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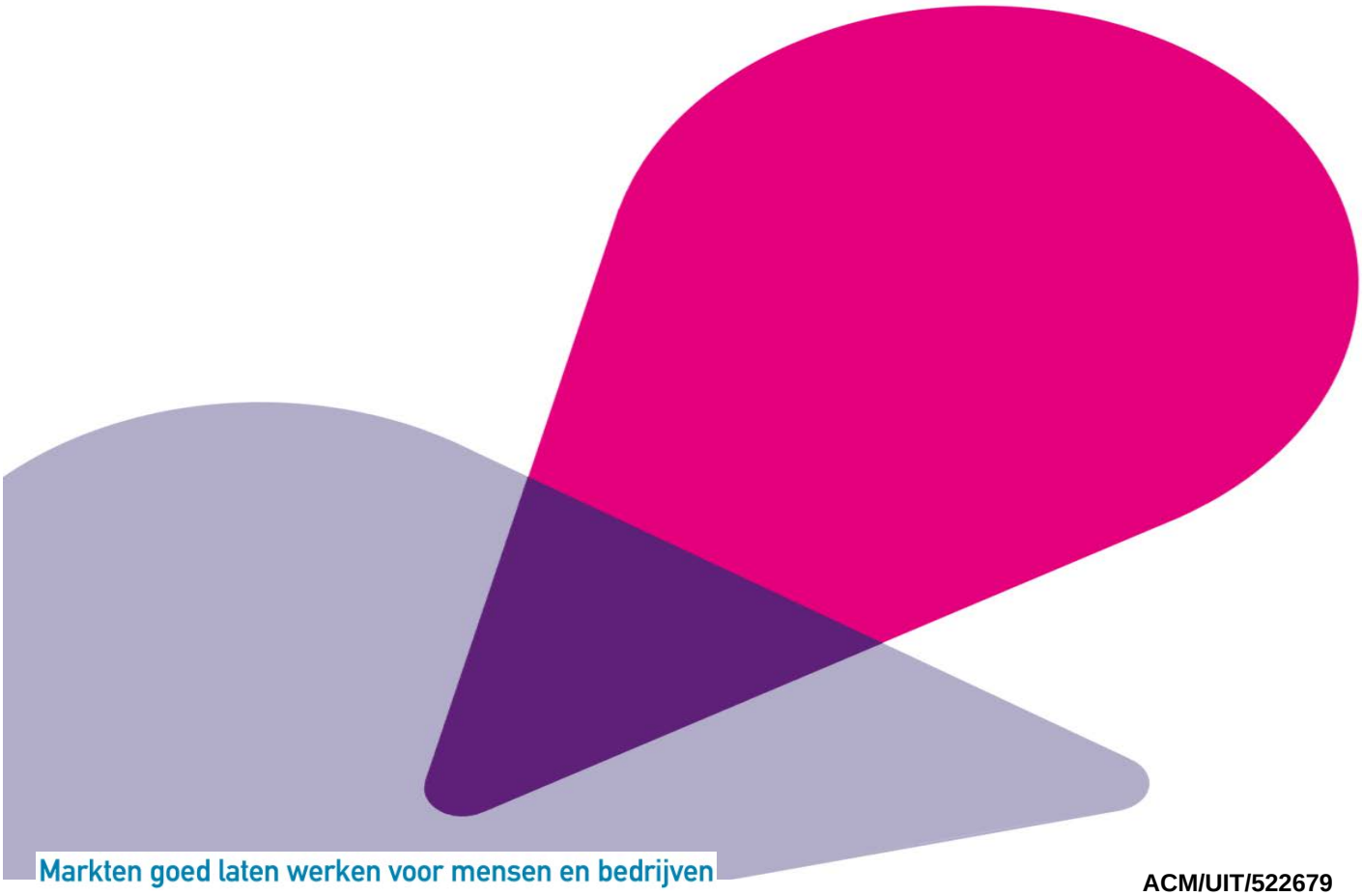
ACM Position Paper

Marginal Pricing for Balancing Energy

a comparison between pricing methods



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Marginal Pricing for Balancing Energy

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Inhoudsopgave

Executive Summary

In this paper we compare two methods for pricing balancing energy for frequency restoration reserves regarding their impact on the incentives for market participants, on settlement of balancing energy and the functioning of balancing markets. These two methods are pricing per optimisation cycle and pricing per imbalance settlement period. Electricity market participants are responsible for balancing the electrical energy they committed to inject or withdraw from the system per ISP and TSOs are responsible for the instantaneous power balance in their own area. The product the TSO uses to balance residual supply and demand is balancing energy provided by contracted providers

In order to incentivise these providers to 1) offer bids, 2) deliver the balancing energy from those bids when activated and 3) reduce incentives to apply mark-ups in bid-prices, the balancing energy price and imbalance price should be equal. If they are not, this will lead to unwelcome incentives on market participants, with detrimental consequences for prices, costs, market efficiency and possibly even operational security.

In order to incentivise market participants to be balanced or to support the system to restore it's balance an imbalance price that corresponds to the real time value of energy is needed and that price is should be determined by the equilibrium between residual supply and demand of electricity in the system.

The method for pricing balancing energy pricing that is chose for the European integration of balancing markets should be compliant to the EB Regulation. Although ISP pricing is clearly compliant with the objectives and requirements on pricing from the EB regulation this cannot be easily concluded for optimisation cycle pricing.

ACM is of the opinion that the introduction of optimisation cycle pricing for balancing energy has a large number of detrimental effects that do not outweigh the slightly increased complexity of the application of ISP pricing in a cross-border context. This position paper concludes that marginal pricing per ISP for the FRR process is the preferred pricing method.

1 Introduction

In this paper we compare two methods for pricing balancing energy for frequency restoration reserves (hereafter: FRR) regarding their impact on settlement between TSO and BSPs and the functioning of balancing markets. The first method sets a marginal price per optimisation cycle[1] (hereafter: "OC pricing"), the second sets one marginal price of balancing energy per imbalance settlement period, or "ISP"[2] (hereafter: "ISP pricing"). For this analysis, the Dutch balancing market design is used as a reference and data source, as marginal pricing per ISP for balancing energy from FRR has been applied there for many years. The Netherlands is the only European country in which the principles from the EB regulation [3] – including merit order activation according to bid prices and short BE gate closure times - are already applied in practice. Annex I provides a summary of the European balancing market design principles.

Chapter 2 describes the responsibilities of market participants and TSOs in respect to balancing. Chapter 3 explains incentives on these market participants, including balancing service providers (BSPs) as well as balancing responsible parties (BRPs) , while chapter 4 assesses the two TSO-BSP pricing options against the evaluation criteria (chapters 4).

2 Responsibilities in the balancing market

In order to understand the responsibilities of different parties in the balancing market[4], it is imperative to differentiate *electrical power* in MW from *electrical energy* in MWh. Market participants (or their BRPs) are responsible to balance the electrical energy per ISP they committed themselves to inject or withdraw from the system. TSOs are responsible for the power balance in their own LFC area and are jointly responsible with other TSOs of a synchronous area to keep the frequency stable. The product the TSOs mainly use foto be compliant is balancing energy provided by BSPs.

2.1 Imbalance market

BRPs are responsible for ensuring that actual total supply and demand of electrical *energy* matches the transacted volume. This volume is bought and sold in various (forward) electricity wholesale markets, including for instance organised day-ahead and intraday markets and is reported to the TSO as the position.[5] This "single position" prescribes what volume of electrical energy the respective BRP must inject into or withdraw from the system during each ISP. BRPs

[1] The optimisation cycle for aFRR is around 4-10s as it is a continuous process
[2] Although a bid is usually provided per validity period we consider the minimum validity period to be equal to an ISP and the ISP to be equal to 15 minutes. For readability we use ISP-pricing even if this alignment is not always fully applicable.
[3] Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing
[4] EB Regulation definition: 'balancing market' means the entirety of institutional, commercial and operational arrangements that establish market-based management of balancing.
[5] The 'position' of a BRP is the sum of its internal and external commercial trade schedules

carry full financial responsibility for any deviations (the "imbalance") from this position. Any imbalance is settled for each ISP with the responsible BRP.

The Netherlands has a "single position", "single price" self-dispatch system: BRPs optimize the dispatch of their own portfolio based on the abovementioned position and there is one imbalance price per ISP at which each imbalance during that ISP is settled. Aside from being penalised for injections and withdrawals that aggravate the system imbalance BRPs are rewarded for "non-aggravating" imbalances[6] that reduce the total system imbalance per ISP. As such single imbalance pricing allows for implicit energy trades of imbalance between the non-aggravating and aggravating BRPs via the TSO at the imbalance price.

As such, the "single position, single imbalance price" system that the EU is moving towards allows for a real-time energy market where energy is traded per ISP between BRPs as well as between BRPs and BSPs (through the TSO) . In order for BRPs to solve either their own or another's energy imbalance through this market, it is important that the prices in the subsequent day ahead, intraday and balancing markets, including the imbalance and balancing energy prices, are consistent with each other and provide all market participants with the correct incentives. This is described in more detail in the next two chapters.

Most EU countries do not currently have such a "single position, single imbalance price" design for their balancing markets. Often, BRPs are not allowed to deviate from their position to support the system, or are always penalized for doing so by added cost components. As a result, the volume of these BRP-BRP exchanges decreases, and all such trades would need to go through the TSO through activation of balancing energy.

2.2 TSO responsibility and the function of aFRR

Although it is the responsibility of market participants to ensure supply and demand of electrical energy per ISP, it is the responsibility of each TSO to deal with the residual power imbalances[7] within the ISP.

Within the whole of continental Europe, all instantaneous power imbalances are immediately countered by frequency *containment* reserves (FCR). After a few seconds, FCR is supplemented by frequency *restoration* reserves of each individual TSO, which can be activated automatically (aFRR) or manually (mFRR). The frequency restoration process currently uses aFRR and mFRR for two purposes:

[6] An 'aggravating imbalance' is defined by TSOs in imbalance settlement harmonisation proposals pursuant to A52.2 as … the imbalance of a BRP … that is opposite in sign to the net volume of balancing energy demand per imbalance area and ISP. A non-aggravating imbalance is the opposite and thus equal in sign (imbalance vs balancing energy)
[7] Power imbalances (comparable to ACE) are caused by instantaneous fluctuations such as ramping of units, fluctuations in renewable generation, or variations in demand during an ISP. When integrating the power imbalance over an ISP, the expected result is zero. Any difference is an energy imbalance that was not correctly solved or prevented by BRPs.

1. To relocate the activated power to the control area with the imbalance (Δp → 0 MW)
2. To restore the frequency to the nominal value, and release activated FCR by activating additional power (Δf → 0 mHz; FCR activated → 0 MW)

In doing so, the frequency restoration process leads to the injection or withdrawal of electrical power into or from the system by activation of balancing energy bids to compensate for the residual power imbalance left by the market participants. This balancing energy delivered by BSPs is thus part of the same real-time market as the imbalances exchanged between the BRPs. As a result, BRPs that have an imbalance buy or sell this energy imbalance either 1) from BRPs that have an opposite imbalance (through TSO-BRP settlement), or 2) from BSPs who supply balancing energy through the TSO. In either case, the volume of balancing energy is considered equal to the volume of the total residual imbalance. Therefore the definition of both the TSO-BRP (imbalance) and TSO-BSP (balancing energy) settlement prices influence the behaviour of market participants in their role as BRP and/or BSP.

In summary, FRR has both a technical function (electrical power control) and a market function (trade balancing energy to match demand and supply).

3 Incentives on BRPs and BSPs

In order to provide BRPs and BSPs with right incentives[8], a consistent market design[9] is required. In accordance with EB Regulation article 44, the settlement arrangements should incentivise BSPs to place bids for balancing energy and – when activated - deliver upon their bids, and should incentivise BRPs to be in balance or to help the system restore its balance. BSPs and BRPs should both receive adequate economic signals which reflect the imbalance situation.

3.1 BSP incentives

Incentive to place bids

As the availability of balancing energy bids is an important prerequisite for the proper functioning of the balancing market (in terms of price formation and TSO compliance), the incentive for BSPs to place balancing energy bids and to deliver on them is important.

In order for a market participant to place a bid, it should be at least as attractive to deliver balancing energy from that bid as it is to have a non-aggravating imbalance with the same energy volume. The relation between the balancing energy price and imbalance price determines how attractive it is for a BSP to place a bid. If the imbalance price is more costly than the balancing energy price paid for the bid over the same ISP, a BSP may decide to hold back the bid, since it is worth more when delivered as non-aggravating imbalance or used to solve the respective BRP's own aggravating imbalance than it would be when delivered as a balancing energy bid. In

[8] Individual behaviour that achieves overall system efficiency
[9] A design in which prices correctly reflect the supply and demand situation

other words, there is a risk that that BRPs 'hold back' potential balancing energy bids to balance their own portfolio, submitting only more expensive bids to the TSO. As such a lack of incentive to place bids could reduce the available volume of free bids, thereby reducing liquidity and competition on balancing energy markets which could raise balancing energy prices, balancing capacity prices and decrease overall market efficiency.

Incentive to deliver on bids

If BSPs do not deliver the requested balancing energy when their bid is selected, this may deteriorate frequency quality, jeopardize operational security, and lead to higher balancing energy prices since additional bids must be activated to compensate for this non-delivery. In order for a BSP to deliver the activated energy from an already placed bid, it should be have the expectation that it is more rewarding to actually deliver the energy than to be rewarded for requested volume of the activated bids without delivering the volume[10] and pay the imbalance price for the non-delivered energy. This relates to the imbalance situations for the BRP where activated balancing energy is corrected through 'imbalance adjustment': a mechanism where non-delivery leads to an (additional) aggravating imbalance of the corresponding BRP. To avoid an incentive for non-delivery, the imbalance price should at least be equal to the effective balancing energy price over the same ISP and preferably higher than the price of the non-delivered bid.

In conclusion, in order to incentivise BSPs to 1) offer bids and 2) deliver the balancing energy from those bids when activated, the balancing energy price and imbalance price should be equal. If they are not, this will lead to unwelcome incentives on market participants, with detrimental consequences for prices, costs, market efficiency and possibly even operational security.

3.2 BRP incentives

Incentive for BRPs to be in balance or to help the system restore its balance

To provide correct short and long term incentives to BRPs to be in balance or help the system to restore its balance, it is important that imbalances are priced and settled in a way that reflects the real time value of energy per ISP as required by article 44(1)(b) of the EB Regulation.

As explained above, the EU balancing market design allows electrical energy to be traded per ISP between BSPs and BRPs through the TSO, and in case of a single position, single imbalance price model also between BRPs with aggravating and BRPs with non-aggravating imbalances. To ensure coherent price signals across all options for exchange, a single (imbalance) price per imbalance area to settle all imbalances is necessary. To ensure that this single imbalance price in practice corresponds to the real time value of energy, several things are necessary:

[10] In the Dutch market, BSPs receive payment for requested volumes of balancing energy, which are then adjusted on the imbalance. Non-delivery is therefore paid for through the imbalance price thus removing arbitrage potential between imbalance and non delivery. In other countries where actually delivered (metered) volumes are settled additional penalisation in case of non delivery thereby introducing arbitrage potential between imbalance and non-delivery

- firstly an imbalance price is needed that is expected to be less attractive than the spot price[11] as aggravating the system balance should not be financially attractive. This will ensure that market participants will attempt to close possible open positions before real-time rather than paying the imbalance price. If the gate closure time for balancing – the last moment at which BSPs can submit balancing energy bids – is brought close to real time, BSPs have a more precise reference price from the intraday market to estimate the balancing energy price. Allowing BSPs to price their bids depending on the results in the previous timeframe will ensure prices that better reflect the final demand/supply situation.
- Secondly, the imbalance price should reflect scarcity in order to provide the correct signals to BRPs to ensure availability of generation. This requires that the imbalance price is corresponds to the activated balancing energy volume: the price should increase exponentially with increasing volumes reflecting scarcity. This will ensure a strong incentive for non-aggravating imbalances in case of large system imbalances such as outages.
- Thirdly, in order to allow BRPs to help restore the system balance, the imbalance price should settle BRPs who counter system imbalances at the price reflecting the actual situation. To allow for this, the TSO should provide transparent information close to real time[12] on 1) the system imbalance and 2) the indicative imbalance price:
    - **Providing system imbalance information:** it is necessary to provide BRPs with the necessary information to know whether selling (or buying) energy in the imbalance market is beneficial considering their marginal costs.
    - **Indicating the imbalance price:** In any single position, single price system the BRP is either actively allowed or at least implicitly incentivised to support the system balance by showing an indication of the imbalance price.

In conclusion, an imbalance price that corresponds to the real time value of energy is determined by the equilibrium between residual supply and demand of electricity in the system.[13] Following from theory, this value for balancing energy is equal to the cost of the marginally activated balancing energy bid to provide this residual volume. In practice, this will hold true when applying merit order activation, in which case the last (marginal) activated balancing energy bid determines the real-time price (and value) of balancing energy for that ISP.

Therefore, the real time value of energy is equal to the marginal costs of the last unit needed to restore balance in an ISP. This is also what the white paper on efficient wholesale price formation published by ACER/CEER in 2017 proposed when linking the marginal price for balancing energy to the real time value of energy.[14]

[11] Spot meaning the last relevant market price on DA or ID market
[12] Reporting the actual system balance no later than 30 minutes after real time (preferably much sooner) including indicative balancing energy and imbalance prices follows from the new Electricity regulation 943/2019 Article 6(13).
[13] This assumes proper market functioning including proper incentives on BSPs and no unnecessary markups to the balancing energy price
[14] European Regulators' White Paper **Efficient Wholesale Price Formation** http://www.acer.europa.eu/Official_documents/Position_Papers/Position%20papers/WP%20ACER%2004%2017.pdf

4 Evaluation of marginal pricing methods

Evaluation criteria

The different methods for the balancing energy pricing period are evaluated on the basis of the following criteria:

1. Risk for mark-ups by BSPs
2. Link between balancing energy price and imbalance price
3. Handling of congestion
4. Incentives on BSP
5. Achieving the objectives & requirements of the EB Regulation

This chapter evaluates ISP pricing and OC pricing for their impact on the above evaluation criteria. In order to evaluate the choices, OC prices per bid, ISP price and the BSP costs per bid have been calculated for a 15 minute period from September 2019 on a 4-second basis and a 15-minutes basis using internal TenneT NL data for the Dutch system with a 4-second granularity. This merit order list is fairly concentrated and the imbalance settlement price was equal to the 15-minute marginal balancing energy price. The results are further explained as relevant to the evaluation criteria.

Figure 1 shows the balancing energy merit order list for balancing energy used for this analysis. Figure 2 shows the a volume of bids activated by the TSO (red line) and the balancing energy volumes delivered by the BSPs[15] (green line). The optimisation cycle price was determined on the basis of the red line. As system imbalance was negative in this ISP only the positive BE merit order list was used for the analysis.

As the analysis is done on current bid prices, it is assumed they would not change under a different pricing methodology.

[15] Considering the relatively slow product (FAT of 15 minutes) used in the Netherlands, for determining the green line an approximation of volumes based on ramping rates corresponding to a 5 minute FAT has been used in the analysis. This approximation was made by directly ramping the red line (negative ACE) on a per-bid basis assuming 20% of total bid volume activated per minute.

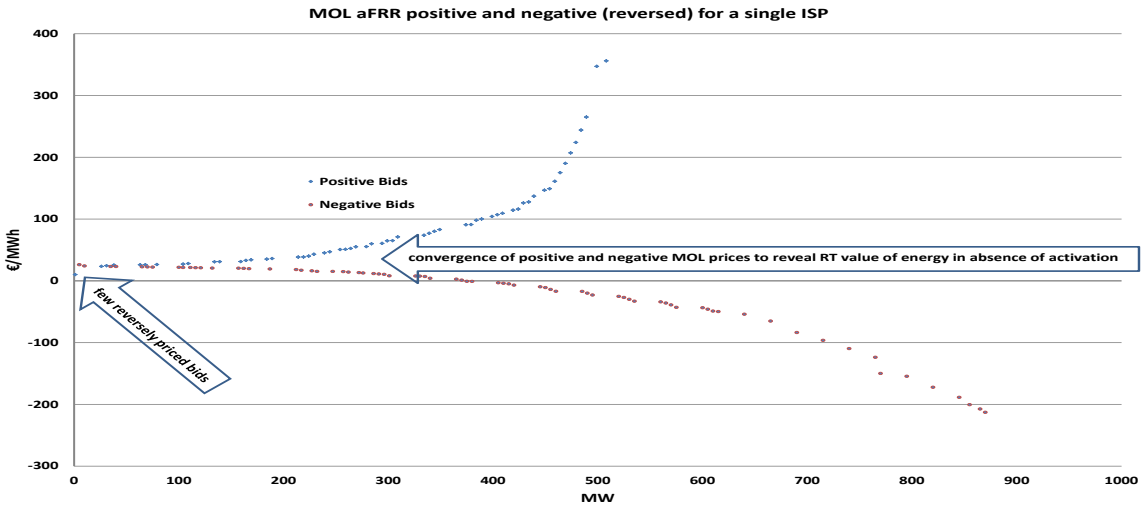

Figure 1 Positive and negative balancing energy merit order lists with bids volumes and bid prices

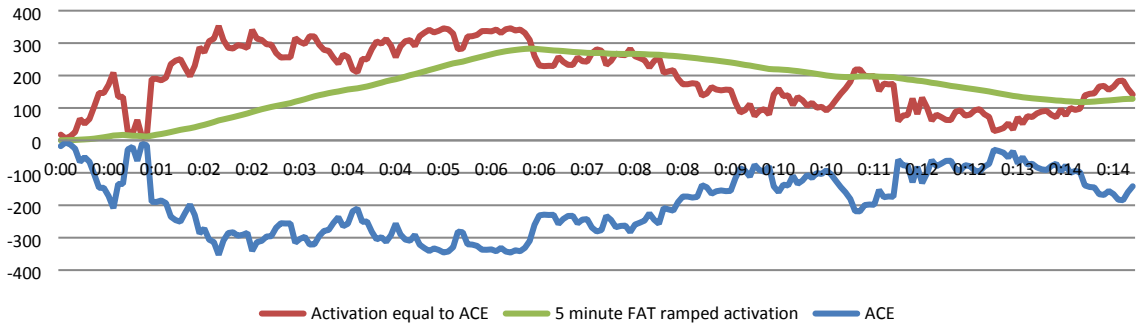

Figure 2 ACE and ramped and unramped activation signal

Criterion 1: Risk for mark-ups by BSPs

As required by article 44(1)(f) the EB regulation the TSO-BSP settlement method should avoid distorting incentives. An incentive to place mark-ups in balancing energy bid prices should be preferably be avoided and if possible not be introduced.

When applying ISP pricing, placing a mark-up will only be beneficial to the BSP that places the marginally activated bid for the ISP. But at the time of bidding a BSP has no way of determining this. In case of ISP pricing the delivered bids of all BSPs are settled at the same marginal price over the whole ISP. The surplus[16] for each selected bid equals the difference between the marginal price and the bid price; more competitive (lower) bids will have a higher surplus. There is thus a clear incentive for BSPs to price their bids at the marginal cost or sometimes even lower than that to ensure being "in merit".

In case of OC pricing, BSP revenue is reduced significantly in comparison to ISP Pricing because the marginal price is different every 4s and equal to the marginal bid. Placing a mark-up on any bid would directly materialize in extra revenue in every 4 second period in which this bid is marginal and selected. Especially on the low end of the CMOL (see Figure 1) a BSP has a high certainty that placing a mark-up will be beneficial and extra revenue will be collected. After every

[16] Surplus defined as revenues minus cost

15 minute period a BSP can basically analyse whether the mark-up has resulted in extra revenue. As the incentive is equally present for all bids that are 'in merit' (per ISP) this could gradually increase prices from all BSPs over time. This would apply to all balancing products. There is evidence for this shift in prices in markets that apply pay-as-bid pricing. Using different prices will invite additional mark-ups compared to uniform pricing across these products.

The figures below show the revenues and volumes per activated bid along the MOL under OC pricing and ISP pricing. They show that difference in revenue (lower in OC pricing than in ISP pricing) is substantial on the low end of the MOL(the graphs shows bids on the x-axis) and that there is clear price discrimination between BSPs within the 15 minutes.

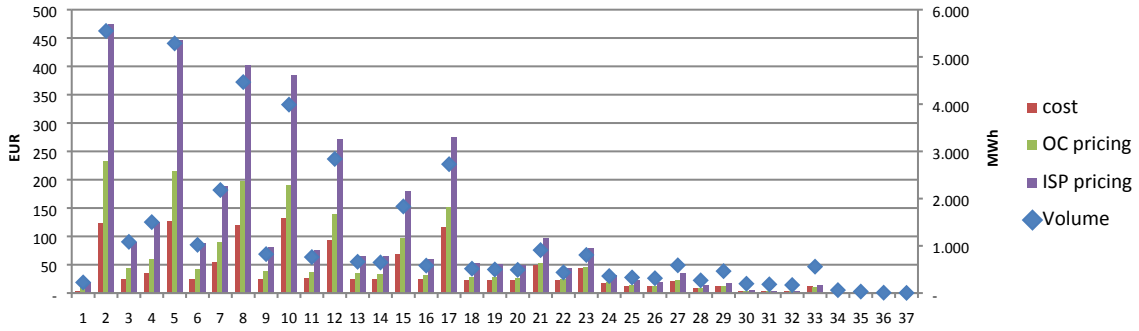

Figure 3 Revenue for OC/ISP pricing, costs and volumes delivered

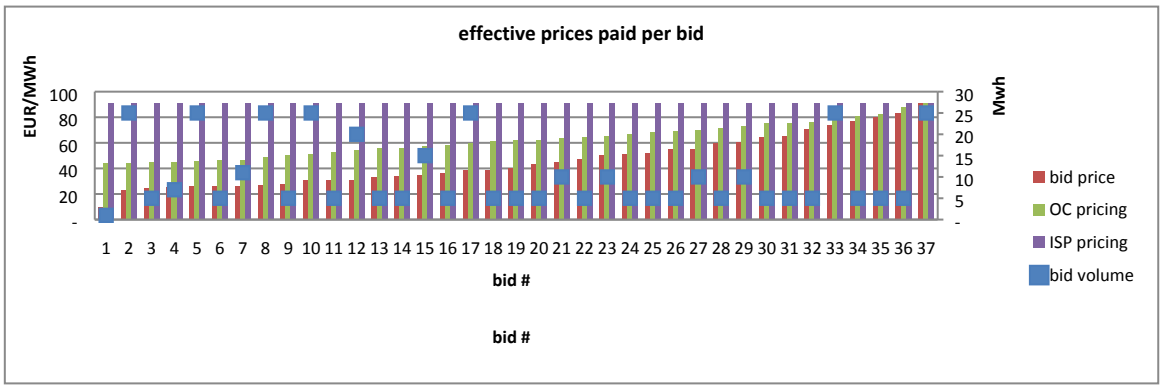

Figure 4 Balancing Energy settlement prices for OC/ISP pricing, bid prices and bid volumes

To calculate the effect on BSPs, revenues have been calculated on the basis of ISP pricing, OC pricing and with remuneration based on bid price. The difference in payment from TSO to BSP has been calculated for each bid activated in the period analysed. The results show an overall surplus reduction of 35% for OC pricing compared to ISP pricing.

Figure 4 also shows the difference in prices (and bid prices) between ISP pricing and OC pricing. It becomes clear that in the case of OC pricing, each bid effectively receives a different price for an identical balancing energy product. These unequal prices and the consequential reduction in revenue are mainly seen on the low end of the merit order if the price is set on the high end. A reduction of surplus for BSPs of this size will provide an incentive for BSPs to place mark-ups on bid prices to compensate for the loss of revenue. For this a BSP would need complex

probabilistic analysis (taking into account price and volume effects) to determine which bid price would maximize his revenue.

In conclusion, it is questionable whether the OC pricing method incentivises BSPs to price their bids at marginal cost (including opportunity costs); our analysis shows a risk that mark-ups will be included. This incentive is more or less equal for all 'infra-marginal' bids (bids that are in merit), also when forming a more competitive common MOL. Although competition between BSPs will have an effect on prices, in a market design that incentivises placing mark-ups, competition will be less efficient than in a an environment that eliminates (some of) these incentives. As our analysis shows, under ISP pricing bid prices and consequently also balancing energy prices will more likely reflect marginal cost than under OC pricing.

Criterion 2: Link between balancing energy price and imbalance price

As mentioned before equality of imbalance and balancing energy prices integrates 'imbalance' fully in the balancing market. This is fully compliant with EB Regulation and its definition of the balancing market[17]. Equality of imbalance and balancing energy prices, and correlation between scarcity and balancing energy per ISP will provide an incentive to reveal the value of flexible resources within a BRPs portfolio. It also provides the incentive to reduce aggravating BRP imbalance and increase non-aggravating BRP imbalance. This effect works through certain price driven forward and backward propagation mechanisms. Forward propagation functions on the expectation of what will happen to the imbalance price depending on the level of activation. Backward propagation functions through information on how much activation is actually occurring. These mechanisms provide additional indirect competitive pressure to BSPs (as it is not through the CMOL) that they take into account in their bidding behaviour. Equality of imbalance and balancing energy settlement prices therefore strongly provides a disincentive for predatory bidding behaviour by BSPs.

In case of OC pricing it is impossible to define an imbalance price equal to the price for balancing energy, as there is no specific (single) price for balancing energy per ISP to refer to as settlement periods are unequal. The two main options to create a weakened link between the two are:

1. to take the marginal (highest) price of balancing energy over the whole ISP as imbalance price; or
2. to take some form of average price of balancing energy over the ISP as imbalance price.

When taking the marginal price of balancing energy as imbalance price BSPs are not correctly incentivised. This will be discussed under criterion 4. Taking the average price of balancing energy as imbalance price improves the incentives on BSPs up to a point but:

- it is impossible to provide BRPs with the correct information to support the system balance as the imbalance price calculation can only be done *ex post* when all the volume data is collected; this information usually takes weeks to collect and is thus unknown close to real time.

[17] article 2(2) of the EB Regulation

- the average imbalance price does not reflect the real time value of energy, as the price of most expensive balancing energy bid necessary in the ISP to match residual supply and demand is higher than the average imbalance price.
- the average imbalance price reduces scarcity incentives on BRPs and reduces the penalty for aggravating the system imbalance. This is contrary to the BRP responsibility to ensure that the real net sum of supply and demand matches the transacted volume over the ISP.

In case of ISP pricing, equalling balancing energy price and imbalance price is straightforward as the maximum price over an ISP for balancing energy can directly be taken as the imbalance price without the need to establish delivered volumes; the imbalance price is known right after the end of the ISP.

Criterion 3: Relationship with congestion

When applying cross-border marginal pricing for aFRR it needs to be determined how to define this marginal price if the size and/or location of congestions between the area's change due to the continuous change in demand during the ISP. As demand and congestion only change based on activation, OC pricing offers an easy solution to determine the cross-border marginal price for each cycle.

In case of ISP pricing, different congested situations within the same ISP need to be combined in order to determine per direction which of the activated bids are price-setting in each of the participating areas. This somewhat increases the complexity of the application of cross-border marginal pricing. However, establishing the marginal price for each imbalance/LFC area is still fairly straightforward. As the highest price for each uncongested area is known for each optimisation cycle, and the marginal price for each direction and for each ISP to be paid to BSPs can be derived from the maximum for positive BE or minimum for negative BE of these values. This implicitly establishes uncongested areas over the ISP as well for each positive and negative CMOL separately.

Criterion 4: Incentives on BSPs

As described earlier, the TSO-BSP settlement method should, in conjunction with the rest of the settlement scheme, incentivise the BSP to offer bids and to deliver on those bids. Since every BSP is tied to a BRP, the BSP is always financially responsible for their actions on the system. As explained in Chapter 3, the incentives on the BSP depend on the relationship between the balancing energy price and the imbalance price.

In case of ISP pricing the imbalance price can be set equal to the marginal price for balancing energy, ensuring also the correct incentives on BSPs to provide bids and deliver them.

In case of OC pricing:

- Different TSO-BSP settlement prices apply in the same ISP for each bid. This means that independent of the choice of imbalance price, there are always BSPs who are either not

incentivised to provide a bid (considering their place in the merit order) or to not deliver their bids, due to a difference between their individual settlement price (determined by the average settlement price of the whole volume of balancing energy they delivered) and the imbalance price.

- In case the imbalance price is taken to be equal to the highest price of balancing energy in the ISP, there is lack of incentive to offer bids. As shown before, the surplus is significantly reduced. This will most likely lead to higher balancing energy bid prices, reduced liquidity of uncontracted (free) bids, reduced liquidity in the balancing capacity market, and higher balancing capacity prices.
- In case the imbalance price is taken to be equal to the volume weighted average price of TSO-BRP settlement costs this also introduces problems with correct and equal incentives for all participating BSPs depending on their place on the merit order list and only partially compensates for the reduced incentives caused by OC pricing.

Criterion 5: Achieving the objectives & requirements of the EB Regulation

The chosen method for TSO-BSP settlement should be compliant to the EB Regulation. This is a firm requirement for any pricing proposal. Although ISP pricing is clearly compliant with the EB Regulation on pricing especially for the objectives included therein, this can not be easily concluded for OC pricing.

In Article 30(1)(c) and Article 45(2)(a) of the EB Regulation requires that at least one price and volume should be determined *for each ISP***.** Prices and volumes determined *for each ISP* are therefore naturally compliant to these articles. The addition 'at least' was included during the drafting of EB Regulation to allow a separate pricing for positive and negative balancing energy in the situation of activations in both directions in the same ISP. Allowing this phrase to establish a different (shorter) pricing period (as needed in case of OC pricing) could be read in Article 30(1)(c) but not in Article 45(2)(a) as the latter defines the dimensions for which a TSO should at least calculate the settlement volumes as a firm requirement. In order to have a functioning market the product purchased should follow the requirements on settlement from the EB regulation. When reading both together the pricing proposal should at least allow settlement per ISP (in ISP price times ISP volume). Proposing OC pricing as a European requirement for pricing would require TSOs to harmonize volume determination further than what is required in the EB regulation.

Aside from this, OC pricing is also fails to achieve the requirements of Article 44 which deals with the general requirements on the settlement processes. As shown before in OC pricing the requirement from Article 44(1)(f) on distorting incentives on BSPs to offer and deliver balancing services are not avoided. Proposed (partial) mitigation of this problem by establishing an average imbalance price is contrary to Article 44(1)(a), (b) and (c), as the incentives on BRPs are reduced, the imbalance price does not reflect the real-time value of energy, and the corresponding signals cannot be given to the market at the right time allowing them to help the system to restore its balance. Providing market participants with the right incentives through settlement (and not

penalisation) is also required by Article 30(1)(d). For these reasons, OC pricing is also considered not to be in line with nor achieving the requirements of article 44 of the EB Regulation.

5 Conclusion

The results from the analysis are summarised in the table below. Introducing OC pricing for TSO-BSP settlement has a large number of detrimental effects that do not outweigh the slightly increased complexity of the application of cross-border marginal pricing per ISP. Lack of compliancy with EB Regulation by itself is sufficient for the OC pricing method not to be acceptable.

Evaluation criterion	**ISP Pricing**	**OC pricing**
Risk for mark-ups by BSPs	limited risk for mark-ups from pricing method as a clear and direct benefit from marking up will not materialize for inframarginal bids	Mark-ups due to pricing method expected as high frequency of the auction makes profit maximisation can be tested by all inframarginal BSPs.
Link between balancing energy and imbalance price	Balancing energy price and imbalance price can be made equal most of the time as prices can be made equal as a rule	Differences between balancing energy price and imbalance price are always present as averaging over an ISP or taking a single OC price is necessary
Relationship with congestion situation	More complexity in determination of uncongested area although separation of positive and negative BE MOLs would reduce this significantly	No concerns
Incentives on BSPs	In case of marginal imbalance pricing without additional components, incentives to provide bids and deliver are not distorted by the pricing method	Pricing method distorts incentives to offer and, depending on choice of imbalance price, to deliver on bids
EB Regulation objectives and requirements	Achieving the objectives and requirements and not requiring more harmonisation than allowed and providing room for national choices.	Not reaching objectives and requirements and going beyond minimum requirements following from the regulation

In case there are concerns in specific areas, for instance where the markets have not fully matured or lack competition or correct incentives on BRPs, that specific high prices are not reflective of the actual scarcity in the system, this issue should be addressed separately through *ex ante* monitoring of bidding behaviour. Attempting to better reflect the value of energy by reducing the impact of these high prices affects scarcity related signals negatively and functions mainly to reduce the BSP surplus without correctly taking into account the value of energy. Rather, the causes of these price peaks should be investigated and it should first be determined if indeed they do not reflect the scarcity situation. If this is not the case the cause most probably lies

with incorrect incentives between balancing energy and imbalance settlement[18]. Equalisation of prices could be a more effective measure to combat the high prices on the MOL than reducing the producer surplus of BSPs because the OC price should reflect the marginal cost every second rather than the real time value of energy over an ISP.

In a well-designed market with correct and consistent incentives on market participants the existence of price peaks in itself can serve to attract new participants, thereby lowering prices. In determining which pricing method to apply for balancing energy in the European markets, in general it should be considered that bid prices and merit order lists are not static and are affected by the market design both in the short and longer term.

[18] High bid prices in the Netherlands only occurred in the first week of the introduction – before the first imbalance settlement bills were sent. Equalisation of BE and imbalance prices has disciplined both BSPs and BRPs ever since.

Annex I: European balancing market design

The EB regulation describes a number of design aspects which together have the objective to provide a consistent market design with balancing energy markets & imbalance settlement that achieves the objectives from the EB Regulation. Below the design aspects set by the EB regulation or following from its (proposed) methodologies are listed.

Balancing energy bidding and activation:

- Balancing energy products are provided as balancing energy bids.
- Bids become firm after the BE GCT which is close to real time delivery
- No caps and floors to balancing energy bid prices.
- Balancing energy bids are per ISP and per activation direction.
- Common MOL is separated per direction and per ISP/validity period (dynamic MOL).
- Bids are activated in merit order according to bid price.

Pricing and settlement of balancing energy:

- Implementation of reserve replacement process is optional for TSOs but EU wide rules on balancing energy and imbalance pricing.
- Pricing and settlement of balancing energy is “at least” per ISP
- Balancing energy is settled per direction, positive (relative injection) respectively negative (relative withdrawal).
- Balancing energy in the same direction and in the same ISP is settled at the *same* marginal price; this represent the real time value of balancing energy, expressed by the bid price of the marginally activated bid in that ISP.
- TSOs publish close to real time information on system balance and estimated balancing energy and imbalance prices

Pricing and settlement of imbalance:

- The ISP is set to 15 minutes by 2025
- No exemptions to balance responsibility; no differentiation between BRPs.
- BRPs position per ISP equal to sum of external and internal commercial trade schedules
- BRPs may change their internal commercial trade schedules after ISP of delivery, where allowed.
- The volume of adjustment to an imbalance of a BRP is either the requested balancing energy or metered balancing energy per ISP from activated bids assigned to that BRP.
- Imbalance prices are at least equal to the weighted average price of FRR and RR (where applicable) price of balancing energy. In case no balancing energy is activated the imbalance price is equal to the value of avoided activation
- In general, single pricing is applied, with dual pricing allowed for specific cases – as defined in the Imbalance Settlement Harmonisation Proposal - in which it is unclear whether the system is long or short, and/or balancing energy is activated in both directions.