nationalgridESO

Short Term Operating Reserve (STOR)
Assessment Principles

Author:	Market Operation
	National Grid Electricity System Operator Limited
	Faraday House
	Warwick Technology Park
	Gallows Hill
	Warwick
	CV34 6DA
Version:	~~1~~2.0
Effective From	31/03/2021
Date Published:	23/03/2021
Website:	https://www.nationalgrideso.com

Introduction

This document sets out the principles that National Grid Electricity System Operator (NGESO) considers in assessing day ahead bids for Short Term Operating Reserve (STOR). It builds on the assessment principles which have historically been published by NGESO for the purposes of the STOR assessment under the Standard Contract Terms (SCTs).

NGESO may update this document from time to time by publication of an updated version on its website, and to the extent required by the Electricity Balancing Guidelines, any variation will be proposed and implemented in accordance with the applicable requirements in the Electricity Balancing Guidelines.

These principles are to be read alongside the STOR Auction Rules, and are subject to the prevailing STOR General Terms and Conditions published by NGESO.

Unless the context otherwise requires, any capitalised term used in this document shall have the meaning given to it (if any) in the prevailing STOR Glossary of Terms and Rules of Interpretation, and the rules of interpretation set out in that document shall also apply.

Prequalification criteria

When undertaking assessment of STOR Bids, NGESO assumes that each STOR Bid has been submitted by or on behalf of an entity with an active registration as a Registered STOR Participant, and that the relevant Plant and Apparatus has been validated by NGESO as an Eligible Asset, and properly allocated to the relevant STOR Unit, and that the STOR Unit has been registered with approved Technical Parameters.

Where NGESO deems a STOR Bid to be non-compliant then the Registered STOR Participant will be notified and the STOR Bid will not be assessed in the relevant auction.

Assessment principles

NGESO's objective is to operate the transmission system economically, and the assessment is made consistent with that. A STOR Bid with respect to a STOR Unit will be accepted only where NGESO believes that the total costs of securing and operating the system are lower with, than without a corresponding STOR Contract from that STOR Unit.

Reserve

STOR is procured to meet some of our reserve requirement through balancing services when it is economic to do so. This requirement is to provide additional energy in megawatts (MW) in short timescales.

Reserve is needed for frequency management when there is an imbalance between supply of energy and demand for energy. When the instantaneous supply is not enough to meet the demand, the frequency falls and extra energy is needed very quickly to re-establish this balance. This can be supplied by additional generation or demand reduction. Initially this is provided by frequency response which initiates automatically. Response is only maintained for a maximum of 30 minutes. Reserve is then instructed within 2-30 minutes in order to replace the frequency response.

STOR Bids

STOR will continue to be procured across STOR Windows, comprising committed (and optional) windows spread across an entire operational day (05.00 to 05.00), but for day ahead STOR procurement NGESO will only run auctions for the committed windows in a *single* operational day.

The STOR Windows, which vary depending on the time of year (Season) and working/non-working days, are published on the NGESO website alongside the new suite of contract documents. These are reviewed and updated by NGESO on an annual basis, as described on the NGESO website.

Each STOR Bid will represent a single offered MW capability, and accompanying price (£/MW/h), for all of the committed windows in an operational day. A STOR Bid must include the same price for each committed window. And it is not possible to submit a STOR Bid for only one of the committed windows in the operational day.

The price associated with the marginal accepted STOR Unit sets the availability (clearing) price for all accepted STOR Bids for the operational day in question (see further below).

More details are provided in the STOR Participation Guidance Document and the STOR Auction Rules.

The alternative cost: the buy curve

The buy curve is the assumed cost to NGESO of procuring STOR in the committed windows in an operational day, by creating short term operating reserve within day as an alternative to running a day ahead auction. This alternative cost will create an availability price cap by showing NGESO's willingness to pay for securing short term operating reserve capacity.

This will be calculated using:

- the volume of actions (MW) required to create the reserve needed, and
- the prices (£/MWh) available to NGESO to access that volume.

A separate buy curve is calculated for each operational day and therefore each auction, using the prevailing STOR requirement volume (currently 1,700MW but as notified by NGESO from time to time). NGESO will endeavour to publish the buy curve for each auction alongside the STOR Daily Report.

This alternative cost for securing within day short term operating reserve capacity may include:

- Costs of securing reserve through:
  - Offers within the Balancing Mechanism (BM) on unsynchronised generation
  - BM Start-Up services
  - Forward Trading within day
  - Market length (zero cost)
  - Market provided headroom (zero cost)
- The energy balancing costs caused by these actions.

Assessment Methodology

The assessment methodology for acceptance of STOR Bids, and establishment of the clearing price, is based on the following key parameters:-

Buy curve – this is produced for each operational day, as explained above.

Supply curve – this is the aggregate MW represented by all STOR Bids received by NGESO for the operational day, sorted from lowest availability price to highest availability price.

Marginal bid – this is the STOR Bid that makes the supply curve cross the buy curve. Any further STOR Bids in the supply curve are above the alternative cost. If this marginal bid causes overholding (ie total procured STOR would exceed the STOR requirement for that day) and cannot be curtailed, then it will need to be rejected. (but see below). There could be more than one marginal bid when there is more than one STOR Bid at the same price and this is the marginal bid.

All compliant STOR Bids received by the STOR Bid Deadline will be assessed in the same way using the following criteria:

- Each STOR Bid will comprise an availability price (£/MW/hr) and megawatt (MW) capacity, and will indicate whether or not curtailable
- STOR Bids are sorted from lowest to highest availability price
- NGESO determines if the marginal bid can be accepted based on the buy curve
  - If it can (including by curtailing if curtailable) then NGESO will accept the marginal bid
  - If not, If not (eg where it needs to be curtailed but is not curtailable), then NGESO will reject the marginal bid (and therefore remove it from the supply curve) and assess the new marginal bid

- This is repeated until the marginal bid is found.

~~The~~ Except in the circumstances described below, the price of the marginal ~~bid's price~~bid found in this way sets the clearing price and all participants with accepted STOR Bids for the ~~operational day~~STOR Service Day in question will receive that price for their accepted volume.

~~This auction will not allow overholding to be caused as this is when additional volume over the requirement is procured. This is in line with our other procured services for response.~~

However, where this marginal bid is found only after rejecting a non-curtailable marginal bid, then NGESO will perform a further assessment to determine if the overall cost would be lower by overholding or underholding (ie total procured STOR would be less than the STOR requirement for that STOR Service Day). It will do this by comparing the overall cost of selecting the marginal bid in this way (Curtailable Cost) with:

- The Overholding Cost – ie STOR bids are sorted as described above but the rejected (or first rejected) non-curtailable marginal bid is accepted in full without curtailment; and

- The Underholding Cost – ie STOR bids are sorted as described above but the rejected (or first rejected) non-curtailable marginal bid is rejected (and removed from the supply curve) and no further marginal bid is found so that the last accepted STOR bid becomes the marginal bid.

This comparison will be done by taking the lowest of the following:

Curtailable Cost (£/MWh) = total supply MW (with rejection of non-curtailable marginal bid(s)) x clearing price set by marginal bid x total number of hours in STOR Committed Windows in relevant STOR Service Day

Overholding Cost (£/MWh) = total supply MW (with acceptance in full of first non-curtailable marginal bid(s)) x clearing price set by first non-curtailable marginal bid x total number of hours in STOR Committed Windows in relevant STOR Service Day

Underholding Cost (£/MWh) = [total supply MW (with rejection of first non-curtailable marginal bid and all other higher bids) x clearing price set by last accepted bid x total number of hours in STOR Committed Windows in relevant STOR Service Day] + missed opportunity cost

Where missed opportunity cost (£/MWh) = Underholding volume (ie max MW from NGESO's buy order – total supply MW) x price of STOR Bid corresponding to max MW from buy order x total number of hours in STOR Committed Windows in relevant STOR Service Day

Where the Curtailable Cost is the same as the Overholding Cost and/or Underholding Cost, it shall be deemed to be the lowest, and where the Overholding Cost and Underholding Cost are the same the Overholding cost shall be deemed to be the lowest.

The clearing price for the relevant STOR Service Day is then set by:

- the original marginal bid where the Curtailable Cost is (or is deemed to be) lowest;

- the first non-curtailable marginal bid where the Overholding Cost is (or is deemed to be) lowest; or

- the last accepted STOR bid prior to rejection of the first non-curtailable marginal bid (which accepted STOR bid shall become the marginal bid for these purposes) where the Underholding Cost is the lowest.

All participants with accepted STOR Bids for the STOR Service Day in question will receive that clearing price for their accepted volume.

Other factors used to differentiate STOR Bids

In the event that there is more than one marginal bid and accepting them all would cause overholding, other factors will be used to differentiate these marginal bids. First the curtailability ratio will be used, and if this fails to differentiate some or all of the marginal bids then a last resort rank will be used.

Curtailability ratio

In the event that accepting two or more marginal bids would cause overholding, the curtailability ratio of each such marginal bid will be calculated as follows:

$$Curtailability\ ratio\ =\ mininmum\ acceptance\ capacity\ MW\ /\ Tendered\ MW$$

The marginal bid that has the lowest curtailability ratio will be accepted at the lower of the remaining requirement or the offered MW capability.

Last resort rank

In the event that there are two or more marginal bids with the same curtailability ratio that cannot all be accepted without causing overloading, then a last resort rank will be used.

The last resort rank is randomly assigned, for each unique STOR auction, to any two or more STOR Bids that are identically priced and with an identical curtailability ratio. It will be applied only where those STOR Bids become marginal bids and cannot both/all be accepted without causing overholding.

The last resort rank that is selected will be accepted at the lower of the remaining requirement or the offered MW capability.

The operation of the curtailability ratio and last resort rank are further explained in the examples below.

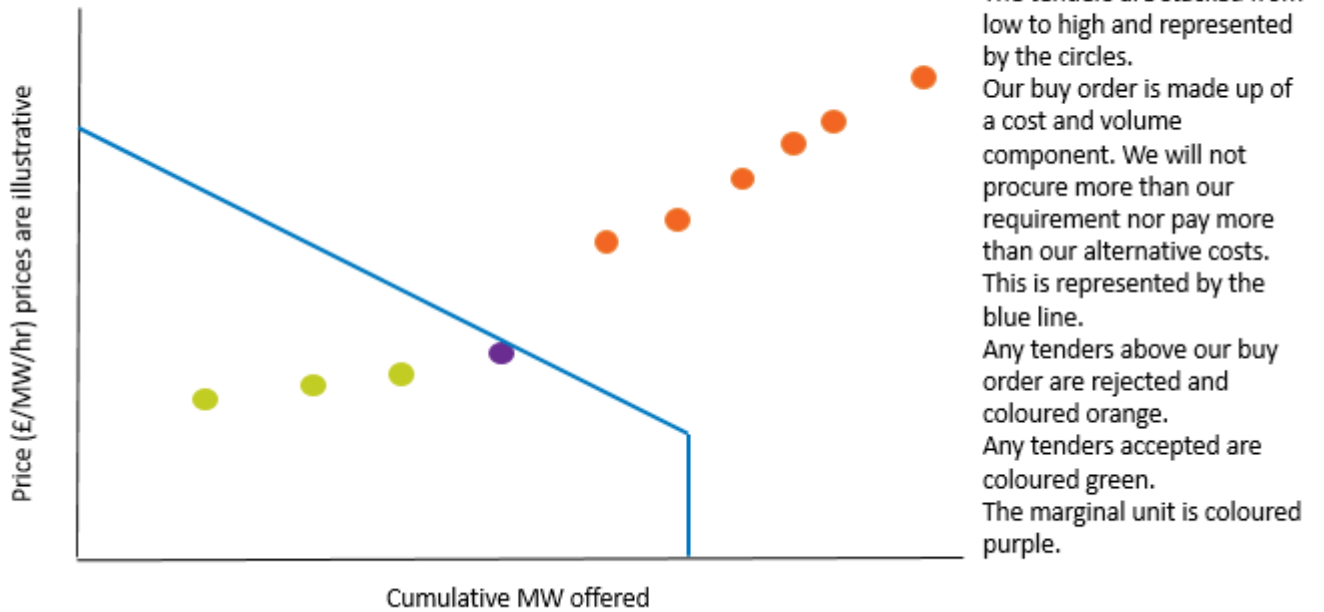# Examples (all prices and volumes are illustrative only)

Example 1

There is one marginal bid (tender 4 in bold box).

It can be accepted without causing overholding so is accepted.

All other STOR Bids are more expensive than alternative actions so are rejected.

	Tendered MW	Mininimum acceptance capacity MW	Curtailability ratio	Price	Accepted MW	Cumulative accepted MW	Remaining reqirement	Accept/Reject
							320	
Tender 1	30	20	0.67	5	30	30	290	Accepted
Tender 2	40	25	0.63	5.3	40	70	250	Accepted
Tender 3	25	20	0.80	5.8	25	95	225	Accepted
Tender 4	60	30	0.50	6	60	155	165	Accepted
Tender 5	50	30	0.60	8	0	155	165	Rejected
Tender 6	60	50	0.83	9	0	155	165	Rejected
Tender 7	80	30	0.38	10	0	155	165	Rejected
Tender 8	55	20	0.36	10	0	155	165	Rejected
Tender 9	60	15	0.25	12	0	155	165	Rejected
Tender 10	120	80	0.67	15	0	155	165	Rejected

The tenders are stacked from low to high and represented by the circles.
Our buy order is made up of a cost and volume component. We will not procure more than our requirement nor pay more than our alternative costs. This is represented by the blue line.
Any tenders above our buy order are rejected and coloured orange.
Any tenders accepted are coloured green.
The marginal unit is coloured purple.

Example 2

There is one marginal bid (tender 7 in bold box)

This STOR Bid cannot be accepted without causing overholding but can be curtailed.

This STOR Bid is curtailed to 55MW which is the remaining requirement and the unit is accepted.

All other STOR Bids are rejected as the requirement has been met by more economic actions.

|	Tendered MW	Mininimum acceptance capacity MW	Curtailability ratio	Price	Accepted MW	Cumulative accepted MW	Remaining reqirement	Accept/Reject
							320	
Tender 1	30	20	0.67	2.5	30	30	290	Accepted
Tender 2	40	25	0.63	2.7	40	70	250	Accepted
Tender 3	25	20	0.80	2.8	25	95	225	Accepted
Tender 4	60	30	0.50	2.9	60	155	165	Accepted
Tender 5	50	30	0.60	3	50	205	115	Accepted
Tender 6	60	50	0.83	3.2	60	265	55	Accepted
Tender 7	80	30	0.38	3.3	55	320	0	Accepted
Tender 8	55	20	0.36	5	0	320	0	Rejected
Tender 9	60	15	0.25	6	0	320	0	Rejected
Tender 10	120	80	0.67	7	0	320	0	Rejected
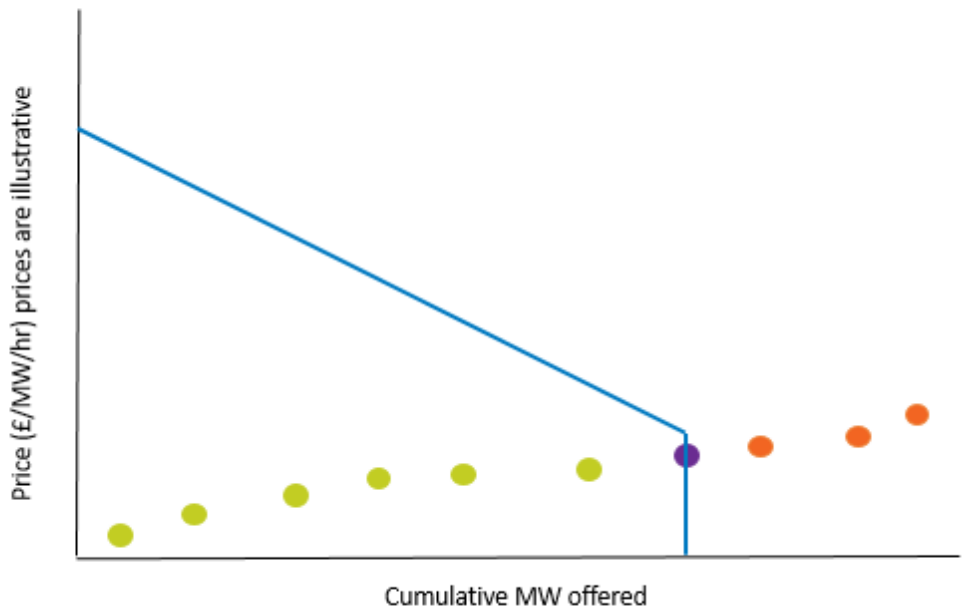
The tenders are stacked from low to high and represented by the circles.

Our buy order is made up of a cost and volume component. We will not procure more than our requirement nor pay more than our alternative costs. This is represented by the blue line.

Any tenders above our buy order are rejected and coloured orange.

Any tenders accepted are coloured green.

The marginal unit is coloured purple and here cannot be fully accepted without causing overholding. If this unit can be curtailed, it will be. If it cannot be curtailed it will be rejected.

Example 3

Where there are multiple STOR Bids at the marginal price all cannot be accepted without causing overholding.

STOR Bids affected (only those at the marginal price) will be ordered on their curtailability ratio from low to high. (Shown by the darker box)

The STOR Bid with the lowest curtailability ratio is accepted for the lower of the remaining requirement or offered MW capability.

	Tendered MW	Mininimum acceptance capacity MW	Curtailability ratio	Price	Accepted MW	Cumulative accepted MW	Remaining reqirement	Accept/Reject
							320	
Tender 1	30	20	0.67	2.5	30	30	290	Accepted
Tender 2	40	25	0.63	2.7	40	70	250	Accepted
Tender 3	25	20	0.80	2.7	25	95	225	Accepted
Tender 4	60	30	0.50	2.9	60	155	165	Accepted
Tender 5	50	30	0.60	3	50	205	115	Accepted
Tender 6	60	50	0.83	3.1	60	265	55	Accepted
Tender 9	60	15	0.25	3.2	55	320	0	Accepted
Tender 7	55	20	0.36	3.2	0	320	0	Rejected
Tender 8	80	30	0.38	3.2	0	320	0	Rejected
Tender 10	120	80	0.67	4.4	0	320	0	Rejected
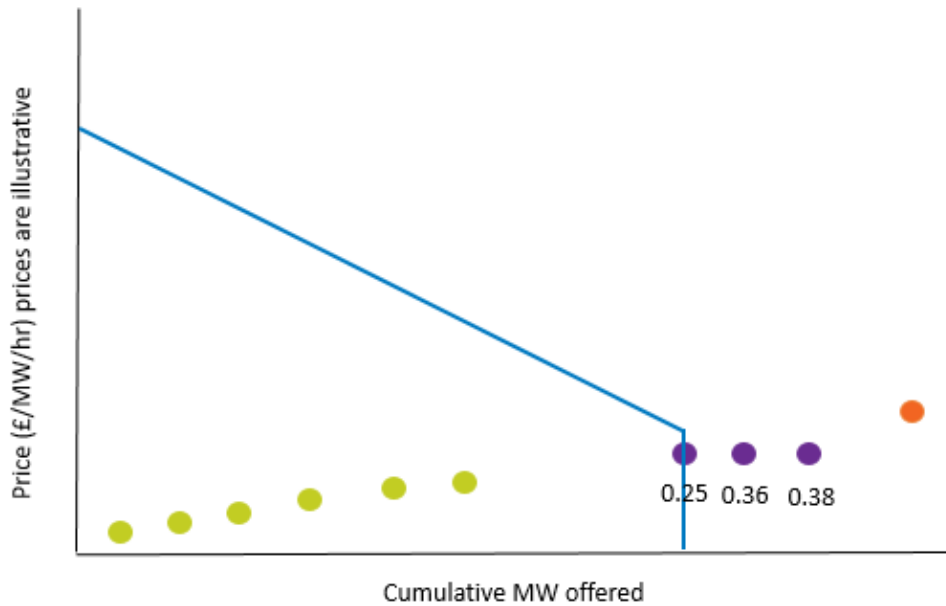
The tenders are stacked from low to high and represented by the circles.
Our buy order is represented by the blue line.
Any tenders above our buy order are rejected and coloured orange.
Any tenders accepted are coloured green.
Here there are three marginal units (purple) with the same price. All of these tenders cannot be accepted without causing overholding. The unit with highest curtailability ratio will be accepted first, if it can be accepted without causing overholding.

Example 4

Where there are multiple STOR Bids at the same marginal price that cannot all be accepted without causing overholding.

STOR Bids affected (only those at the marginal price) will be ordered on their curtailability ratio from low to high. (Shown by the darker box)

The STOR Bid with the lowest curtailability ratio is accepted for the lower of the remaining requirement or offered MW capability.

If there is any remaining requirement the next lowest curtailability ratio is accepted if there is sufficient remaining requirement to not cause overholding.

	Tendered MW	Mininimum acceptance capacity MW	Curtailability ratio	Price	Accepted MW	Cumulative accepted MW	Remaining reqirement	Accept/Reject
							320	
Tender 1	30	20	0.67	2.5	30	30	290	Accepted
Tender 2	40	25	0.63	2.7	40	70	250	Accepted
Tender 3	25	20	0.80	2.7	25	95	225	Accepted
Tender 4	60	30	0.50	2.9	60	155	165	Accepted
Tender 5	50	30	0.60	3	50	205	115	Accepted
Tender 6	60	50	0.83	3.1	60	265	55	Accepted
Tender 9	35	9	0.26	3.2	35	300	20	Accepted
Tender 7	55	20	0.36	3.2	20	320	0	Accepted
Tender 8	80	30	0.38	3.2	0	320	0	Rejected
Tender 10	120	80	0.67	4.4	0	320	0	Rejected
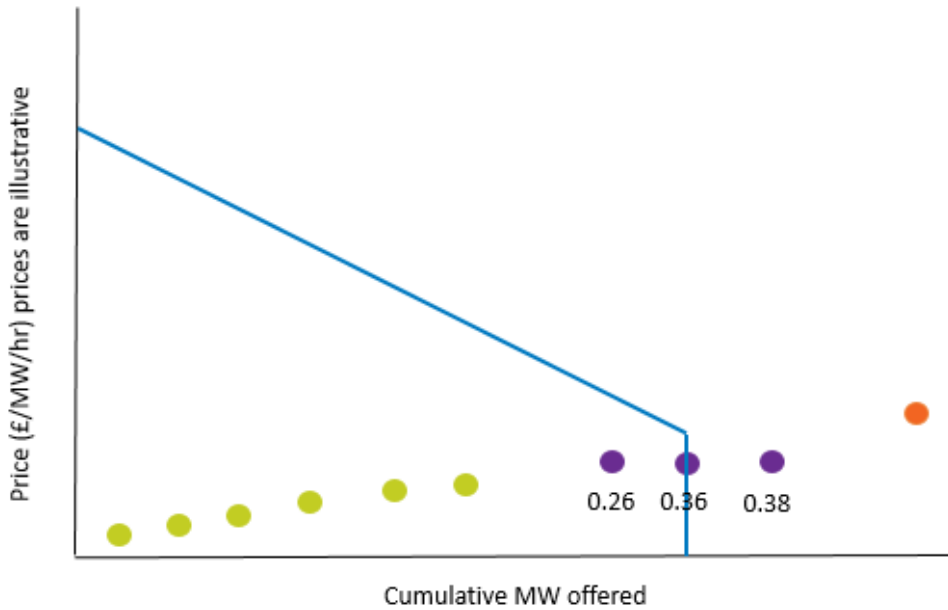
The tenders are stacked from low to high and represented by the circles.
Our buy order is represented by the blue line.
Any tenders above our buy order are rejected and coloured orange.
Any tenders accepted are coloured green.
Here there are three marginal units (purple) with the same price. All of these tenders cannot be accepted without causing overholding. The unit with highest curtailability ratio will be accepted first, if it can be accepted without causing overholding.

Example 5

Where there are multiple STOR Bids at the same marginal price that cannot all be accepted without causing overholding.

The marginal bids are ordered by the last resort rank.

STOR Bids are accepted in this order for the lower of the remaining requirement or their offered MW capability.

Any remaining requirement is awarded to the marginally priced STOR Bid with the highest last resort rank (shown in green).

	Tendered MW	Mininimum acceptance capacity MW	Curtailability ratio	Price	Last resort rank	Accepted MW	Cumulative accepted MW	Remaining reqirement
								320
Tender 1	30	20	0.67	2.5		30	30	290
Tender 2	40	25	0.63	2.7		40	70	250
Tender 3	25	20	0.80	2.8		25	95	225
Tender 4	60	30	0.50	2.9		60	155	165
Tender 5	50	30	0.60	3		50	205	115
Tender 6	60	50	0.83	3.2		60	265	55
Tender 9	80	44	0.55	3.3	1	55	320	0
Tender 7	55	30	0.55	3.3	2	0	320	0
Tender 8	31	17	0.55	3.3	3	0	320	0
Tender 10	120	80	0.67	7		0	320	0
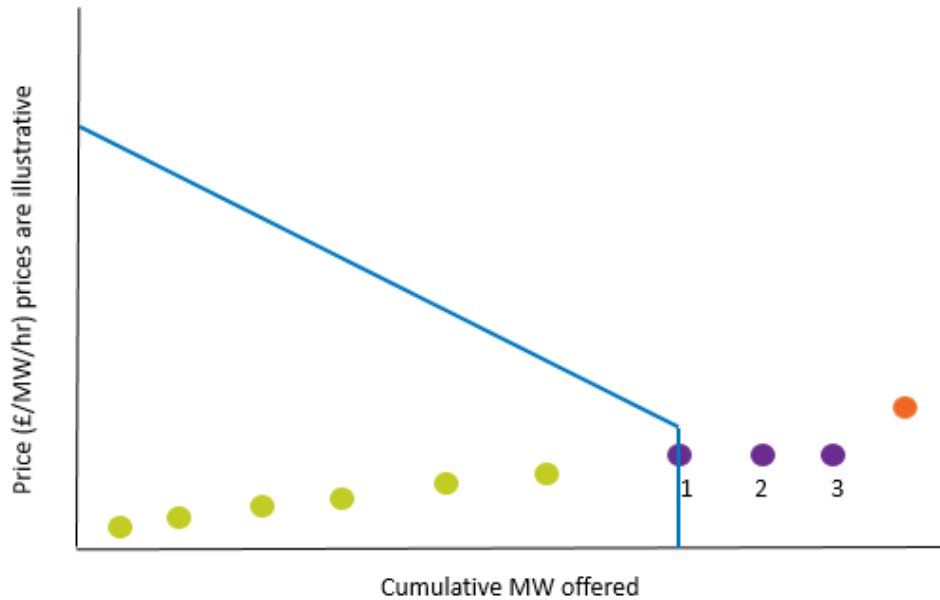
The tenders are stacked from low to high and represented by the circles.
Our buy order is represented by the blue line.
Any tenders above our buy order are rejected and coloured orange.
Any tenders accepted are coloured green.
Here there are three marginal units (purple) with the same price. All of these tenders cannot be accepted without causing overholding. These units all have the same curtailability ratio so will use the last resort rank low to high.

Example 6

Where there is one STOR Bid at the marginal price and that STOR Bid cannot be curtailed to meet the buy order requirement.

There are more expensive STOR Bids that would fit into the requirement that are below the buy curve cap.

In this example the cost of overholding is cheaper than rejecting STOR Bid 6.

	Tendered MW	Mininimum acceptance capacity MW	Curtailability ratio	Price	Accepted MW	Cumulative accepted MW	Remaining reqirement	Accept/Reject
							320	
Tender 1	50	50	1.00	0.1	50	50	270	Accepted
Tender 2	50	50	1.00	0.1	50	100	220	Accepted
Tender 3	50	50	1.00	0.1	50	150	170	Accepted
Tender 4	100	100	1.00	0.2	100	250	70	Accepted
Tender 5	30	30	1.00	0.2	30	280	40	Accepted
Tender 6	300	300	1.00	0.3	300	580	0	Accepted
Tender 7	20	20	1.00	1	0	580	0	Rejected
Tender 8	10	10	1.00	2	0	580	0	Rejected
Tender 9	10	10	1.00	3	0	580	0	Rejected
Tender 10	50	50	1.00	7	0	580	0	Rejected

	Clearing price	Cleared volume	Volume not procured	Buy curve price cap	Hours	Cost
Curtailable cost	3	320			13	£ 12,480
Overholding cost	**0.3**	**580**			**13**	**£ 2,262**
underholding cost	0.2	280	40	6	13	£ 3,848

Example 7

Where there is one STOR Bid at the marginal price and that STOR Bid cannot be curtailed to meet the buy order requirement.

There are more expensive STOR Bids that would fit into the remaining requirement that are below the buy curve cap.

In this example the cost of underholding is cheaper than the curtailable cost

	Tendered MW	Mininimum acceptance capacity MW	Curtailability ratio	Price	Accepted MW	Cumulative accepted MW	Remaining reqirement	Accept/Reject
							320	
Tender 1	50	50	1.00	0.1	50	50	270	Accepted
Tender 2	50	50	1.00	0.1	50	100	220	Accepted
Tender 3	50	50	1.00	0.1	50	150	170	Accepted
Tender 4	100	100	1.00	0.2	100	250	70	Accepted
Tender 5	30	30	1.00	0.2	30	280	40	Accepted
Tender 6	35	35	1.00	0.3	35	315	5	Accepted
Tender 7	300	300	1.00	0.5	300	615	-295	Rejected
Tender 8	10	10	1.00	2	0	615	-295	Rejected
Tender 9	10	10	1.00	3	0	615	-295	Rejected
Tender 10	5	5	1.00	5.5	0	615	-295	Rejected

	Clearing price	Cleared volume	Volume not procured	Buy curve price cap	Hours	Cost
Curtailable cost	5.5	320			13	£ 22,880
Overholding cost	0.5	615			13	£ 3,998
underholding cost	**0.3**	**315**	**5**	**6**	**13**	**£ 1,619**