Appendix 1: Recast Electricity Regulation Article 6(4)

Evidence for maintaining the Balancing Mechanism and STOR (i.e. GB Specific RR Products) as pay-as-bid rather than pay-as-cleared

Executive Summary

This report provides supporting evidence to retain the Balancing Mechanism and (the utilisation payment of) Short-Term Operating Reserve (STOR) as pay-as-bid, rather than moving to pay-as-cleared arrangements, as is envisaged in the recast Electricity Regulation.

Pay-as-cleared settlement (marginal pricing) is a requirement of Article 6(4) of the recast Electricity Regulation[1] unless an alternative pricing method is approved pursuant to Article 6(4) or alternatively unless a derogation is provided pursuant to Article 6(14). Since their inception, the Balancing Mechanism and STOR have been settled as pay-as-bid.

For the both the **Balancing Mechanism** and **STOR**, this report provides evidence to retain pay-as-bid settlement based on two areas of analysis:

- The economic theory of pay-as-bid and pay-as-cleared markets, and an assumption of competitive markets applied to the Balancing Mechanism and STOR; and
- Quantitative analysis of the impact to consumers, which is evidenced through modelling the cost detriment to consumers if the Balancing Mechanism and/or STOR were settled as pay-as-cleared.

This report demonstrates that the existing pricing method for the Balancing Mechanism and STOR as pay-as-bid provides a more efficient outcome than changing to pay-as-cleared as envisaged in the recast Electricity Regulation. Therefore, approval of a derogation by Ofgem is requested to avoid multi-million pound forecasted consumer detriment if pay-as-cleared were to be implemented for the Balancing Mechanism or STOR.

We also highlight ongoing and future work being undertaken to form our response and reserve products such as STOR, including commitments in our ESO Forward Plan 2019-2021[2], and in our draft ESO RIIO-2 Business Plan proposals[3].

Background

Recast Electricity Regulation

The recast *regulation on the internal market for electricity (EU) 2019/943* (as part of the Clean Energy Package) places requirements on each of the Member States, in amongst other areas, related to the settlement of balancing energy within that Member State and cross-border with other Members States.

The specific element under consideration in this report is Article 6(4) as follows:

> *'The settlement of balancing energy for standard balancing products and specific balancing products shall be based on marginal pricing (pay-as-cleared) unless all regulatory authorities approve an alternative pricing method on the basis of a joint proposal by all transmission system operators following an analysis demonstrating that that alternative pricing method is more efficient.'*
>
> *Article 6(4), Regulation (EU) 2019/943*

In this report, the two specific balancing products are the Balancing Mechanism and STOR.

[1] Regulation on the internal market for electricity (EU) 2019/943
[2] https://www.nationalgrideso.com/about-us/business-planning-riio/forward-plans-2021
[3] https://www.nationalgrideso.com/about-us/business-planning-riio/riio-2-draft-business-plan

Balancing Mechanism

The Balancing Mechanism is one of the primary tools used by the ESO to balance electricity supply and demand close to real time. The Balancing Mechanism allows BSC Parties to submit Offers to sell energy (by increasing generation or decreasing consumption) to the system and Bids to buy energy (by decreasing generation or increasing consumption) from the system, at a price of the BSC Party's choosing[4]. The term 'bid' in the Balancing Mechanism should not be confused with "pay-as-bid" which is a type of market. Prices are offered for given volumes by providers during each settlement period. The ESO takes actions to balance the system by accepting bids or offers. The parties are then paid for the volume of energy they provided at the price they tendered in to the Balancing Mechanism for the volume provided and it is a pay-as-bid market.

There are two uses of energy offered in the Balancing Mechanism that we utilise as ESO. Firstly, to address constraints on the system - this is where, although the system is in balance (i.e. supply equals demand), there are thermal, voltage or other constraints on part of the network. This constraint means that energy cannot be effectively transmitted from where it is generated to where it is needed. A typical action in this situation is to reduce generation behind a constraint (i.e. the ESO will accept a bid), and increase it in front of the constraint (i.e. accept an offer). The one provider is paid for reducing their output (i.e. their lost opportunity cost), the other is paid for increasing it (i.e. broadly their short-run-marginal cost). These actions are known as *System Operator Actions* and are flagged as such, so they do not affect the imbalance price calculated by Elexon under the Balancing and Settlement Code. The imbalance calculation (which is not part of this report) is used as a signal to market parties to ensure they 'self-balance' their supply and demand BMUs.

The settlement of energy costs for constraint management are not within the scope of Article 6(4), so are not considered further within this report.

The second use of the energy via the Balancing Mechanism is to ensure supply equals demand in real-time. Therefore, the ESO will need to adjust for the whole market being either long or short, and to adjust for within settlement period variations in energy usage due to deviation from published positions and short-duration demand changes. The costs of these actions are used in the calculation of the imbalance price.

All trades under the Balancing Mechanism are paid to the provider on a pay-as-bid basis.

STOR

The ESO procures STOR to help meet our reserve requirements. STOR is a contracted balancing service whereby the service provider delivers a contracted level of power (within pre-agreed parameters) when instructed by the ESO. The requirement for STOR varies depending on the time of year, week and day, being a function of the system demand profile at that time. STOR can be provided by Balancing Mechanism (BM) and non-BM participants.

STOR service providers are paid an availability payment for their capacity being available, and a utilisation payment for energy they provide. Only the utilisation payment is in scope of this report.

Because of the Electricity Balancing Guidelines[5] (EBGL) the way in which the utilisation price for STOR is set is changing in future. Market parties historically set their utilisation price only at the time of contracting for the capacity, but under proposals being implemented (by 31st January 2020) as a result of EBGL, market parties will be able to update their utilisation price in real-time up to gate-closure.

Today, and in future, STOR utilisation is settled to each provider on a pay-as-bid basis based on their submitted utilisation price rather than on a pay-as-cleared basis.

Supporting Economic Theory

In a **pay-as-bid** market, participants receive the price that they provide to the market. The product is purchased in the "merit order" in that the cheapest (compliant) products are taken first. Each party receives their own price, so the total cost is the sum of each party's volume multiplied by their bid price.

In a **pay-as-cleared** market, all participants receive the price of the most expensive item procured. For example, the Capacity Market is a pay-as-cleared auction. The products are still purchased in merit order, but the most expensive item sets the price for all providers. The total cost is therefore the volume procured multiplied by the most expensive accepted product. All providers receive the market's marginal cost.

[4] https://www.elexon.co.uk/knowledgebase/what-are-bids-and-offers/
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R2195&from=EN

Economic theory assumptions

Under economic theory, in a *competitive* market a pay-as-bid market and a pay-as-cleared market should produce similar results for the following reasons:

- Under a pay-as-bid auction participants are incentivised to bid at the price of the most expensive offer that is expected to be accepted – there is an incentive to bid above their short-run marginal cost. This maximises the money a party will receive, but if you bid too high you will be 'out of merit' and so not accepted.
- Under a pay-as-cleared market participants are automatically awarded the most expensive offer accepted, so there is an incentive to bid only at your short-run marginal cost, and you will be paid the market clearing price. You bid enough to cover your costs, and the market determines if there is a need for surplus profit valuing the contribution of your product to the market.

In this sense, a pay-as-cleared market discovers the marginal cost of the balancing energy based on a merit order of individual short-run marginal costs and pays it to everyone. In a pay-as-bid auction providers should say how much they are willing to accept, but there is an incentive to try and hit the marginal cost to maximise your profit.

These conclusions are however predicated on assumptions about the market structures being sufficiently competitive.

Drawing from economic theory, there are three key assumptions derived from elements of the model of perfect competition:

i) There is a homogenous product;

ii) There are sufficient levels of competition i.e. a large number of small providers, with no party exercising market power; and

iii) There is perfect information about the market to the parties.

We shall now explore these assumptions in more detail below for each specific balancing product.

Analysis for the Balancing Mechanism

Original rationale for Balancing Mechanism as pay-as-bid

Since its inception, the Balancing Mechanism has been pay-as-bid. The original justification for these pay-as-bid market arrangements was given as twofold:

- A pay-as-bid process will provide the appropriate economic signals and be consistent with the operation of the forwards and future markets that are expected to emerge; and
- When markets are broadly competitive, SMP [pay-as-cleared] and pay-as-bid produce similar results, but that when market power is evident, pay-as-bid can have advantages.

The New Electricity Trading Arrangements, Ofgem/DTI Consultation Document, October 1999

At present many elements of the electricity market are pay-as-bid – for example bilateral trading in wholesale energy, and the provision of response and reserve products to ESO. This is consistent with the 'future markets' envisaged at the time of NETA. There were clearly concerns about market power and the dominance of certain parties and hence the need to use pay-as-bid. However, this will need assessing in the contemporary market.

Economic theory applied to the Balancing Mechanism

Economic theory says, under the assumption of sufficient competition, pay-as-bid and pay-as-cleared markets should produce similar results. We will now test the assumption of sufficient competition for the Balancing Mechanism.

Assumption i) A homogenous product

On first evidence, balancing energy procured through the Balancing Mechanism appears to be homogeneous – "electricity" at least in lay terms is a homogeneous product. However, there are many nuances in how the ESO views and uses sources of energy in near real-time in its role as residual balancer. We will now consider the ways in which the Balancing Mechanism exhibits attributes of a non-homogenous product.

There are three main areas where non-homogeneity appears in the Balancing Mechanism:

1. The Balancing Mechanism provides energy for both constraint/system management and energy balancing purposes, drawn from one merit order.
2. The configuration of the system on a given day, means that it may not be possible to take the cheapest energy balancing options, due to other constraints on the system.
3. Different balancing energy in the Balancing Mechanism has different technical attributes, such as speed of response, reliability of the provider, and the longevity of the action.

Decisions taken in operational timescales are usually a mixture of the three aforementioned challenges, where the actions taken are done to minimise costs whilst ensuring the continued secure operation of the system.

For '1' above, the Balancing Mechanism serves two key purposes for the ESO. It efficiently provides a single merit order of energy to allow the ESO to both manage constraints and to balance the system. These two roles are inter-related however, and choices to resolve one matter can impact on available options for the other one. For example, in an unconstrained system the control room would take the cheapest energy action to balance supply and demand. However, in a constrained system, the actions available to remedy the constraint are limited by location related to the constraint.

For example, consider a situation where there is a constraint between North and South, but where the system is overall short. The control room is now limited in which units it can use to address the constraint (i.e. it must reduce generation behind the constraint, and increase it in front of the constraint), taking the cheapest units that are either side of the constraint. It must then take a unit to solve the imbalance which does not affect the constraint.

In addition, for '2' above the most marginal unit for energy balancing may already have been used for constraint management and vice-versa. It can be considered that there are (at least) two markets operating in real-time drawing on one merit order under the Balancing Mechanism. The constraint and energy requirements will have - both between them, and within them - differing product requirements by the ESO in near-real time.

For example, let us assume the cheapest marginal unit is behind a constraint, and the system is short. In this case the marginal unit will be taken for constraint management, and a more expensive unit will be taken for energy. This more expensive unit, then in a pay-as-cleared market, would set the energy clearing price, even though it wasn't the marginal unit in this example.

Moreover, actions will often be taken that (partially) resolve both constraint and energy actions. For example, bidding-off 50MW behind a constraint, and bidding on 75MW in front a constraint resolve both the constraint *and* a 25MW shortage in the energy market. In reality constraints management and energy balancing is a multi-dimensional problem, which constantly evolves with the real-time operation of the system.

For '3' above, the merit order of all bid and offers is not equal to the ESO in real-time. The specific bid / offer accepted will depend on the location, the speed of response to the instruction, the reliability of the provider, and the potential longevity of the action. This means that actions will be taken out of merit order for good reason. This is particularly difficult in a pay-as-cleared market, where the market price is discovered by the marginal action taken.

The example here is when energy is required to respond quickly, and reliably to something like a TV-pickup. The timings of TV-pickups can move around, as can the volume of energy required. In this situation, a plant such a pumped-hydro can respond quickly, and reliably to meet the needs of the system. In response, the provider is able to offer a 'premium' price for the additional technical capability it provides over other units.

In combination, these three aspects mean that the Balancing Mechanism does not constitute a homogenous product.

The consequences of moving the Balancing Mechanism to a pay-as-cleared market would mean that the market would 'discover' the marginal cost. However, due to the heterogeneity of the product to the ESO in near-real time, there is no single marginal cost. Therefore, pay-as-bid allows market parties to offer in their product and the marginal price for their individual energy, and the ESO then takes the locally cheapest action subject to operational constraints. In a pay-as-cleared market expensive balancing action such as a fast-responding pumped storage needed for a small amount of energy associated with a TV pick-up, or constraint actions taken slightly out of merit for good reason, would set the clearing price for all energy.

To seek to remedy the above anomaly, it follows that we could try to construct more homogenous products, by splitting the Balancing Mechanism into separate markets. For example, one for system operation actions and one for energy balancing actions.

You could construct separate markets for separate products. This however, doesn't work for the purposes of effectively operating the system. The ESO takes the most efficient choice of actions which may resolve multiple constraints and energy actions together. Forcing the ESO to take unique actions for system operator actions and energy balancing is neither efficient nor practical in operational terms.

Multiple markets and systems would create difficulties and inefficiencies for market parties. Maintaining and serving different systems and markets would be expensive for market parties. In addition, and more importantly, there would be the complexity of deciding which markets to participate in, and at which price when you don't know how your energy may be used, and which you can't know in advance.

Therefore, it follows that we must logically retain one merit order. We could therefore try to construct a homogenous product by constructing different rules for settlement of groups of actions. Again, this would be difficult as firstly, at what price would a party offer their energy into the market given it could be settled in different ways depending on how it is used. Secondly, this would be complex and opaque to administer compared to the current arrangements. Thirdly, given that actions taken by the ESO in near real-time can contribute to the resolution of multiple issues, tagging an action into one market or another would be challenging and have an impact on clearing prices. Although noting this last issue already exists with flagging for the exclusion of system action from the calculation of the imbalance price.

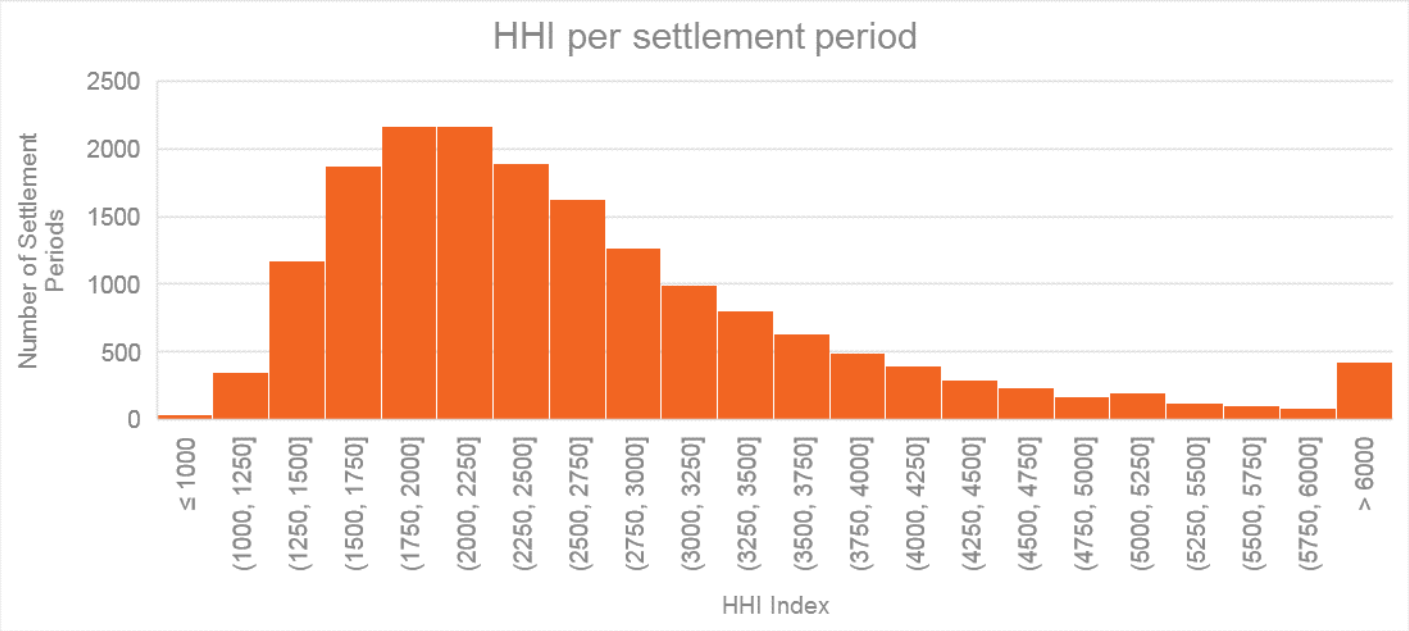
Maintaining a single merit order, settled on pay-as-bid prices allows the ESO to take the actions which are needed, without polluting the clearing price for the whole market or part of the market, and without introducing unnecessary complexity. The Balancing Mechanism is already complex and costly, and we are working towards widening access and participation to increase liquidity and drive benefits for consumers. Introducing further complexity could be viewed as a barrier to entry for market participants, which would stifle competition and reduce the benefit of wider participation.

We see a spread of market prices offered into the Balancing Mechanism by market parties. Economic theory would suggest, that under a pay-as-bid auction, the prices offered to the market should aim to discover the market marginal price. As we have demonstrated, as there is no single market marginal price, it follows that market parties instead put in their short-run marginal cost and/or price their specific characteristics (e.g. fast-responding) into their bids and offers.

Therefore, there is sufficient evidence to challenge the assumption that balancing energy in the Balancing Mechanism is a homogenous product. Overall, moving the Balancing Mechanism to a pay-as-cleared mechanism is likely to fail to discover the marginal cost, as there are multiple marginal costs to discover as detailed above.

Assumption ii) Sufficient levels of competition

To address the issue about competition in the balancing market, we have calculated the Herfindahl-Hirschman Index (HHI) for the market share by volume[6] by Balancing Mechanism Party[7] *per Settlement Period*. The data in this section, and elsewhere, is based on the entire calendar year of 2018. The Balancing Mechanism can be thought of as a market running each (thirty minute) settlement period. The volume of energy in each thirty-minute period procured varies significantly, therefore, we have calculated the HHI index separately for each settlement period and looked at the distribution of the indices. The data considers the market share of BSC parties in each settlement period.



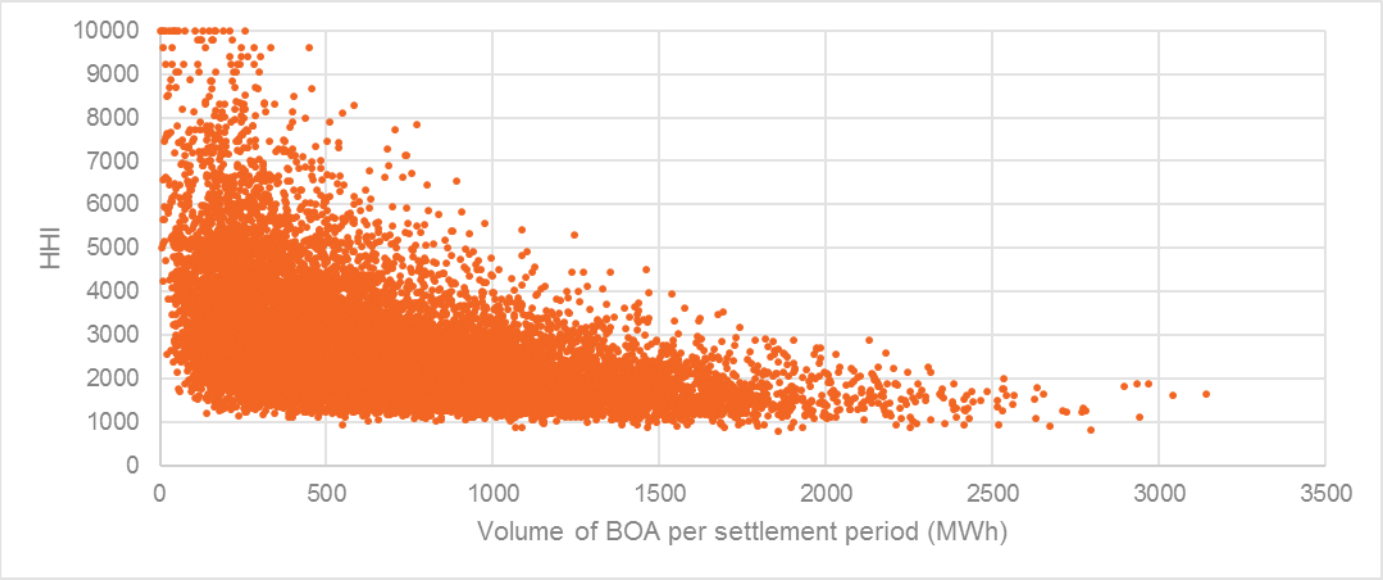
The average (mean) value of the HHI is 2680. The median value is 2376. This reflects the long-tailed distribution of the values. In both cases this value suggests a market which is at the top end of being moderately concentrated and moving in the highly concentrated.

The breakdown of HHI values into categories is given in the following table:

Market Structure	HHI range	Count	% SP
Highly Competitive Industry	0 ≤ HHI < 100	0	0%
Unconcentrated Industry	100 ≤ HHI < 1500	6	<0.05%
Moderately concentrated industry	1500 ≤ HHI < 2500	8103	51%
Highly concentrated market	HHI ≥ 2500	7852	49%

These values indicate that for most the time, there is evidence of a moderately or highly concentrated market, where the majority of market share of the bid and offers accepted for energy balancing is being provided by a small number of providers. This is particularly the case - as you might expect - when the volume of energy procured is low as the number of providers required is low. This is further evidenced in the following scatterplot of HHI compared to energy procured.

[6] We have taken the sum of the absolute value of offer energy provided and bid energy provided. We are therefore considering scale of energy, not "direction" of energy.
[7] Cetrus paribus, this will overstate competition in the market, as companies which are more linked (through a parent company) but who are separate Balancing Mechanism parties will count as two independent market parties. For example, (SSE Generation Ltd and Keady Generation Ltd are separate Balancing Mechanism parties, but have the same parent company SSE plc.



There is some evidence to suggest that there is some competition in the provision of bid and offer volume. However, there are a large proportions of settlement periods when the market is dominated by a few parties thus enjoying a large market share. Under a pay-as-cleared auction, they could possibly be incentivised to tacitly collude to the set the clearing price benefiting all parties, but at detriment to consumers. Maintaining pay-as-bid means that market parties are taken in (approximate) merit order and are not able to pollute the market clearing price for others.

During many settlement periods the volume of energy procured and the number of parties is low. Even considered for the entirety of 2018, the HHI for the Bid Market (across all Settlement Periods) is 1074, and for the Offer market 705, which does show an unconcentrated industry.

The following table shows the market share of the top BSC parties[8] in providing bid and offer volumes across 2018.

Party Name	Bid Volume Market Share
RWE Generation UK plc	19%
EDF Energy (Thermal Generation)	18%
Uniper UK Limited	15%
Carrington Power Ltd	7%
EP UK INVESTMENTS LIMITED	7%
SCCL	6%
Drax Power Ltd	5%
Severn Power Limited	4%
Spalding Energy Company Ltd	3%
Rocksavage Power Company Ltd	3%
Others	13%
HHI	**1074**

Party Name	Offer Volume Market Share
EDF Energy (Thermal Generation	15%
Uniper UK Limited	14%
EP UK INVESTMENTS LIMITED	10%
Drax Generation Enterprise Ltd	9%
Seabank Power Limited	6%
RWE Generation UK plc	6%
Severn Power Limited	5%
Keadby Generation Limited	5%
Carrington Power Ltd	4%
Spalding Energy Company Ltd	4%
Others	22%
HHI	**705**

[8] The mapping of BMU level data to market parties is completed using the currently Balancing Mechanism registration database. Therefore, for example, unit sold by Scottish Power to Drax are listed under Drax, even though in 2018 they were owned by Scottish Power.

Overall, the HHI data challenges the assumption that the Balancing Mechanism is an unconcentrated market, and at least at certain periods there may not be sufficient competition (especially given the heterogeneity of the product) to say there is sufficient competition.

Market power in establishing the marginal price and evidence for heterogeneity of product

As an example, to look at the power of market parties, we consider further the party who has the most expensive bid or offer accepted in each settlement period. It is worth noting that more than one BMU may have the same maximum price accepted, and therefore both units are counted.

The following table shows the number of occasions when a BMU Unit from a given company was the maximum offer price within a settlement period during 2018.

Party who accepted offer was the maximum offer price in a settlement period	% of Occasions
First Hydro Company	28%
Drax Generation Enterprise Ltd	14%
Uniper UK Limited	8%
EDF Energy (Thermal Generation	6%
RWE Generation UK plc	6%
Others	38%

To consider the heterogeneity of the product further we considered the number of times a particular fuel type set the maximum offer price. In the table below, we observe that Hydro sets the maximum offer price on 43% of occasions and on 9/10 of those occasions it is from one of three pumped storage generators (i.e. Dinorwig, Festioniog and Cruachan). Also, we observe that the average maximum price for Hydro is significantly higher than all other fuels.

This lends further evidence to the fact that the product is not homogenous. Pumped storage sets a significantly higher price commanding a premium for the type of fast response it can provide. To use the pumped storage price to clear all offer energy in a settlement period would artificially set the offer energy clearing price too high and this would result in gains to generators at consumer detriment.

Primary fuel type[9]	% of Occasions	Average Maximum Offer £/MWh
HYDRO	43%	118
GAS	34%	97
CCGT	8%	80
COAL	6%	88
BIOMASS	1%	80

This analysis, as well as demonstrating that the marginal price is determined in a market with some concentration, lends significant further evidence to the argument that the product in the balancing market is not homogeneous.

[9] Produced using Elexon's BMU Fuel Type Spreadsheet - https://www.bmreports.com/bmrs/cloud_doc/BMUFuelType.xls

Assumption iii) Perfect Information

There are two areas where the assumption of perfect information is invalid for the Balancing Mechanism.

Firstly, market parties do not know i) how much energy is going to be required to be procured in a settlement period in advance, and ii) for what purpose the ESO requires their energy (i.e. constraints or energy balancing). This is a feature of the market design in Great Britain, as well as the role of the ESO as residual balancer. Moreover, as discussed above the heterogeneity of the product means the ESO may not take products in merit order causing an issue for polluting the price in a pay-as-cleared market.

Secondly, there is significant data[10] available to the market post-event – including the bid and offers provided, the bids and offers accepted, technical characteristics, and the price and volume paid. However, due to the real-time nature of the activities of the ESO, whilst these guide market parties in general trends, the specifics in a given settlement period cannot be fully known until real-time, in a timescale in which market parties cannot effectively respond.

Other considerations of economic theory

One of the potential advantages of a pay-as-cleared auction is there is an opportunity – especially for newer or smaller market participants to operate as a 'price taker'. They bid in their short-run marginal cost, and the market discovers the markets cost which may be higher. However, the issue of access to the Balancing Mechanism is wider than just the style of market settlement used and at present numerous industry initiatives[11] are underway to improve access to the Balancing Mechanism for a wider portfolio of parties within the construct of the domestic market.

Conversely, a pay-as-bid auction is arguably simpler for market parties to understand and to administer than compared to where pay-as-cleared. The reason being that you are incentivised to bid at the system marginal price, but if you offer underneath that it is a benefit to the consumer. Pay-as-bid is a convenient way to remunerate different products taken with their own merit order within the same market. That is, pay-as-bid allows reflection of the heterogeneity of the product, through the different characteristics and location of the provided energy.

Other considerations: transitional costs

This report has not considered, in detail, the one-off or enduring costs of moving from a pay-as-bid to a pay-as-cleared market for the Balancing Mechanism. As there would be a cost to industry of the change, this would flow through as increased consumer detriment. There are many areas where further consideration would be needed:

- Centrally, code modifications and system changes in respect of the Balancing and Settlement Code would be required to settle trades under the Balancing Mechanism under pay-as-cleared rules rather than pay-as-bid rules. Consequently, impacts could be envisaged on other BSC processes such as credit cover, etc.
- Changes to the prices of items in the Balancing Mechanism would also flow through into imbalance pricing calculations, and there may be a need to consider the consequential impact on cash-out processes.
- Disparately, all market parties would need to adjust their pricing strategy for the Balancing Mechanism to reflect the new arrangements. This will likely include substantial IS system change for those that interface directly with central systems.
- Changes to revenue streams through the Balancing Mechanism may also have consequential impacts to other parts of the market. For example, provision of other services to the ESO to secure the system may be impacted by a change in desirability or price in the Balancing Mechanism as the impacts of change to one revenue stream could impact others.

Evidence from historic market data – modelling a pay-as-cleared Balancing Mechanism market

The historic data from all settlement periods from 1st January 2018 until 31st December 2018 has been considered.

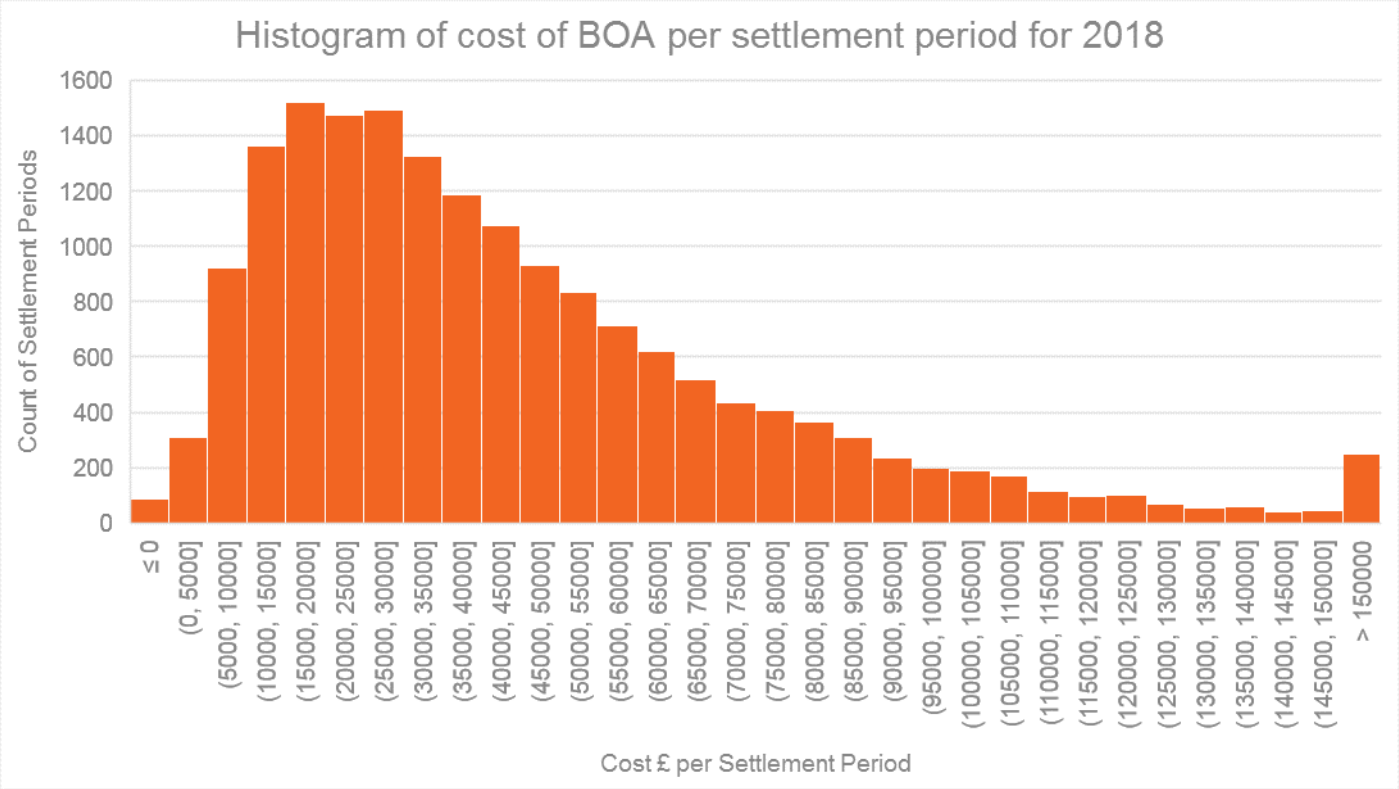
The individual Bid and Offer acceptance data was collated from BRMS data.

The following histogram shows the frequency of the total cost of bid and offers by settlement periods.

The distribution is left-skewed with a mean of £50k per settlement period, and median of £63k per settlement period.

[10] Primarily through the Balancing Mechanism Reporting Service (BMRS) provided by Elexon under the Balancing and Settlement Code.
[11] For example, https://www.nationalgrideso.com/balancing-services/wider-access

Periods of total high cost tend to coincide with needing to take a particular "high-cost" action, such as other actions were being exhausted or need to pay for particularly characteristic, such as fast responding plant. Given the non-homogeneity of the product, there is a risk that these high-cost actions taken for specific purposes would pollute the clearing price, if the market were settled on a pay-as-cleared basis.



Forecast model of consumer detriment if Balancing Mechanism settled as pay-as-cleared

To consider the impact of moving to a pay-as-cleared price for the Balancing Mechanism we have modelled the expected consumer impact compared to the status quo of the pay-as-bid market for the Balancing Mechanism.

Our modelling uses the historic market data, and then constructs a proxy pay-as-cleared price. We recognise the limitation of the modelling and address these limitations below. The key limitation is that the prices offered to the market by market parties were priced knowing the market is pay-as-bid. Parties may use a different pricing strategy if they had known the market would be settled on a pay-as-cleared basis.

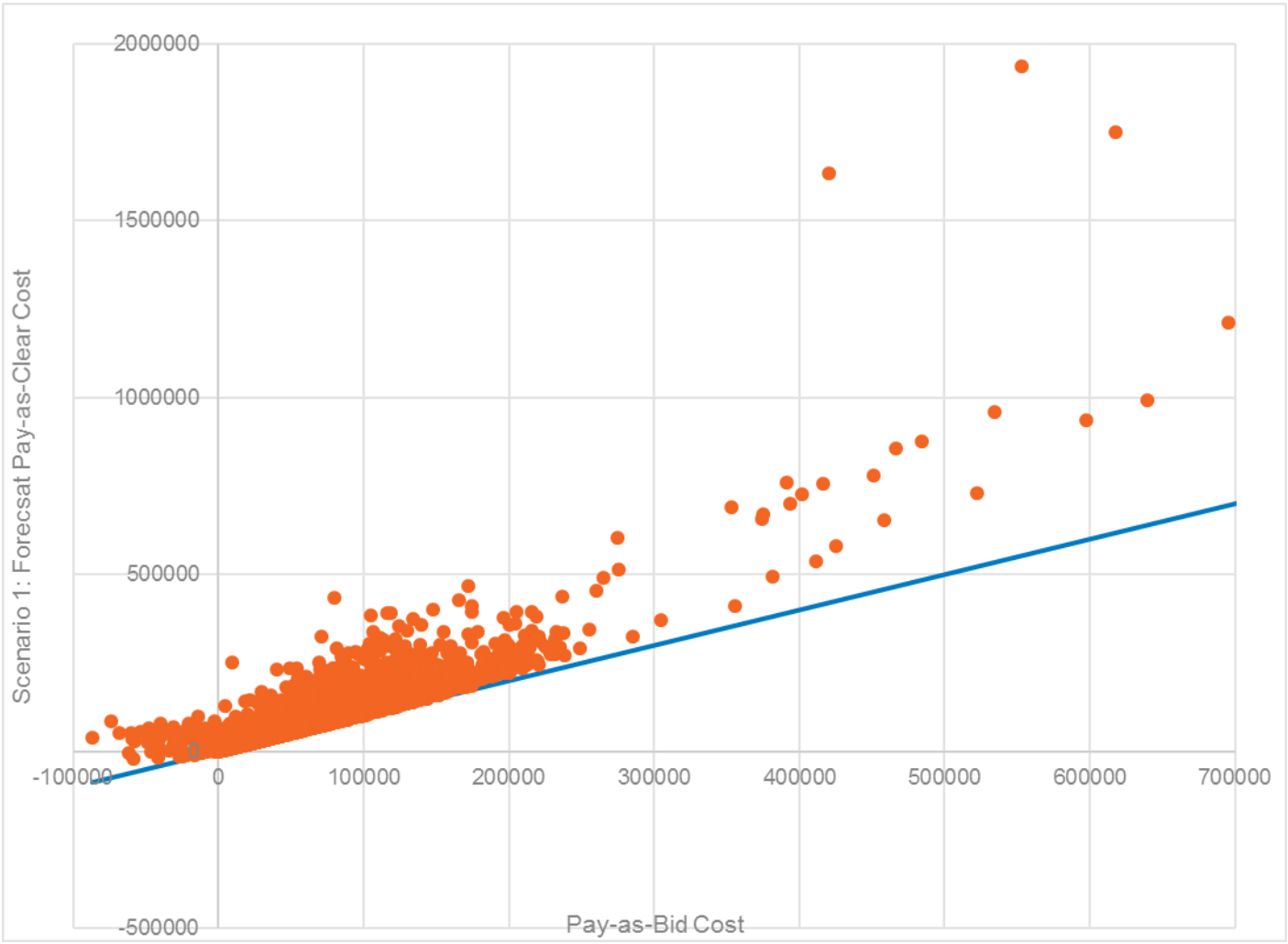
The limitation of this scenario is however recognised, as the market prices are determined by market parties bidding in to a pay-as-bid market not a pay-as-cleared market, and they may have different strategies in these markets.

The modelling does however provide a useful upper bound and scale for the likely consumer detriment.

Scenario 1: maximum pay-as-bid price is used as pay-as-cleared price

If the market were to be settled as pay-as-cleared using the marginal offer and the marginal bid price, **the additional consumer cost is forecast to be £256m per year (based on 2018 data).** This is because all bids and offers would be settled at the maximum accepted bid and offer price respectively in each settlement period. In this situation, there are no settlement period when pay-as-cleared offers a consumer benefit.

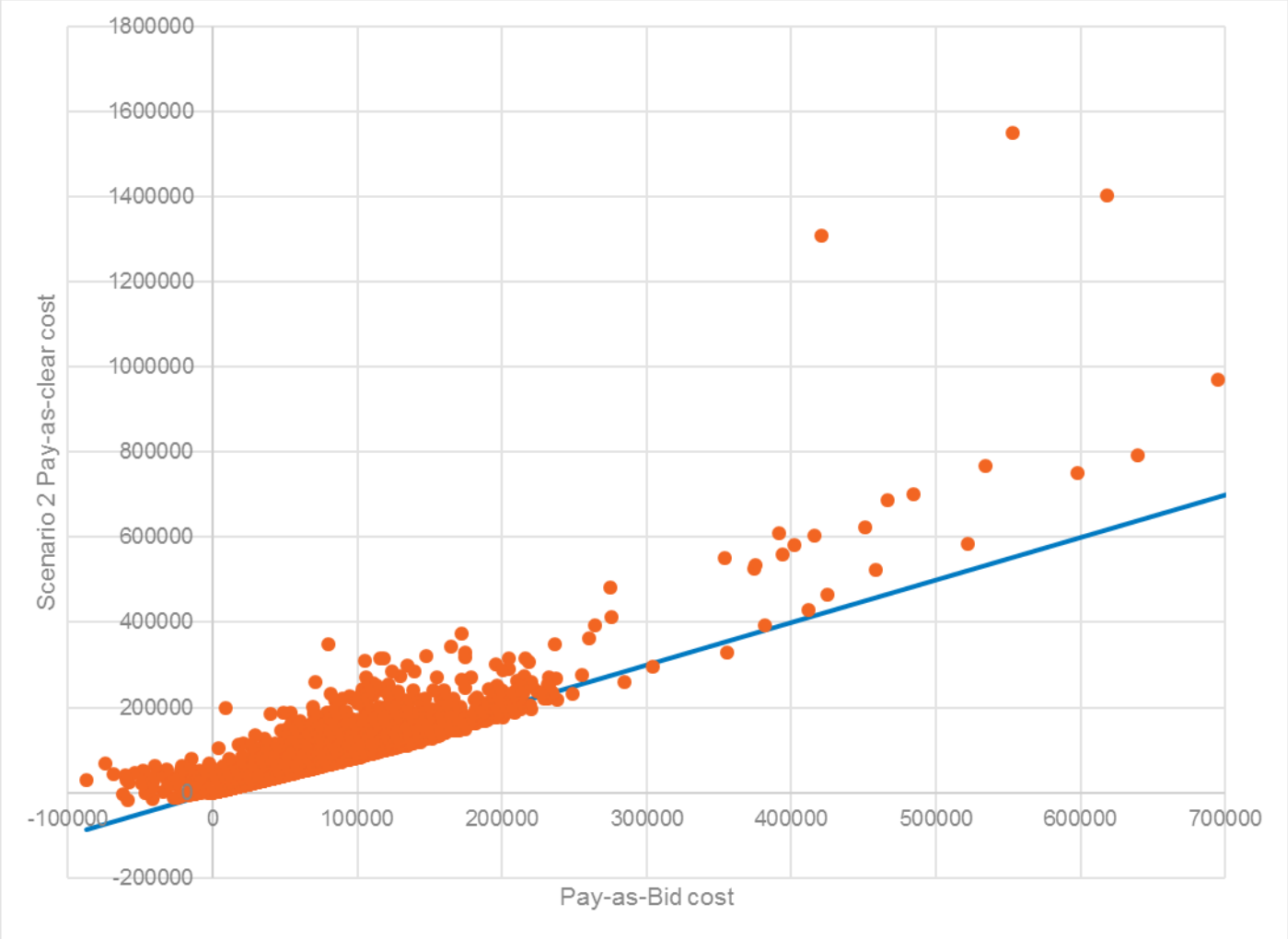
The following scatterplot, shows the modelled pay-as-clear cost against the actual pay-as-bid costs. Each dot represents a settlement period, and the blue line is where the pay-as-cleared cost is equal to the pay-as-bid cost. When the price gets higher, the volume of energy increases, and typically the number of parties increase (so the HHI decreases), then pay-as-bid is close to the pay-as-cleared at the marginal cost. However, there are many lower price settlement periods when the marginal unit is more expensive than the weighted average, postulated to be due to the heterogeneity.



Scenario 2: Pay-as-clear price is 80% of maximum bid and offer price

The assumption in Scenario 1 is that the marginal price is the maximum bid price and maximum offer price accepted in the settlement period. Accepting that parties will bid in differently to a pay-as-cleared Balancing Mechanism, we look at some sensitivities to this assumption.

Under this scenario, we therefore use 80% of the maximum bid and offer price as a proxy for the pay-as-cleared market price. The following scatterplot show the forecast pay-as-clear cost per settlement period plotted against the pay-as-bid cost. Settlement periods to the right of the diagonal have a pay-as-cleared total less than the pay-as-bid total.



Under this scenario there are now 35% of settlement periods that would result in a lower cost to the consumer under pay-as-cleared, bringing a forecast £50m of consumer benefit per annum. However, in the other 65% of settlement periods the pay-as-cleared cost is higher than the pay-as-bid cost resulting in forecast consumer detriment of £98m. **Overall, there is forecast to be an annual consumer detriment of £48m for scenario 2 using a pay-as-cleared approach rather than a pay-as-bid approach.**

For completeness, the consumer detriment is £0m, if we use 76% of the maximum bid and maximum offer prices to set the pay-as-cleared price, compared to pay-as-bid. In this case, there are now 73% of settlement periods showing positive consumer benefits, equally balanced by 27% showing negative consumer benefit. The difference from 50/50 is due to the skew of the distribution and the impact of the long expensive tail.

Analysis for STOR

Economic theory applied to the STOR as pay-as-bid or pay-as-cleared

Economic theory says, under the assumption of sufficient competition, pay-as-bid and pay-as-cleared markets should produce similar results. We will now test the assumption of sufficient competition for the STOR.

Assumption i) A homogenous product

STOR compared to the Balancing Mechanism is a more homogenous product. There are specific technical requirements for providers in terms of the speed of response of the service, and the duration of the service.

When STOR capacity is procured, the primary consideration is economic, although some consideration is given to the location of the units being distributed across the country[12]. However, the seasonal block procurement cannot take into account the particular constraints on the system in operational timescales. This means that, when STOR is required, an active constraint on the network may limit the ability of certain STOR units to provide balancing energy to the ESO. The consequence of this, is that a STOR unit 'out of merit' may be taken over a cheaper unit behind a constraint. This more expensive unit would then set the marginal price for all units in that auction period.

STOR is a more homogenous product that the Balancing Mechanism, although there are some issues in how the product is deployed effectively in operational timescales that might mean that there are elements of heterogeneity.

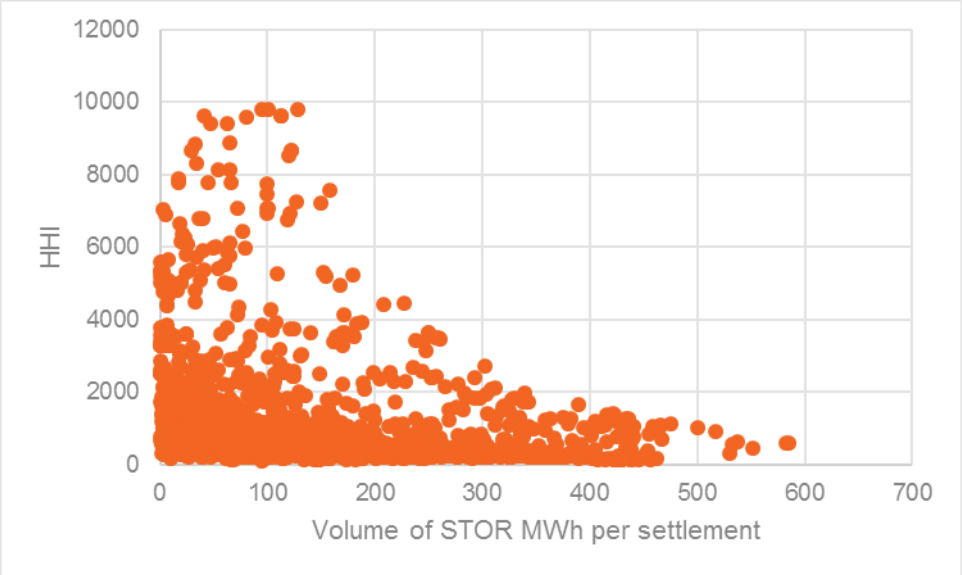
Assumption ii) Sufficient levels of competition

To participate in STOR, units must be able to meet specific technical requirements. This limits the units that can offer the service. Further, only a certain capacity of STOR is required in certain time-blocks, so parties must have tendered in and been successful in the market procurement for them to provide the energy in operational timescales.

STOR can be provided by both Balancing Mechanism parties, and non-Balancing Mechanism parties. Non-BM parties are typically smaller units that do not participate fully in the Balancing Mechanism. In this sense, the portfolio of parties able to provide STOR is drawn from a broader set of providers than if only BM users were considered. To illustrate this point 86% of STOR energy volumes in 2018 was taken from various non-BM providers.

In 2018, STOR was used in around 25% of settlement periods. In the settlement periods STOR was used then in 20% of those periods only one provider was used – so the HHI index for these settlement periods is 10000. In the other 80% of settlement periods that STOR was used, multiple providers were used and the average HHI was 918. This indicates an unconcentrated market, likely driven by the various non-BM providers who provide the majority of STOR volume.

Similarly, excluding the settlement periods when only one provider is used, we see the expected relationship that as the volume of energy required increases, then the HHI index decreases as illustrated in the following graph.



[12] https://www.nationalgrid.com/sites/default/files/documents/STOR%20Assessment%20Principles%20v4%20(Dec%202013).pdf

The ESO is committed to increasing access to our balancing markets. Increasing access to new participants should, in accordance with economic theory, increase the liquidity of the market and reduce the cost to the consumer.

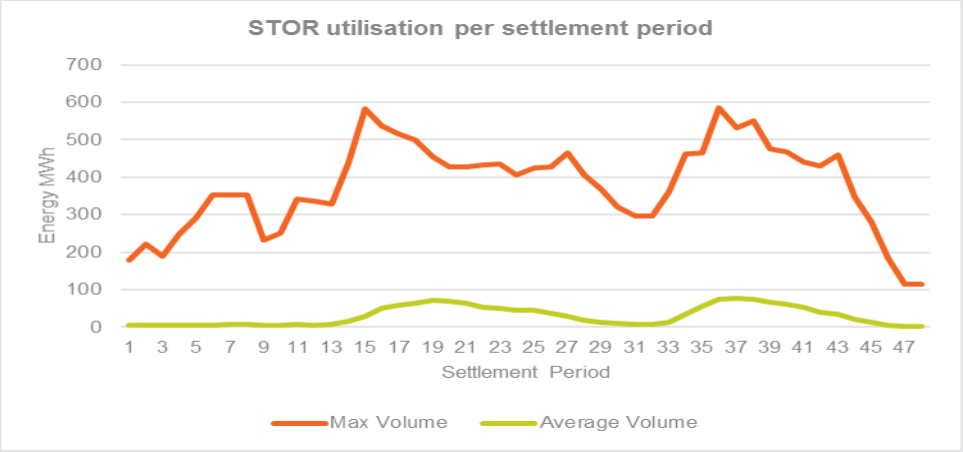
Given the way in which the product is procured (i.e. through a tender which is a desired capacity), and the fact that it is a reserve product (so the volume required can vary significantly) there seems to be sufficient evidence to conclude that STOR is sufficiently competitive – particularly helped by the large number of non-BM providers.

Assumption iii) Perfect Information

The volume of STOR that will be utilised in each settlement period is not known in advance. The capacity of STOR that is secured is known (i.e. the maximum amount that could be called) but this is recompensed through the availability payment, which is outside of the scope of this report. In a particular settlement period the amount of energy that is going to be required is driven by market and technical reasons and this is the feature of the market design in Great Britain, with the ESO holding the role of residual balancer.

To illustrate the variability, STOR is expected to be used in the morning and evening peak, but can be used at any time. STOR was used in about 25% of Settlement Periods in 2018. The following graph highlights the average volume of STOR (green) taken in each settlement period over the year, and the maximum volume of STOR (orange) taken in that settlement period over the year. It can be seen that the maximum is notably higher than the average, and the volume taken can vary significantly.

There is significant data[13] available to the market post-event – including the bid and offers provided, the bids and offers accepted, technical characteristics, and the price and volume paid. However, due to the real-time nature of the activities of the ESO, whilst these guide market parties in general trends, the specifics in a given settlement period cannot be fully known until real-time, in a timescale in which market parties cannot effectively respond.



Other considerations: transitional costs

This report has not considered, in detail, the one-off or enduring costs of moving from a pay-as-bid to a pay-as-cleared market for the settlement of STOR. As there would be a cost to industry of the change, this would flow through as increased consumer detriment. There are many areas where further consideration would be needed:

Centrally, contract modifications and system changes will be required to settle trades under STOR under pay-as-cleared rules rather than pay-as-bid rules. There will also have an impact to Elexon's reporting system as STOR details are reported through BMRS.

In addition, all market parties would need to adjust their pricing strategy for the Balancing Mechanism to reflect the new arrangements. This will likely include substantial IS system change for those that interface directly with central systems.

Changes to revenue streams through STOR may also have consequential impacts to other parts of the market. For example, provision of other services to the ESO to secure the system may be impacted by a change in desirability or price in the STOR market as the impacts of change to one revenue stream could impact others.

[13] Primarily through the Balancing Mechanism Reporting Service (BMRS) provided by Elexon under the Balancing and Settlement Code.

Forecast model of consumer detriment if STOR were settled as pay-as-cleared

To consider the impact of moving to a pay-as-cleared price for STOR we have modelled the expected consumer impact compared to the status quo of the pay-as-bid market for STOR.

Our modelling uses the historic market data (for 2018), and then constructs a proxy pay-as-cleared price. We recognise the limitation of the modelling and address these limitations below. The key limitation is that the prices offered to the market by market parties were priced knowing the market is pay-as-bid. Parties may use a different pricing strategy if they had known the market would be settled on a pay-as-cleared basis. Similarly, STOR parties also receive an availability price and we have not modelled how this might change in moving from a pay-as-bid to pay-as-cleared market.

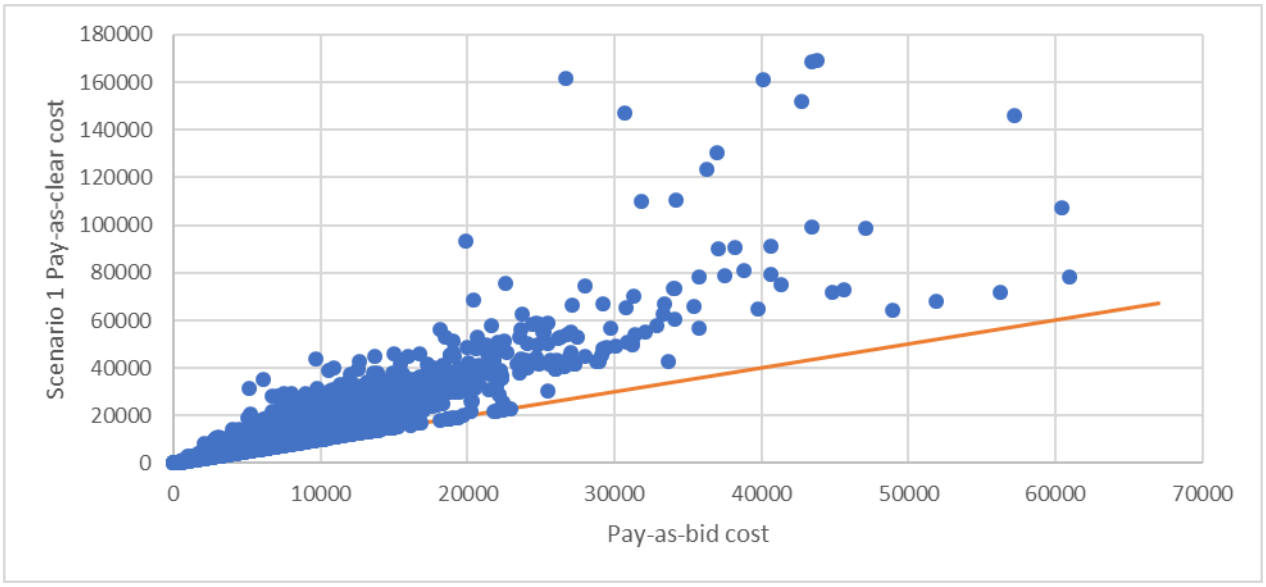
The limitation of this scenario is however recognised, as the market prices are determined by market parties bidding in to a pay-as-bid market not a pay-as-cleared market, and they may have different strategies in these markets.

The modelling does however provide a useful upper bound and scale for the likely consumer detriment.

Scenario 1: maximum pay-as-bid price is used as pay-as-cleared price

If the STOR market were to be settled as pay-as-cleared using the marginal offer and the marginal bid price, **the additional consumer cost is forecast to be £14m per annum.** This is the additional cost above the pay-as-bid utilisation cost of ~£28m if each STOR offer were settled at the maximum accepted STOR offer price in each settlement period. In this situation, there are no settlement period when pay-as-cleared offers a consumer benefit – in 29% of the settlement periods STOR is used, there is only one price. STOR was used in 26% of settlement periods in 2018.

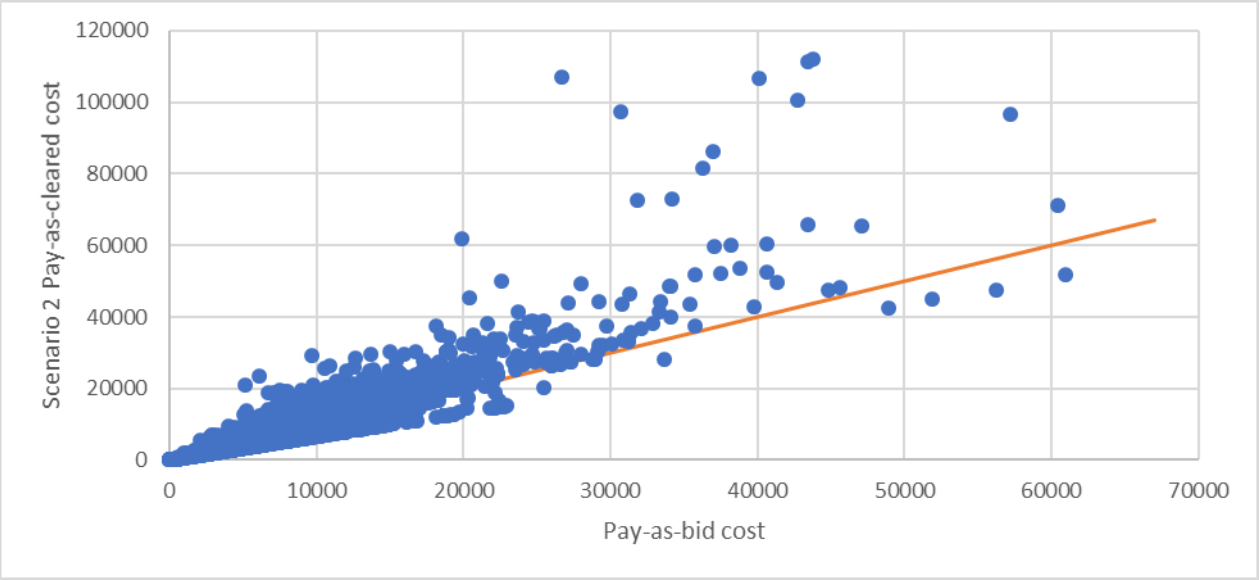
The following scatterplot, shows the modelled pay-as-clear cost against the actual pay-as-bid costs. Each dot represents a settlement period, and the orange line is where the pay-as-cleared cost is equal to the pay-as-bid cost.



Scenario 2: Pay-as-clear price is 80% of maximum bid and offer price

The assumption in Scenario 1 is that the marginal price is the maximum bid price and maximum offer price accepted in the settlement period. Accepting that parties will bid in differently to a pay-as-cleared STOR market, we look at some sensitivities to this assumption.

Under this scenario, we therefore use 80% of the maximum bid and offer price as a proxy for the pay-as-cleared market price. The following scatterplot show the forecast pay-as-clear cost per settlement period plotted against the pay-as-bid cost. Settlement periods to the right of the diagonal have a pay-as-cleared total less than the pay-as-bid total.



Under this scenario there are now 71% of settlement periods when STOR is utilised that would result in a lower cost to the consumer under pay-as-cleared, bringing a forecast ~£2m of consumer benefit per annum. However, in the other 29% of settlement periods the pay-as-cleared cost is higher than the pay-as-bid cost resulting in forecast consumer detriment of ~£8m. **Overall, there is forecast to be an annual consumer detriment of £5.9m for scenario 2 using a pay-as-cleared approach rather than a pay-as-bid approach.**

For completeness, the consumer detriment is £0m, if we use 66% of the maximum STOR prices to set the pay-as-cleared price, compared to pay-as-bid. In this case, there are now 21% of utilised settlement periods showing positive consumer benefits, equally balanced by 79% showing negative consumer benefit. The difference from 50/50 is due to the skew of the distribution and the impact of the long expensive tail.

Conclusion

We have shown that the **Balancing Mechanism** does not demonstrate the required market features to be treated as a sufficiently competitive market in respect of a move from pay-as-bid to pay-as-cleared as follows:

- Homogenous product - there is sizable evidence that the Balancing Mechanism does not represent a homogeneous product due to the differences in the operational requirements of the ESO and in market data that three pumped storage sites dominate the maximum price.
- Sufficient competition - a pay-as-cleared market is susceptible to pollution of the clearing price by dominant market parties. There is some evidence that the market is concentrated, as least in a number of the settlement periods reviewed, due to the small duration of each market and sometimes the low quantity of energy required.
- Perfect information - the nature of the uncertainty of real-time operation of the electricity system means that market participants do not have perfect information about the market and their competitors in the market.

Importantly, our modelling suggests that there is an expected consumer detriment of many millions of pounds per year (i.e. a maximum of £256m for the Balancing Mechanism) of moving to a pay-as-cleared market. The issues affecting concentration of market power and the non-homogeneity of the product suggest we are not well suited to a market which is pay-as-cleared. Furthermore, the implementation costs associated with moving to pay-as-cleared would be significant and this would be borne by consumers.

We have also illustrated that **STOR** does not demonstrate all of the required market features to be treated as a sufficiently competitive market in respect of a move from pay-as-bid to pay-as-cleared as follows:

- Perfect information – as for the Balancing Mechanism, the nature of the uncertainty of real-time operation of the electricity system means that market participants do not have perfect information about the STOR required and their competitors in the market. There is significant variability in the quantity of STOR used.

There is more evidence for STOR (than the Balancing Mechanism) that it is a homogeneous product. There is also evidence that there is sufficient competition, notwithstanding the variability about when and how much STOR is required in each market period.

Importantly, however, our modelling suggests that there is an expected consumer detriment of many millions of pounds per year (i.e. a maximum of £28m for STOR) of moving to a pay-as-cleared market. Furthermore, the implementation costs associated with moving to pay-as-cleared would be significant and this would be borne by consumers, when the ESO has already indicated a broader package of reform to response and reform products to drive consumer benefits.

Overall, there is no compelling argument to move to a pay-as-cleared market for the Balancing Mechanism or STOR. Moreover, we have demonstrated in this report that the alternative (i.e. the status quo pay-as-bid market) is more efficient for both the Balancing Mechanism and STOR. We will keep this position under review, including in relation to any changes as a result of our response and reserve reform programme.

Annex 1

Comparison of Balancing Mechanism, STOR and the Capacity Market settlement methods

The Capacity Market is held up as an example of pay-as-cleared market that delivers good value for consumers. This market was designed as 'pay-as-cleared' from its inception. However, the market is significantly different in character from the Balancing Mechanism and STOR. The following table shows a comparison of the features of the Balancing Mechanism, STOR and the Capacity Market market/auction mechanisms.

	Balancing Mechanism	STOR	Capacity Market
Auction Type	Pay-as-bid; upward merit order	Pay-as-bid; upward merit order drawn from pre-qualified parties	Pay-as-cleared; downward clock
Homogenous Product	No Energy, but technical characteristic important for ESO despatch and constraint management	Yes Technical characteristics must be met in advance.	Yes Derating factors are used to create a homogeneous capacity product across players in market
Perfect Information	No Demand curve unknown	No Demand curve unknown, and significant variability between settlement periods and across days	Yes The precise quantity of (derated) capacity required is published. As market progresses data is published about capacity exiting the auction
Pricing strategy	One price for bid and offer volume per BMU submitted before gate closure	Price for STOR utilisation submitted before gate closure (from 31/1/2020)	Option to dynamically adjust price between (certain) auction rounds.
Market Power	Average HHI by settlement period 2680 (highly concentrated)	In 20% of settlement periods, Average HHI is 913 (unconcentrated) In 5%, HHI 10000 as only one provider used In 75%, STOR was not used	HHI 922[14] (unconcentrated)
Frequency	48 markets per day; for both bids and offers	48 markets per day, but STOR only used in ~ 25% of settlement periods, but not known in advance.	Typically, one year ahead and one longer term auction per annum

[14] From 2022-23 T-4 CM Register