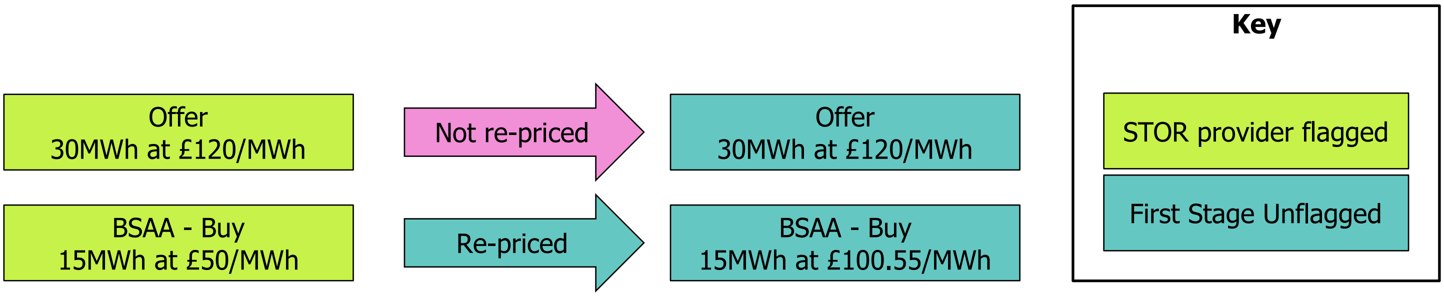
STOR actions are identified by the System Operator using a STOR Provider Flag. For BM STOR the capacity's bid offer acceptance (BOA) is flagged. Volumes for non-BM STOR are fed into the imbalance price as a Balancing Service Adjustment Action (BSAA), and these will also receive a STOR Provider Flag.

Actions derived from BOAs and BSAAs that are STOR Provider Flagged, and that are accepted during STOR Availability Windows are included in the calculation of imbalance prices as individual STOR actions, with a price which is the **greater** of:

- The Utilisation Price for an action (the price that STOR capacity is paid when it is called upon); and
- The Reserve Scarcity Price (RSP), as determined by LOLP*VoLL.

The Loss of Load Probability is determined using the De-rated Margin, in accordance with the Loss of Load Probability Calculation Statement. That LOLP is then multiplied by Value of VoLL to determine the RSP.

In the example below, two actions have been flagged by the System Operator as having come from STOR providers, and the Settlement Period is during a STOR Availability window. The De-rated Margin at Gate Closure is 1238MW, and this corresponds to a LOLP of 0.0334, as determined by the LOLP Calculation Statement. The Reserve Scarcity Price is therefore £100.55 (0.00334*£3,000).



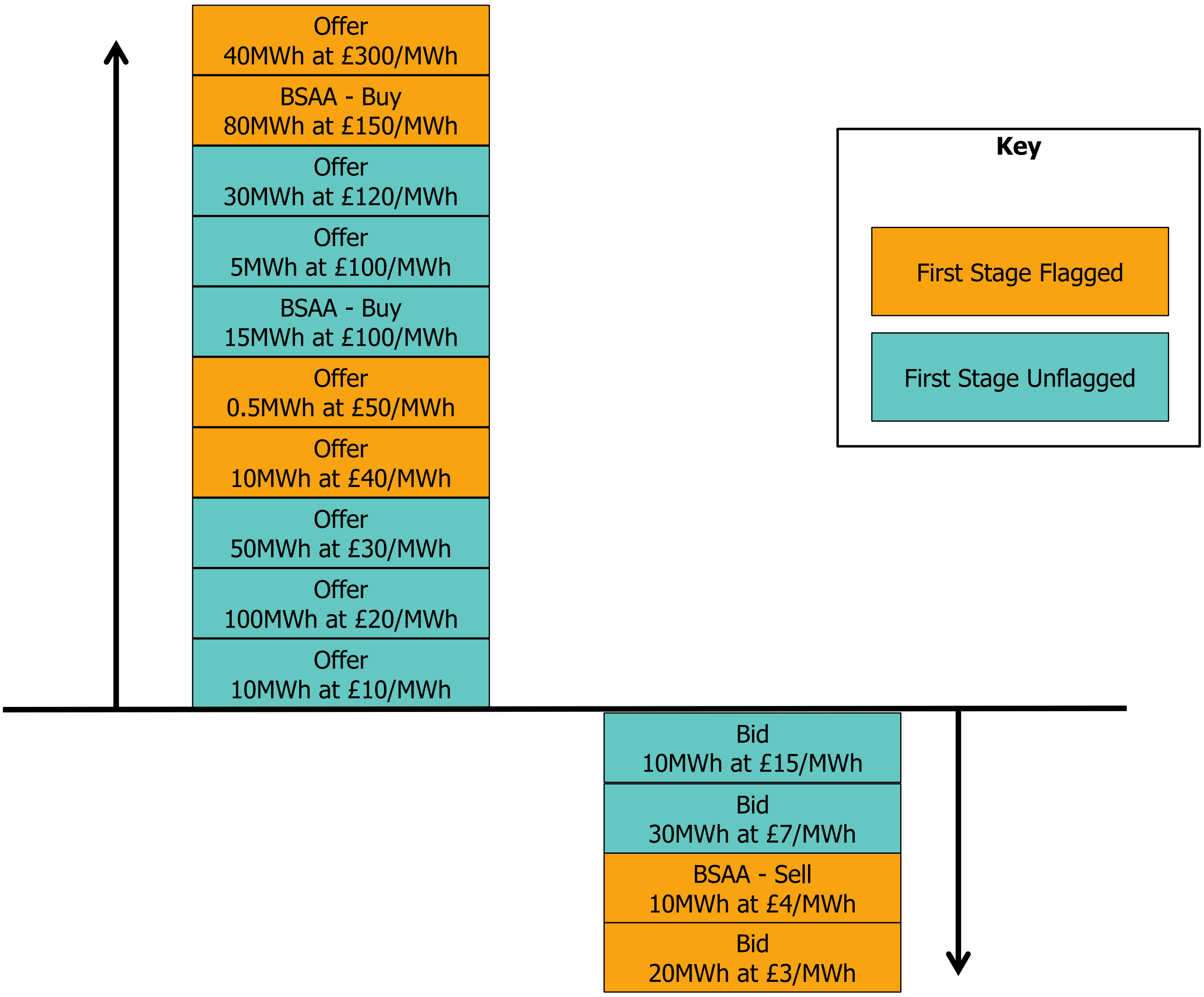
STOR actions then become **first stage unflagged**, and are treated like other BOAs and BSAAs for the next steps of price calculation (ranking, tagging, etc). Actions from STOR plant outside the STOR Availability Windows are not re-priced.

What is De-Rated Margin?

De-rated Margin is a measure of the excess supply on the system, which has been adjusted to take account of the likely availability of plant, specific to each type of generation technology. It reflects the proportion of an electricity source which is likely to be technically available to generate when needed.

3. Formulate the Ranked Sets of balancing actions

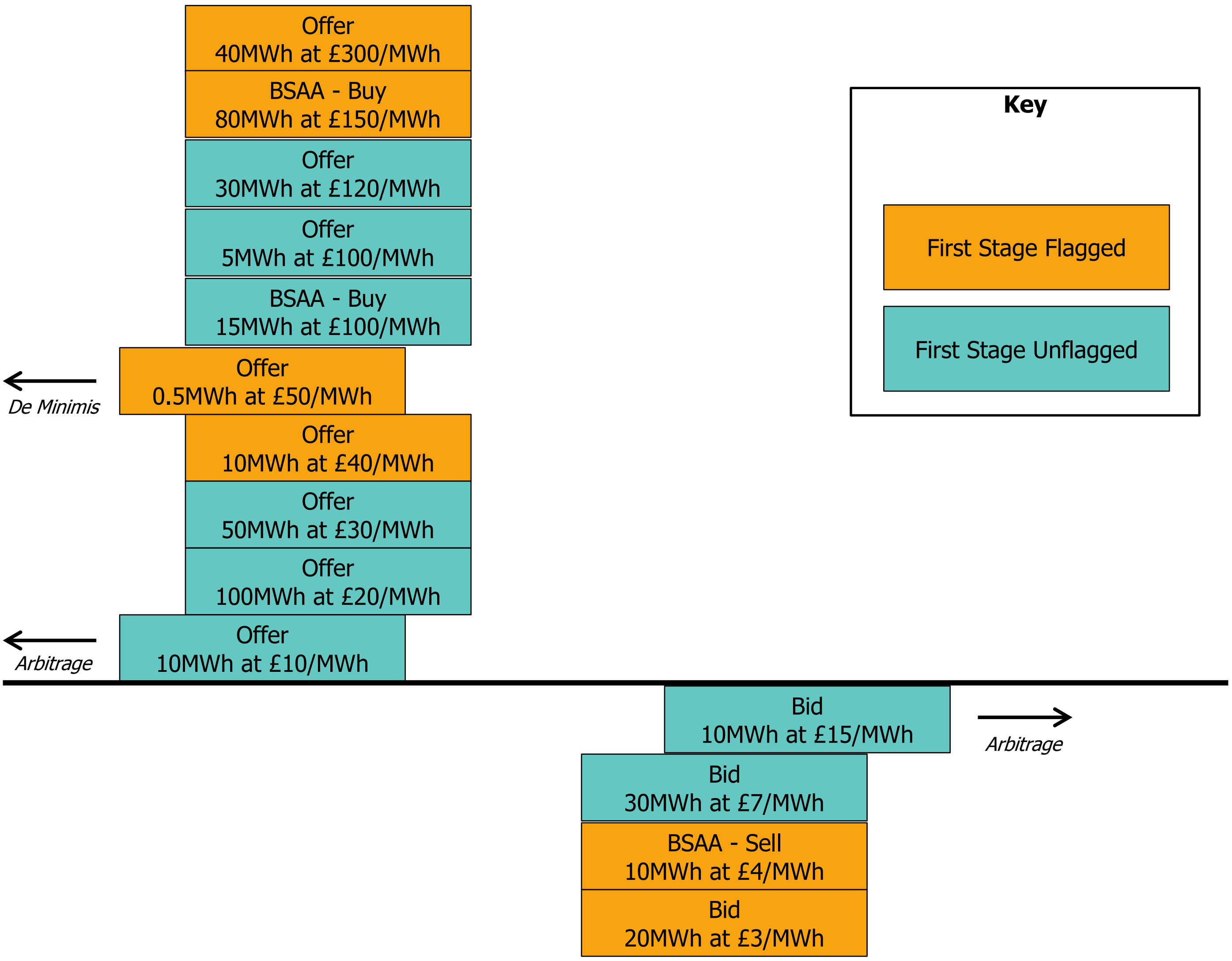
The balancing actions are separated into those that increase the energy on the Transmission System (buy balancing actions) and those that decrease the energy on the Transmission System (sell balancing actions). They are then ranked in price order - least expensive balancing action ranked first, most expensive balancing action ranked last. In the diagram below, the direction of the Sell Ranked Set is opposite (the most expensive balancing action is at the bottom) to the direction of the Buy Ranked Set (the most expensive balancing action is at the top). The price ranking is indicated by the arrows.



4. Remove De Minimis and Arbitrage actions

Balancing actions which are less than 1MWh are removed from the price stack. In the example below one action (0.5MWh at £50/MWh) is removed by De Minimis Tagging.

In the example there is also a £10/MWh Offer and a £15/MWh Bid which can be removed though Arbitrage Tagging. Arbitrage Tagging removes equal volumes from each Ranked Set.

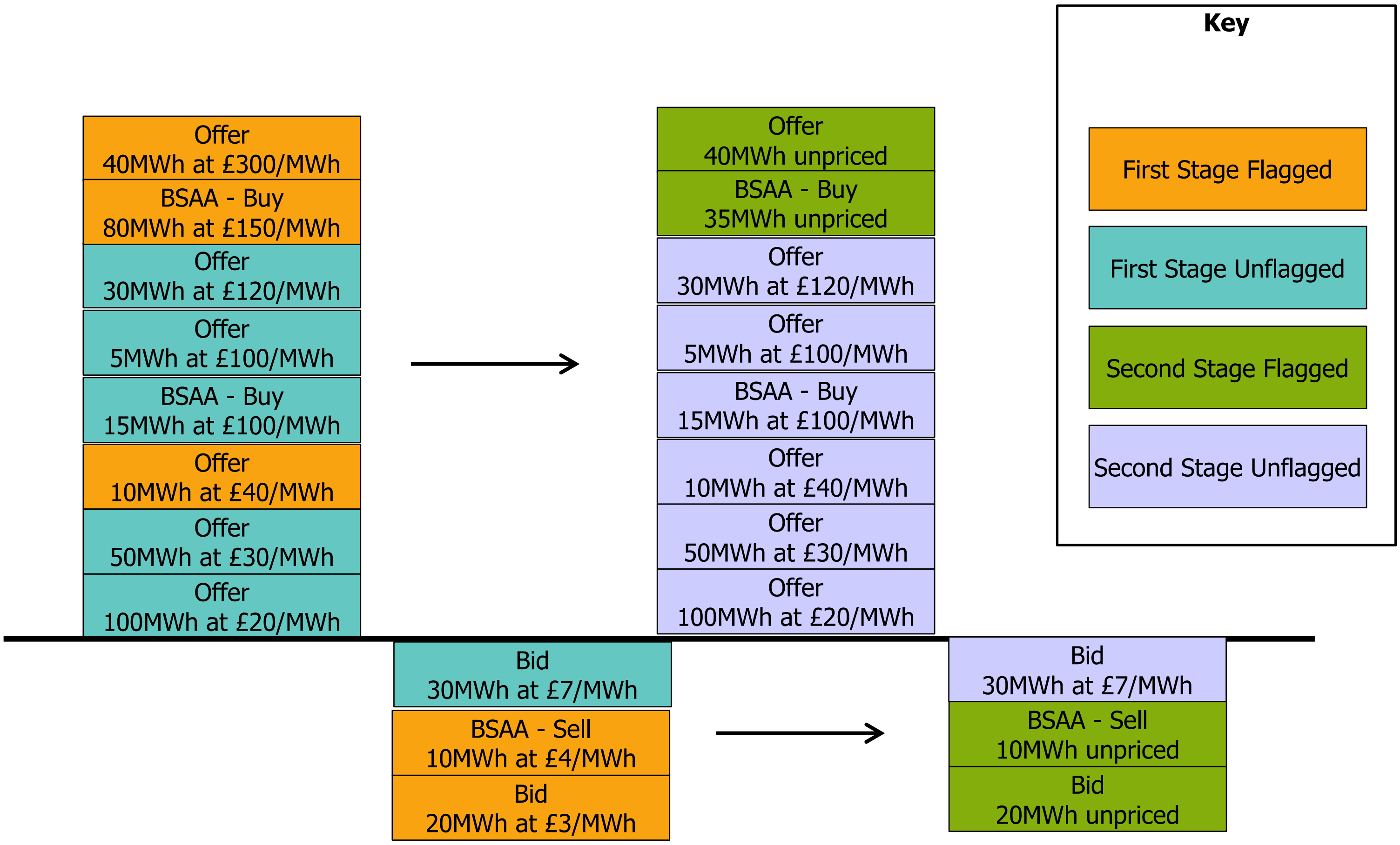


5. Classification

Balancing actions which are First Stage Unflagged are energy balancing actions and so are reclassified as Second Stage Unflagged balancing actions. These remain priced.

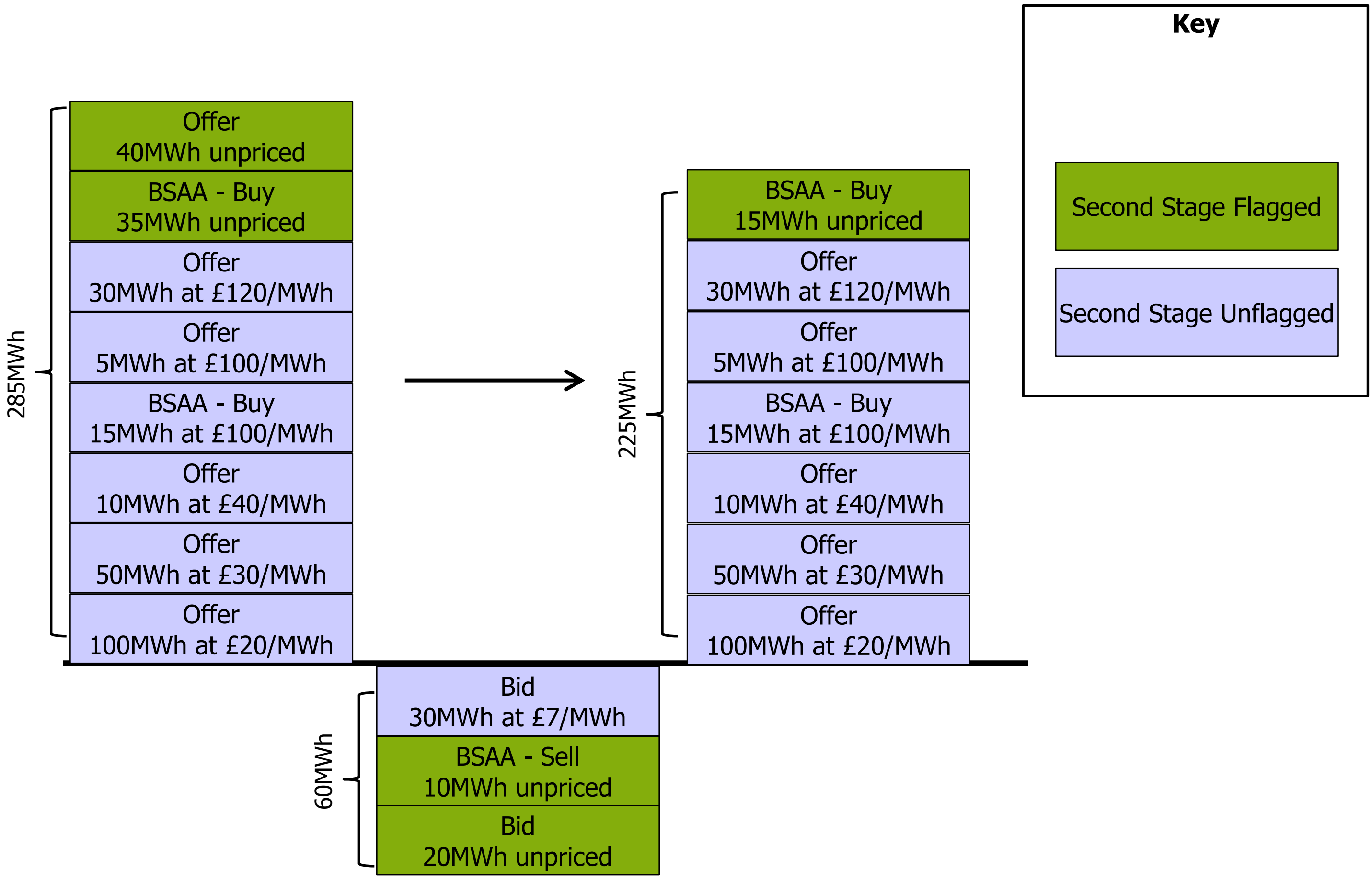
For each of the First Stage Flagged balancing actions, the BSC Systems consider whether there is a more expensive First Stage Unflagged balancing action. If there is a more expensive First Stage Unflagged balancing action, then the First Stage Flagged balancing action is classified as a Second Stage Unflagged balancing action and is priced. If there is not, then the First Stage Flagged balancing action is classified as a Second Stage Flagged balancing action and is unpriced.

In this example, the 10MWh at £40/MWh balancing action becomes Second Stage Unflagged and retains its price.



6. Net Imbalance Volume (NIV) Tagging

In order to establish the NIV, the volume of the smaller Sell stack is removed from the top of the larger Buy stack. The Sell stack has a volume of 60MWh. The corresponding volume at the top of the Buy stack removes the top Offer (40MWh), and 20MWh of the next Offer.



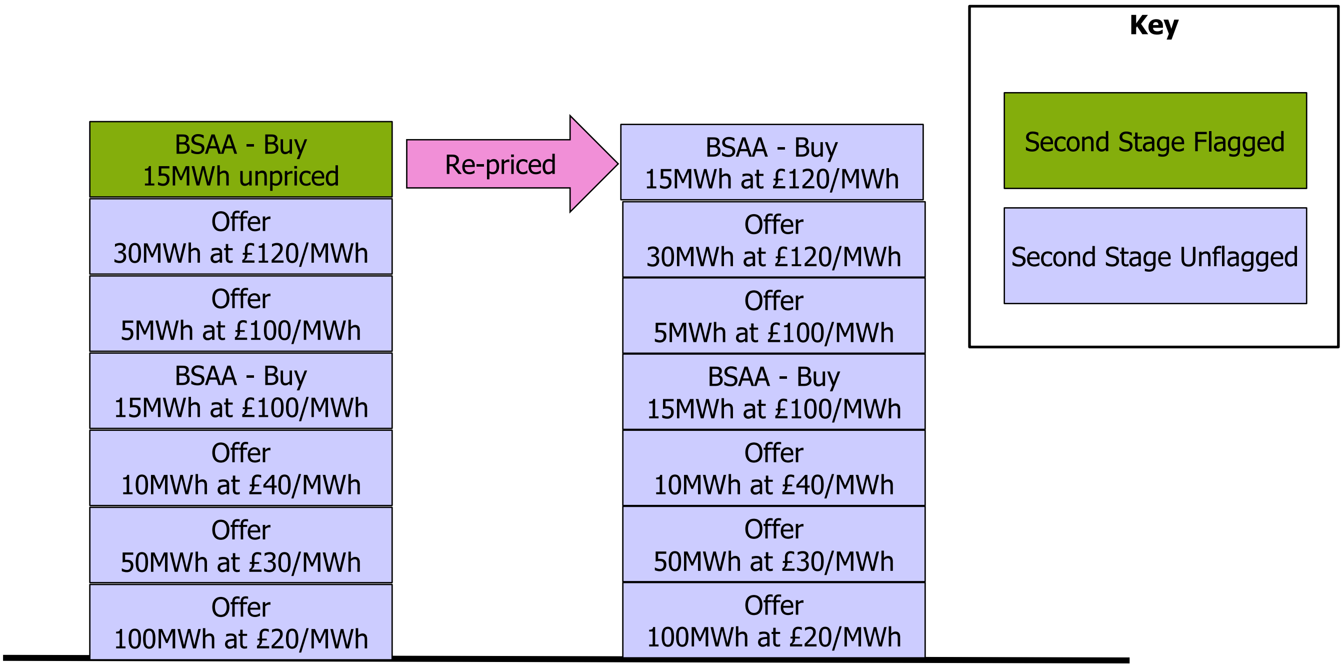
7. Replacement Price

BSC Systems assign a Replacement Price to any unpriced balancing actions. In the example there is an unpriced 15MWh balancing action which is assigned a Replacement Price.

The Replacement Price is calculated from a volume-weighted average of the most expensive 1MWh of priced balancing actions. For this example the most expensive 1MWh of priced balancing actions is set at £120/MWh.

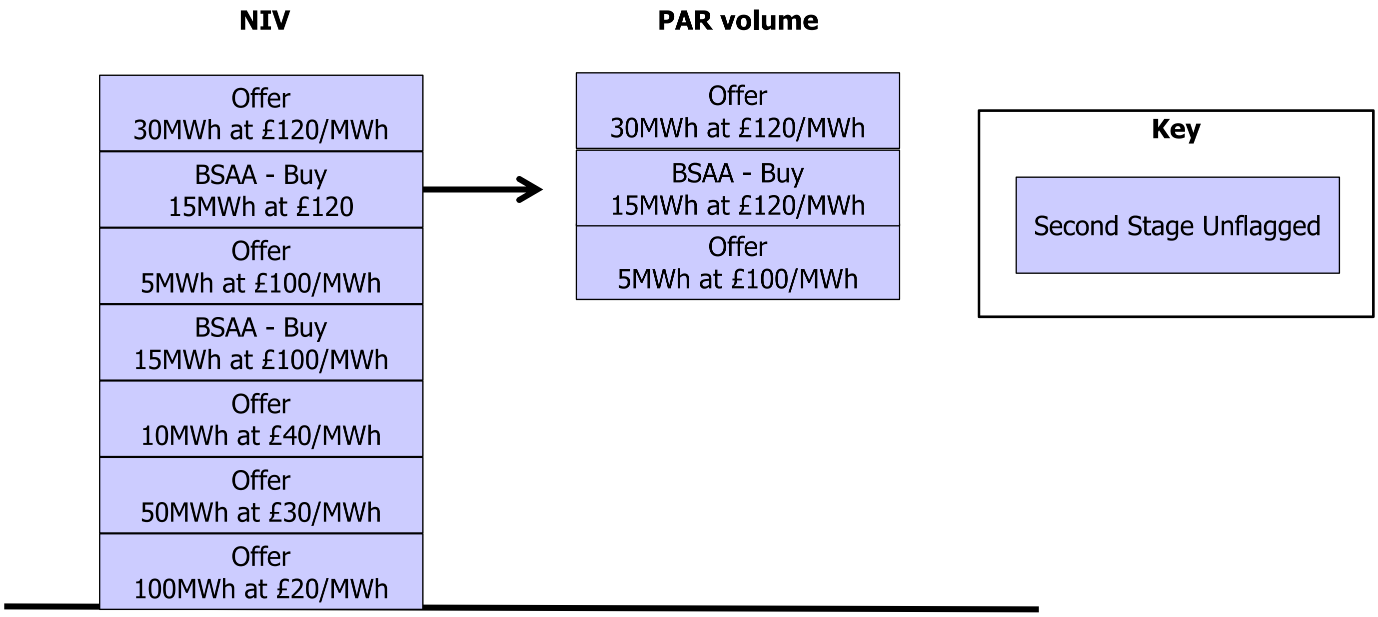
Once the unpriced balancing action is repriced it is considered as a Second Stage Unflagged balancing action.

Once the Replacement Price process has been completed, all balancing actions are Second Stage Unflagged and priced.



8. Price Average Reference Volume (PAR) Tagging

The final tagging rule is PAR Tagging. With PAR Tagging, a volume-weighted average of the 50MWh of most expensive actions is used to calculate the final energy imbalance price. In the example the volume of the NIV is 225MWh and PAR Tagging will use the most expensive 50MWh.



9. Buy Price Price Adjustment (BPA) / Sell Price Price Adjustment (SPA)

The NIV is positive so we use the BPA (as opposed to the SPA). For this Settlement Period, the BPA which the SO sent to us is **£5/MWh**. See Appendix 3 for more information about how the SO calculates the BPA and SPA.

10. Transmission Loss Multiplier and final energy imbalance price calculation

For this Settlement Period the Transmission Loss Multiplier is assumed to be:

- For non-Interconnector BMUs in delivering Trading Units: **0.99051**
- For non-Interconnector BMUs in offtaking Trading Units: **1.011849**

For this Settlement Period all Offers are from non-Interconnector BMUs in delivering Trading Units. TLMs are not applied to Balancing Services Adjustment Actions as the adjustment has already been made by the SO. In the example the 15MWh at £50/MWh balancing action is not TLM adjusted.

Volume weighted average of PAR = (30MWh x £120/MWh x 0.99051) + (15MWh x £120/MWh) + (5MWh x £100/MWh x 0.99051) / ((35MWh x 0.99051) + 15MWh)

Volume weighted average of PAR = £118.01

System Buy Price = £118.01 + £5/MWh

System Buy Price = £123.01/MWh

5. How does the Market Price work?

Introduction

The Market Price is used as the imbalance price when there are no actions left after flagging and tagging (ie NIV = 0). This price reflects the wholesale electricity price. The method for calculating the Market Price is set out in BSC Section T4.3A based upon **Market Index Data (MID)** received from each **Market Index Data Provider (MIDP)**. The formula for Market Index Data is set out in the **Market Index Definition Statement (MIDS)**. The Market Price is calculated for every Settlement Period.

The Market Index Definition Statement

The **Market Price** is based on trading in the 'short-term' market ahead of Gate Closure. The current version of the MIDS is always available on the BSC Website. The MIDS can only be changed with Ofgem's approval after industry consultation.

The Market Price is derived from trades made on power exchanges. Any power exchange offering energy trades for sale or delivery in the GB market can potentially be appointed as a MIDP. However, in order to accurately reflect a market price in the 'short-term' market, power exchanges with a significant market share of spot market trades are more likely to be appointed as an MIDP.

Each MIDP is required to derive a **Market Index Price (MIP)** and a **Market Index Volume (MIV)** which, in combination, are referred to as MID for each Settlement Period. The data is calculated by each MIDP in accordance with the MIDS. The MIDP is required to send MID on a Settlement Period basis to the BSC Systems.

The MIDS contains a description of the 'qualifying products', which are types of contract traded on the power exchanges from which the MIP and MIV are derived. The MIDS also sets out the time and qualifying product weightings that should be applied when calculating MID.

In order to reduce the likelihood that the Market Price is set by a single trade, there is an **Individual Liquidity Threshold (ILT).** The ILT is the minimum volume of qualifying products that must be equalled or exceeded for a MIDP's data to contribute to setting the Market Price in that Settlement Period. This is set high enough to reduce the likelihood that the MIP is set on a single trade, but low enough that it minimises the number of Settlement Periods where the MIP cannot be calculated and hence defaults to the main energy imbalance price.

MIDS – Structure and method

The MIDS splits the period deemed to constitute 'short term' into defined timebands. Products traded in the timebands near to real time are weighted more, to ensure that they have a more proportionate effect on the Market Index Price. The MIDP is required to provide functionality for weighting qualifying products/timeband combinations by values from 0 to 1.

With Ofgem's approval, the BSC Panel may from time to time adjust the MIDS parameters (qualifying products, weightings and ILT) which define the subset of power exchange trades and data used for calculating the Market Price.

6. Imbalance charges

How do the BSC Systems calculate Parties' imbalance volumes?

A Party's imbalance position is simply its Metered Volumes compared to its contracted volumes. The contracted volumes are adjusted for any accepted Bids and Offers or delivery of Balancing Services.

Energy imbalance volume = Energy – (Balancing Services + contracts)

This results in a positive or negative volume of imbalance.

A negative imbalance volume means that a Party has under-contracted and is therefore short of energy. A positive imbalance volume means that a Party has over-contracted and is therefore long on energy. The BSC Systems calculate the imbalance volumes for all Parties for every Settlement Period.

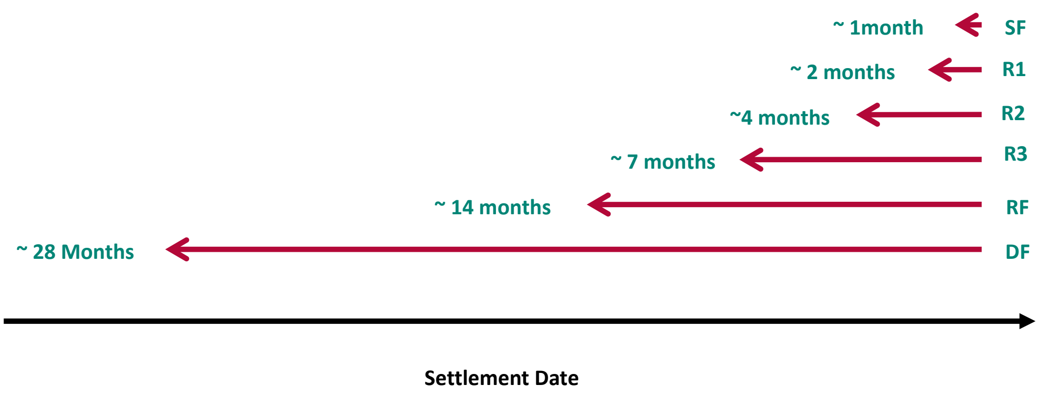
How do the BSC Systems calculate Parties' imbalance cashflows?

Once the BSC Systems know Parties' imbalance positions, they can calculate Parties' cashflows (imbalance charges) for each Settlement Period:

Energy imbalance cashflow = Energy imbalance volume x imbalance price

When are Parties billed for imbalance charges?

In order to accurately calculate imbalance charges, a complete set of metered data is required. This presents a problem. The data is readily available for sites metered Half Hourly. However, for Non Half Hourly sites the metered data will not be available until the Meter is read manually. Because of this the BSC Systems carry out a number of Settlement Runs at pre-defined points during the year (the Settlement Calendar).



In addition to the Settlement Runs shown above, an Interim Information (II) Settlement Run is calculated 5 Working Days after the Settlement Date. The II Run is for information only and no Parties are charged/credited after this run.

After the SF Run (and after all subsequent Reconciliation Runs – R1, R2, R3 and RF), invoices are generated and sent out to Parties by the Funds Administration Agent (FAA). The payment date for the SF run is always 29 calendar days after the Settlement Date. If any volumes at RF are still under dispute then another run (DF) can be carried out when the corrected data has been received. Any Party can raise a Dispute but it is the decision of the Trading Disputes Committee as to whether a DF Run is carried out.

7. Imbalance pricing data

Publishing data on the BMRS

Imbalance pricing data is published on the Balancing Mechanism Reporting Service (BMRS) by the Balancing Mechanism Reporting Agent (BMRA). The BMRS is available in two services:

- The High Grade service is a dedicated private communications network used by the BMRS to actively publish data to subscribing participants as soon as it is available; and
- The Low Grade service is the public website, http://www.bmreports.com, on which we publish the data.

Data is available to the High and Low Grade services at the same time, but if a Party is accessing the Low Grade service it will need to use the Refresh facility to retrieve the latest data as it becomes available.

The following imbalance pricing data is available on the BMRS for each Settlement Period:

- FPNs;
- Bid-Offer Pairs;
- BOAs (including SO-Flagging details);
- SBP/SSP;
- BSAD; and
- Market Price;
- De-Rated Margin;
- Loss of Load Probability;
- Reserve Scarcity Price;
- NIV.

Settlement Reports

The Settlement Run information is reported through the Settlement Administration Agent (SAA) I014 'Settlement Reports' (SAA-I014). The SAA produces three variants of the SAA-I014 for each Settlement Run for each Settlement Period:

- SAA-I014 sub-flow 1 – Parties' versions;
- SAA-I014 sub-flow 2 – SO version; and
- SAA-I014 sub-flow 3 – BSCCo (ELEXON) version.

The SAA-I014 is electronically sent to the above recipients on a daily basis (so each daily SAA-I014 contains all the Settlement Run data for that day). The SAA-I014 sub-flow 2 is also available to any BSC Party that wants to download it.

The SAA-I014 contains all the data a Party needs to understand its imbalance position for each Settlement Period. The SAA-I014 sub-flow 1 is tailored for each Party (so only contains data for that Party). The SAA-I014 sub-flow 2 contains data for all Parties. This includes:

- Party imbalance charges;
- Bid-Offer Pairs;
- BOAs (including SO-Flagging details);
- BSAD;
- Market Price; and
- NIV.

8. Glossary

Glossary	
Applicable Balancing Services Volume Data (ABSVD)	Volume adjustments to BM Units that are instructed by the SO to provide automatic frequency response These volumes are identified post-event by the SO using a set of matrices of frequency response for each individual BM Unit that provides the service.
Arbitrage Tagging	Arbitrage occurs when the price of a Buy balancing action is lower than the price of a Sell balancing action. In cases of arbitrage, equivalent Sell balancing actions and Buy balancing actions are excluded from the energy imbalance price calculation.
Balancing action	Either a Bid-Offer Acceptance or a Balancing Services Adjustment Action which is taken by the SO to balance the Transmission System.
Balancing and Settlement Code (BSC)	The BSC contains the rules and governance arrangements for electricity balancing and settlement in Great Britain and all licensed electricity companies must sign it (others may choose to do so).
Balancing Mechanism Units (BMUs)	BMUs represent the generation or consumption at a particular location. Each Party is assigned BMUs for their Power Stations or areas of demand. The BSC Systems sum up a Party's BMU volumes and contracts when they carry out the Settlement calculations.
Balancing Services Adjustment Action	Where the SO takes a balancing action outside the Balancing Mechanism, it inputs it into the BSC Systems as a Balancing Services Adjustment Action.
Balancing Services Adjustment Data (BSAD)	Balancing Services outside of the Balancing Mechanism are submitted using Balancing Services Adjustment Data (BSAD).
Bid	A Bid is a proposal on the Balancing Mechanism to reduce generation or increase demand.
Bid-Offer Acceptance (BOA)	An Offer or Bid which has been accepted by the SO to balance the Transmission System.
BSC Panel	The BSC Panel is the industry committee charged with ensuring the provisions of the BSC are carried out correctly and in such a manner as will promote the SO's Transmission Licence obligations, the efficient, economic and co-ordinated operation of the Transmission System and effective competition in the generation, supply, sale and purchase of electricity.
BSC Parties (Parties)	Organisations which have signed up to the Balancing and Settlement Code.
Buy Price Price Adjustment (BPA)	The BPA is a reflection of the costs to the SO of regulating reserve and BM start-up. In the event that the System Operator has to use Supplemental Balancing Reserve (SBR) the Buy Price Price Adjustment will be used to inflate the imbalance price so it reflects SBRs at a price of Value of Lost Load (VoLL). It is added when the NIV is positive.

Glossary	
CADL Flagged	A BOA which is less than 15 minutes in duration and has been flagged by the BSC Systems.
CADL Flagging	BOAs which are less than 15 minutes in duration are flagged by the BSC Systems.
Classification	The process by which the BSC Systems distinguish whether a First Stage Flagged Action is an energy balancing or a system balancing action.
Continuous Acceptance Duration Limit (CADL)	The time limit that distinguishes between short-duration balancing actions. The current CADL is set at 15 minutes and may be altered by the BSC Panel with Ofgem's approval, after consultation with the SO and Parties.
De Minimis Acceptance Threshold (DMAT)	The DMAT is 1MWh. The Panel can alter the DMAT with Ofgem's approval after consultation with the SO and Parties.
De Minimis Tagging	Balancing actions with a volume less than 1MWh are completely removed from the energy imbalance price calculation.
Demand Control	A last resort balancing action if the System Operator is unable to call on Bids and Offers or other Balancing Services to meet the current demand. When the SO issues a 'Demand Control Instruction' it will instruct the Distribution Network Operators to reduce demand on their Distribution Systems, either through reducing voltage across the network and/or disconnecting consumers.
Demand Control Instruction	An instruction from the SO to the Distribution Network Operators to reduce demand on their Distribution Systems, either through reducing voltage across the network and/or disconnecting consumers.
Demand Control Volume	The amount of electricity that is subject to a Demand Control Instruction
Demand Side Balancing Reserve	One form of the SO's contingency balancing reserve. This is provided by non-domestic customers with the ability to reduce or shift demand when called upon.
De-Rated Margin	De-rated Margin is a measure of the excess supply on the system, which has been adjusted to take account of the likely availability of plant, specific to each type of generation technology. It reflects the proportion of an electricity source which is likely to be technically available to generate when needed.
Distribution Network	The lower voltage network which supplies electricity from the Transmission System to customers.
Emergency Acceptance	An Emergency Instruction taken for energy balancing reasons.
Emergency Flagged	An Emergency Instruction taken for potentially system balancing reasons.
Energy balancing	Balancing actions taken to balance the short-term energy imbalance of the Transmission System.
Energy imbalance price	The energy imbalance price is calculated using the balancing actions that the SO accepted for that Settlement Period. Parties will pay the energy imbalance price when they are short, and are paid the energy imbalance price when they are long.

Glossary	
Energy Contract Volume Aggregation Agent (ECVAA)	The BSC System responsible for aggregating ECVNs.
Energy Contract Volume Notification (ECVN)	A notification of a bilateral contract between Parties. ECVNs must be submitted before Gate Closure for each Settlement Period.
Final Physical Notification (FPN)	Once Gate Closure has occurred for a Settlement Period the latest Physical Notifications become Final Physical Notifications.
First Stage Flagged balancing action	A balancing action taken for potentially system balancing reasons (SO-Flagged, Emergency Flagged or CADL Flagged).
First Stage Unflagged balancing action	An energy balancing action. At Classification, a First Stage Unflagged balancing action will automatically become a Second Stage Unflagged balancing action. It will also keep its original price.
Gate Closure	One hour before each Settlement Period the physical and contractual positions of Parties are frozen. This is called Gate Closure.
Generators	Organisations that produce electricity.
Individual Liquidity Threshold (ILT)	The ILT sets a minimum requirement for the volume of trades in a given Settlement Period for each MIDP. The ILT is currently set to 25MWh and can be altered through a change to the Market Index Definition Statement by the Panel with Ofgem's approval and after industry consultation.
Largest Loss Reserve	The Largest Loss Reserve represents the margin that the SO will always hold to protect against the instantaneous loss of the prevailing largest infeed into the system (eg a large generator).
Loss of Load Probability (LOLP)	Loss of Load Probability (LOLP) is a measure of reliability that will be calculated for each Settlement Period. For a given level of MW demand on the system the associated LoLP indicates the probability that there will be insufficient generating supply to meet the capacity requirement. National Grid's method is set out in the Loss of Load Probability Calculation Statement.
Market Index Data (MID)	The combination of Market Index Price and Market Index Volume derived by each MIDP for each Settlement Period.
Market Index Data Provider (MIDP)	A provider of Market Index Data.
Market Index Definition Statement (MIDS)	The MIDS sets out the method for calculating the Market Price
Market Index Price (MIP)	The price derived by each MIDP for each Settlement Period based on the short-term trades on its power exchanges made in accordance with the MIDS.
Market Index Volume (MIV)	The volume derived by each MIDP for each Settlement Period based on the short-term trades on its power exchanges made in accordance with the MIDS.
Market Price	The Market Price is calculated from the MID received from each MIDP for each Settlement Period. It is intended to reflect the price a Party would have obtained if it had bought or sold its imbalance on a power exchange.

Glossary	
Net Imbalance Volume (NIV)	The remaining volume following NIV Tagging.
Net Imbalance Volume Tagging	The volume of the Buy balancing actions are netted off against the volume of Sell balancing actions so that only the Net Imbalance Volume is used in the final calculation.
Offer	An Offer is a proposal on the Balancing Mechanism to increase generation or reduce demand.
Physical Notifications	Physical Notifications contain details of a generator's expected level of generation or a Supplier's expected level of demand. Generators and Suppliers must submit Physical Notifications for each BMU to the SO for each Settlement Period.
Price Average Reference volume (PAR)	The Price Average Reference volume is the most expensively priced 50MWh of balancing actions in the Net Imbalance Volume.
Ranked Set	Once all the BSC Systems have received all the balancing actions from the SO they are ranked in price order in two separate Ranked Sets (one for all the Sell balancing actions and one for Buy balancing actions).
Reserve Scarcity Price	A pricing mechanism used to re-price balancing actions from STOR plant when they are used during STOR Availability Windows, and when their Utilisation Prices are lower than the Reserve Scarcity Price. The RSP is determined by LOLP*VoLL.
Replacement Price	The price assigned to unpriced balancing actions which enter the Net Imbalance Volume. The Replacement Price is calculated from a volume-weighted average of the most expensively priced 1MWh of priced actions.
Replacement Price Average Reference volume (RPAR)	The Replacement Price is calculated from a volume-weighted average of the most expensively priced 1MWh of priced actions. This is known as the Replacement Price Average Reference Volume (RPAR).
Second Stage Flagged balancing action	A system balancing action which becomes unpriced.
Second Stage Unflagged balancing action	An energy balancing action which keeps its original price.
Sell Price Price Adjustment (SPA)	The SPA is a reflection of option fees for negative reserve and forward contracts. It is added when the Net Imbalance Volume is positive.
Settlement Period	The basic trading period for electricity is half an hour and is called a Settlement Period. Each day is split into 48 Settlement Period units (unless it is a day where the clocks change, which has either 46 or 50 half hours).
Short Term Operating Reserve (STOR)	One form of balancing reserve procured by the SO.
SO-Flagged	A balancing action which has been flagged by the SO.
SO-Flagging	The process by which the SO identifies or 'flags' balancing actions which have been impacted by transmission constraints.
STOR Availability Window	The time during which providers of STOR are required to be available.

Glossary	
STOR Provider Flag	A flag which identifies a STOR provider.
Supplemental Balancing Reserve	One form of contingency balancing reserve procured by the SO. It is provided by generation that would otherwise not be available in the market (eg due to closure or mothballing).
Suppliers	Organisations that supply electricity to their customers.
System balancing	Balancing actions taken for non-energy, system-management reasons.
System Buy Price (SBP)	If a Party has under-generated or over-demanded it will have to buy that shortfall of energy from the Transmission System. To do this it pays System Buy Price (SBP).
System Management Action Flagging Methodology Statement	The statement required by the Transmission License which details the SO's methodology for SO-Flagging.
System Operator (SO)	National Grid is the SO and is required to balance the Transmission System.
System Sell Price (SSP)	If a Party has over-generated or under-demanded it will have to sell that extra energy to the Transmission System. To do this it is paid System Sell Price (SSP).
Transmission constraint	Any limit on the ability of the Transmission System, or any part of it, to transmit power to a location which demands it.
Transmission Loss Multiplier (TLM)	The value calculated for each Settlement Period and used to scale each BM Unit's Metered Volume for Settlement. Transmission losses are allocated so that: • 45% of losses are allocated across non-Interconnector BM Units in net delivering Trading Units; • 55% of losses are allocated across non-Interconnector BM Units in net offtaking Trading Units; and • Interconnector BM Units have a TLM of 1 applied and 0% of losses are allocated to these BM Units.
Transmission System	The high voltage network that transports electricity throughout Great Britain. The Transmission System delivers electricity to the lower voltage Distribution Networks which in turn supply electricity to customers.
Transmission System length / net imbalance	The net imbalance of the Transmission System. When there is not enough generation is Transmission System is 'short'. When there is too much generation the Transmission System is 'long'.
Value of Lost Load (VoLL)	VoLL is a defined parameter in the BSC and is based on an assessment of the average value that electricity consumers attribute to the security of supply. It is currently set at £3,000/MWh.
Voltage Reduction	One action that Distribution Network Operators can take following a Demand Control Instruction.

9. Appendix 1 – The Reserve Scarcity Price

What is Short Term Operating Reserve (STOR)?

In addition to balancing actions called upon in the balancing mechanism, the SO can enter into contracts with capacity to deliver when called upon. These additional sources of power are referred to as reserve. Most of the reserve that the SO procures is called Short Term Operating Reserve (STOR).

The SO procures STOR ahead of time via a competitive tender process. Under STOR contracts, availability payments are made to the balancing service provider in return for the capacity being made available to the SO during specific times (STOR Availability Windows). When STOR is called upon, the SO pays for its use at a pre-agreed price (its Utilisation Price). Some STOR is dispatched in the balancing mechanism (BM STOR) while some is dispatched separately (Non-BM STOR).

All STOR is included in the calculation of Imbalance Prices as STOR Actions. The price attributed to a STOR Action depends on its Utilisation Price and prevailing market conditions.

Why are STOR Actions re-priced?

STOR Actions may be re-priced because of how STOR is procured by the SO, and how this can affect how its costs are reflected in the imbalance price calculation.

There are two main differences between how STOR is procured compared to most balancing energy (eg bids and offers in the balancing mechanism). Firstly STOR is procured by the System Operator before it is needed, sometimes months before it is actually used. This means that the price paid to STOR capacity when it is used (its Utilisation Price) has been pre-agreed in a STOR contract. Prices for bids and offers submitted into the balancing mechanism, on the other hand, can be updated up until an hour ahead of the beginning of a Settlement Period (Gate Closure). Secondly STOR providers also receive availability payments for the periods when they are available for the SO. This separate stream of revenue means that – unlike Bids and Offers accepted in the balancing mechanism – STOR providers do not earn all their revenue when they are utilised.

The combination of these two factors means that the Utilisation Prices STOR plant are paid when called upon may be noticeably different to the price the SO may have paid had it called upon a non-STOR balancing mechanism action. To correct this, we now use a pricing mechanism to determine a **Reserve Scarcity Price** which can be applied to STOR actions.

Key terms: The Reserve Scarcity Function (RSP), Loss of Load Probability (LOLP) and Value of Lost Load (VoLL)

The **Reserve Scarcity Price** function is a pricing mechanism designed to respond to system scarcity so that STOR Actions better reflect prevailing market conditions. The pricing function produces the Reserve Scarcity Price (RSP) that rises as the system gets tighter (i.e. the gap between available and required generation narrows).

The RSP is calculated for each settlement period as the product of a measure of system reliability called **Loss of Load Probability (LOLP)** and the **Value of Lost Load (VoLL)**.

The LoLP is a measure of reliability that will be calculated for each Settlement Period. For a given level of MW demand on the system the associated LoLP indicates the probability that there will be insufficient generating supply to meet the capacity requirement. LOLP is a value between 0 and 1.

STOR is designed to protect against emergency actions, such as Demand Control actions, which may result in customers being disconnected. If customers are disconnected, these volumes are priced at the **Value of Lost Load (VoLL)**. VoLL is a defined parameter in the BSC and is based on an assessment of the average value that electricity consumers attribute to the security of supply. It is currently set at £3,000/MWh[1].

Based on the principle that the chance of load being lost increases as the margin tightens, the RSP is calculated as the product of:

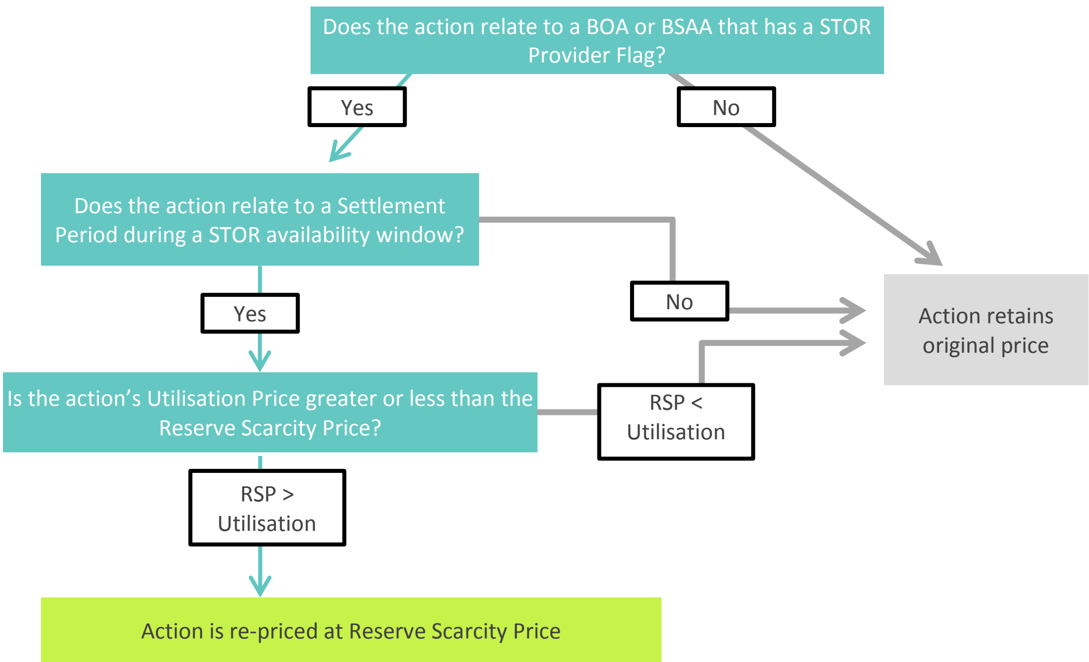
- the LoLP, as determined by the SO at Gate Closure for each Settlement Period; and
- the Value of Lost Load (VoLL), currently set at £3,000/MWh.

How are STOR actions re-priced?

Capacity that provide STOR are first identified by the System Operator using a 'STOR Provider Flag'. For BM STOR the relevant bid offer acceptance (BOA) is flagged. Volumes for non-BM STOR are fed into the imbalance price as a Balancing Service Adjustment Action (BSAA), which will also receive a STOR Provider flag.

All STOR is included in the calculation of Imbalance Prices but if STOR Actions are accepted during **STOR Availability Windows** they may be re-priced. They are included in the calculation of imbalance prices as individual actions, with a price which is the **greater** of:

- The Utilisation Price for an action (the price that STOR capacity is paid when it is called upon); and
- The Reserve Scarcity Price (RSP), as determined by LOLP*VoLL.



[1] In accordance with Approved Modification P305, the VOLL is due to rise to £6000/MWh on 1 November 2018.

Re-priced STOR actions are then treated like other BOAs for the next steps of price calculation (ranking, tagging, etc). Actions from STOR plant outside the STOR Availability Windows are not re-priced.

How does the SO calculate LOLP?

LOLP is a measure of reliability that is calculated for each Settlement Period. It reflects the probability that there will be insufficient generating supply to meet a given level of demand. The full LOLP calculation is set out in the LoLP Methodology Calculation Statement. At its simplest, the metric measures the probability that available generation will be greater than the capacity requirement, ie:

$$\mathbf{LoLP = P(Z - D < 0)}$$

Z represents generation, where

$$Z = \text{De-Rated conventional generation} + \text{wind forecast}$$

D represents demand, where:

$$D = \text{System Demand} + \text{Largest Loss Reserve} - \text{Non-BM STOR}$$

Generating capacity reflects the **De-rated Margin** of available conventional plant (including BM STOR plant). De-rated Margin is a measure of the excess supply on the system, which has been adjusted to take account of the likely availability of plant, specific to each type of generation technology. It reflects the proportion of an electricity source which is likely to be technically available to generate when needed.

Total System Demand includes a measure of demand for GB customers, interconnector flows (exports are positive; imports are negative), transmission losses on the transmission network and the demand from power stations. The **Largest Loss Reserve** represents the margin that the SO will always hold to protect against the instantaneous loss of the prevailing largest infeed into the system (eg a large generator). Non-BM STOR volumes are subtracted as they are not included in the conventional generation calculation.

Static and Dynamic Methods

There are two methods for calculating LOLP: a static LOLP method, which will apply until 31 October 2018; and a dynamic LOLP method, which will apply from 1 November 2018.

The 'static' LoLP function is set out in a look-up table that is available on the ELEXON Portal. It reflects the relationship between historical values of De-rated Margin and LOLP. Parties can convert a forecasted De-rated Margin into a LoLP value to calculate the Settlement Period's RSP.

From 1 November 2018 LOLP will be calculated using a dynamic function. This will calculate LOLP for each settlement period using up-to-date information.

When is LOLP published?

In the run-up to Gate Closure, ELEXON publishes the Transmission Company's forecasts of the De-rated Margin (and Indicative LoLPs from 1 May 2018) on the BMRS. Forecasts are published, as a minimum, at midday the day before the relevant settlement period, as well as eight, four, two and one hour(s) prior to the start of each Settlement Period. The one hour ahead (Gate Closure) value is used to determine the Final LoLP, which is used in the calculation of the RSP for that Settlement Period. Participants can use the forecast information to derive their own estimate of the LoLP value in the run-up to Gate Closure and the intention is that this provides a better signal of potentially tightening margins.

10. Appendix 2 – Contingency Balancing Reserve and Demand Control actions

There are some actions that the SO uses only as a last resort to balance the system in the rare event that there is insufficient capacity in the market to meet demand. These include Contingency Balancing Reserve and Demand Control. If they are used they will be included in the imbalance price calculation at a price of Value of Lost Load (VoLL).

What is Contingency Balancing Reserve?

Contingency Balancing Reserve is made up of last resort reserve services procured by the SO. It comes in two forms:

- **Supplemental Balancing Reserve (SBR).** This is provided by generation that would otherwise not be available in the market (eg due to closure or mothballing).
- **Demand Side Balancing Reserve (DSBR).** This is provided by non-domestic customers with the ability to reduce or shift demand when called upon.

Where in the BSC?

The processes relating to Demand Control Instructions are set out in Section Q.6.9

Providers of Contingency Balancing Reserve will receive payments for being available and utilisation payments if they are used. SBR is dispatched in the balancing mechanism by means of a BOA while DSBR is dispatched outside the balancing mechanism[2].

How contingency balancing reserve is reflected in the imbalance price

When the SO uses SBR or DSBR to balance the system, these actions will be included as Offers in the imbalance Price calculation at a price of VoLL.

DSBR actions are fed into the price calculation as Balancing Services Adjustment Actions (BSAA) with an associated BSAA Cost (£) that reflects the VoLL (£/MWh). These actions are then treated like any other BSAA, and are subject to the normal flagging and tagging rules described above. See section 2 for further detail on BSAA actions.

When the SO uses SBR to balance the system, the SO will identify associated BOAs which will be re-priced at VoLL in the imbalance calculation. These are the BOAs which instruct an SBR unit above its Stable Export Limit (SEL).

The SO also uses the Balancing Mechanism to instruct SBR providers to 'ramp-up' so they are in a position to deliver SBR services (i.e. running at their SEL). BOAs for 'ramping' up to a unit's SEL (and remaining at this level) do not strictly represent SBR for pricing purposes as additional offer volume will be available for these periods. In addition, as their Offer Price (i.e. Utilisation Price) is unlikely to be a good representation of the prevailing energy price they are SO-flagged by the Transmission Company. BOAs for SBR ramping are reflected in the imbalance price calculation as First Stage Flagged balancing actions.

Re-pricing SBR BOAs equal to VoLL does not affect what the SBR provider is paid (its utilisation payment).

[2] For more information on Contingency Balancing Reserve see: http://www2.nationalgrid.com/UK/Services/Balancing-services/System-security/Contingency-Balancing-Reserve/

Re-pricing SBR actions

In practice the SO will identify SBR BOAs after the Settlement Period it dispatches them for. This SBR Notice is delivered manually and does not immediately affect the calculation of Imbalance Prices by ELEXON's Central Systems. Upon receipt of such a notice, ELEXON follows a process to ensure the Imbalance Price subsequently reflects that SBR BOAs are priced equal to VoLL, rather than based on the BOAs' original Offer Prices. This is done via an adjustment to the BPA. See Appendix 3 for further detail.

What is Demand Control?

If the SO is unable to call on Bids and Offers or other Balancing Services to meet the current demand, then it can instruct Demand Control as a last resort emergency action to manage the situation. When it issues a 'Demand Control Instruction' it will instruct the Distribution Network Operators to reduce demand on their Distribution Systems, either through reducing voltage across the network and/or disconnecting consumers.

Reflecting Demand Control in the imbalance price

For each Settlement Period affected by a Demand Control Event, the Transmission Company will provide ELEXON with an estimate of the volume associated with the Demand Control Instructions on a per DNO basis. This volume (the Demand Control Volume) is included in the Imbalance Price calculation as if it was an Offer priced at VoLL. It is then subject to the normal rules for calculating the Imbalance Price, including the flagging and tagging rules. The Transmission Company has a reasonable endeavours requirement to provide to ELEXON an estimate of the volumes in time for the indicative Imbalance Price calculated 15 minutes after a Settlement Period.

Where in the BSC?

The processes relating to Demand Control Instructions are set out in Section Q.6.9

Reflecting Demand Control in suppliers' imbalance positions

Demand Control Events will also affect the imbalance positions of the suppliers of those customers who have been disconnected. In particular, Demand Control will show as lower demand and these suppliers will have a 'longer' imbalance position than they would have otherwise had.

A 'bottom-up' approach is used to calculate the likely impact of Demand Control on individual Supplier BM Units, i.e. specifically a Demand Disconnection volume[3], which is used to correct affected suppliers' imbalance positions to reflect their likely position had their not been Demand Control. This approach involves identifying the individual customers affected and estimating what they would have consumed had the disconnection not taken place. ELEXON add this estimate of consumption (minus an estimate for any voluntary actions requested by the SO, such as demand side Non-BM STOR or DSBR) to suppliers' imbalance positions as Balancing Services. This adjusts their imbalance position back to what it would have been had their customers not been subjected to the involuntary disconnections. This process is carried out in time for the Initial Settlement Run (SF). This process is set out in more detail in BSC Section S, the BSCPs and in the Demand Control Guidance Document.

[3] At this stage, a method for estimating and adjusting imbalance volumes to reflect Voltage Reduction actions has not been developed.

11. Appendix 3 – The BPA and SPA

The BPA/SPA is a reflection of the costs to the SO of regulating reserve and BM start-up. In the event that the System Operator has to use Supplemental Balancing Reserve (SBR) the Buy Price Price Adjustment will be reflected to include a price for this at Value of Lost Load (VoLL). The SPA is made up of option fees for negative reserve and forward contracts.

In practice, the BPA impacts the energy imbalance price calculation more frequently than the SPA. This is primarily because option fees for negative reserve and forward contracts occur relatively infrequently compared with regulating reserve and BM start-up availability fees.

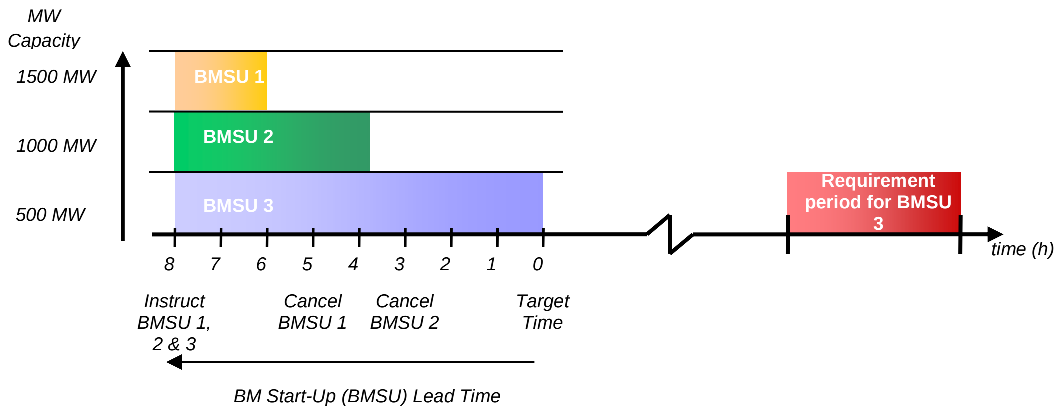
BM start up

The SO instructs BM start up units to meet identified additional plant requirements over the peaks. The SO does this for a requirement period (or 'window'). The costs of BM start-up are then targeted at the Settlement Periods within this window.

The BM start up component (BPA BMSU) is procured on the day. The cost is allocated through the BPA based on the requirement window. The option fee for BM start up is paid hourly from the time it is instructed and not in full at the time of instruction.

As an example, assume that the SO concurrently instructs three BM start-ups at an eight hour lead time to meet a requirement of 1500MW for two hours in the future. Each BM start-up provides 500MW. Getting closer to the requirement window, the SO requires less of the BM start-up plant and progressively cancels the prior instructions as shown in the diagram below. All BM start up in the example is paid at a rate of £2000/hr.

BM start-up component example



BPA BMSU is then calculated based on summing the per-hour cost of the BM start-ups instructed (and not cancelled) and dividing it by the MWh requirement for that hour. This gives a cost in £/MWh for that hour. These are then summed from the initial instruction until the target time (or the last BM start-up is cancelled). This cost is then allocated to each Settlement Period within the requirement window in which the system is short.

Therefore, in the example, the cost for the first hour of the instruction (target time minus eight hours to target time minus seven hours) is three BM start-ups at £2000 = £6000. The total BM start-up volume gained (for the window) over the hour was 3000MWh. This gives a cost for that hour of £2/MWh.

This needs to be repeated for the entire time in which the BM start-up was instructed (and not cancelled).

This can be seen in the table below.

BM start-up example

Lead time (hours)	T-8 to T-7	T-7 to T-6	T-6 to T-5	T-5 to T-4	T-4 to T-3	T-3 to T-2	T-2 to T-1	T-1 to Target time
Total cost for this lead time (£)	6000	6000	4000	4000	2000	2000	2000	2000
Total volume (MWh)	3000	3000	2000	2000	1000	1000	1000	1000
Cost/volume (£/MWh)	2	2	2	2	2	2	2	2

Then to sum the total £/MWh cost incurred by the instruction of BM start-up we need to add the bottom row of the table. This gives:

BPA BMSU = (2+2+2+2+2+2+2+2) = £16/MWh. (3)

Therefore £16/MWh is added to the calculation of the BPA for those Settlement Periods within the requirement window. The BPA is then added to energy imbalance price when the system is short.

Combining the Examples

The total BPA sums the BPA calculated for STOR and that calculated for BM start-up. This gives:

BPA = BPASTOR + BPABMSU

If we assume that the requirement window of BPABMSU fell in Settlement Period 1 of the BPASTOR example then:

BPA = £2.60/MWh + £16/MWh = £18.60/MWh (2) + (3)

Furthermore, if we assume that this BPA was for the energy imbalance price calculated in the Section 3 example (where (1) is the volume weighted price of actions in the PAR stack) we get a SBP of:

SBP = £29.60 + £18.60 = £48.20/MWh (1) + (2) + (3)

Supplemental Balancing Reserve (SBR)

Supplemental Balancing Reserve is one form of **contingency balancing reserve** available to the SO in the rare event that there is insufficient capacity to meet demand. It is procured by the SO and provided by generation that would otherwise not be in the market (eg due to closure or mothballing).

SBR providers are paid availability fees when they are available, and Utilisation Prices when they are called upon. SBR is dispatched via offers in the Balancing Mechanism.

When the SO uses SBR to balance the system, it will identify associated BOAs which will be re-priced at VoLL. The SO also uses the balancing mechanism to instruct SBR providers to 'ramp-up' so they are in a position to deliver SBR services. BOAs for 'ramping' do not strictly represent SBR for pricing purposes. Therefore these BOAs retain their original Offer Price (i.e. Utilisation Price) and are reflected in the imbalance price calculation. Re-pricing SBR BOAs equal to VoLL does not affect what the SBR provider is paid (its Utilisation Payment).

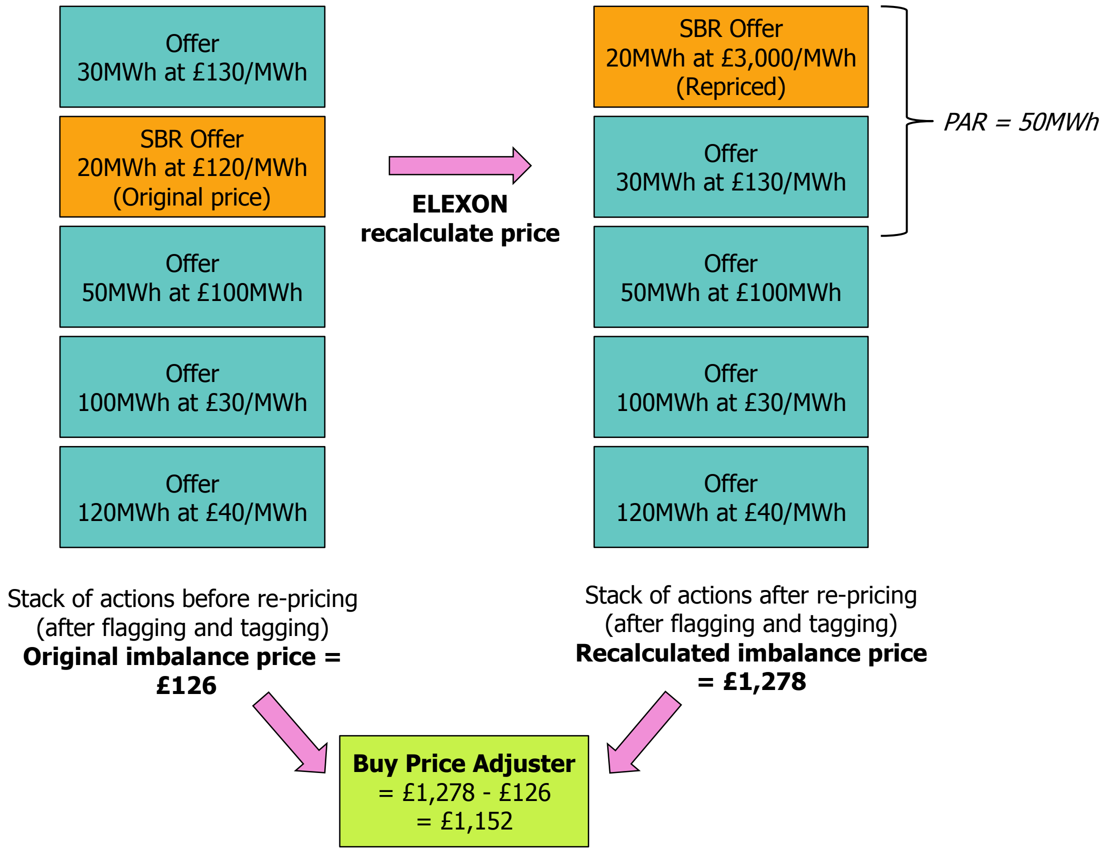
Manual Solution

In practice the SO will identify SBR BOAs after the Settlement Period it dispatches them for. This SBR Notice is delivered manually and does not immediately affect the calculation of Imbalance Prices by ELEXON's Central Systems (i.e. as part of the BMRAs indicative system price calculation at 15 minutes after the Settlement Period). Upon receipt of such a notice, ELEXON follows a process to ensure the Imbalance Price subsequently reflects that SBR BOAs are priced equal to VoLL, rather than based on the BOAs' original Offer Prices.

Due to system constraints, ELEXON cannot simply re-price SBR BOAs equal to VoLL in Central Systems. Instead, ELEXON calculate an adjustment to the Buy Price Adjuster (BPA) that would have the effect of ensuring that the Imbalance Price reflects SBR priced at VoLL. ELEXON does this by re-calculating the original imbalance price as if the SBR had been priced at VoLL. The difference between the original price and the re-calculated price is fed into the Buy Price Adjuster (BPA).

In the example below (which ignores transmission losses for simplicity) the Buy Price Adjuster is equal to £1,152. This is added to the original imbalance price, to bring the final Energy Imbalance price to £1,278.

Supplemental Balancing Reserve example



12. Appendix 4 – Changes from November 2018

There are three changes to the imbalance price parameters that are due to come in on 1 November 2018. These were approved by BSC Modification P305. These are:

1. A reduction in the PAR value to 1MWh. RPAR will remain at 1MWh.
2. The introduction of a 'dynamic' LOLP function.
3. An increase in the VoLL to £6,000MWh. This will apply to all instances of VoLL in arrangements, including the RSP function.

The dynamic LOLP function

From 1 November 2018 Loss of Load Probability (LOLP) will be calculated using a dynamic function. This means that LOLP will be calculated for each settlement period using up-to-date information, rather than the historical LOLP/De-Rated Capacity Margin relationships set out in the LOLP Calculation Statement.

Need more information?

For more information please contact the **BSC Service Desk** at bscservicedesk@cgi.com or call **0870 010 6950**.