Recommended Values for I-SEM Imbalance Settlement Parameters

Report to the Regulatory Authorities

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1. SEMC Policy and Trading & Settlement Code Obligations

1.1 Overview of the SEM

The I-SEM arrangements place a large focus on "Balance Responsibility". This can be seen in two regards. One is responsibility for being in balance with the energy which they have traded in the ex-ante markets to buy or sell. This is done through the signals in the Imbalance Settlement Price, and the fact that all Participants are financially responsible for the differences between their trade volumes (in terms of Trading and Settlement Code terminology, the Ex-Ante Quantity, QEX) and their actual consumption or generation (the Metered Quantity, QM) through the imbalance settlement arrangements (the Imbalance Component Charge or Payment, CIMB).

Another aspect of balance responsibility, specific to generators, is generating in accordance with the dispatch instructions issued by the System Operators (SOs). In addition to the reasons for generating in accordance with dispatch instructions outlined elsewhere, this is an important requirement because, from a system security standpoint, under or over generation is undesirable as it can result in ramping, and stopping units unnecessarily increasing the potential for possible for unit trips and or wear on units. When units start, stop and ramp, the potential for wear, damage and unit trips increases significantly over steady state operation.

This is done through additional signals – the Uninstructed Imbalance Charges – which incentivise Participants to generate in a way which matches the instructions given by the SOs. The mechanism accounts for units matching instructions in accordance with the technical characteristics submitted by the Participant, as doing otherwise would incur a charge which reduces the revenue they receive (in cases of over generation) and increases the revenue they pay (in cases of under generation). This signal takes into account deviations for reasons of automatic frequency control which would not be reflected in dispatch instructions, setting tolerances which reflect the capability of units to carry out this control so that any deviations within those tolerances do not incur these additional charges.

All dispatchable generation is required to follow instructions from the control centres within practical limits to ensure the safe and secure operation of the power system. Failure to do so will lead to increased constraint costs as the SOs would be required to redispatch other generation at short notice to account for the mismatch in actual and instructed generation and could, at worst, lead to system blackout. Thus, economic signals to ensure that dispatchable generation follows instructions within acceptable practical limits are required. In the SEM, and also in the I-SEM, the Uninstructed Imbalance mechanism, as set out in the Trading and Settlement Code, provides such signals.

The Uninstructed Imbalance mechanism should provide economic signals that:

- are sufficient to ensure generators follow dispatch instructions;
- are cost related – where possible;
- are not unreasonably punitive; and
- avoid perverse incentives.

A generator's output will vary in response to fluctuations in the system frequency (known as frequency regulation). Under the Grid Code, each generator must be fitted with a governor or control device to provide this frequency regulation under normal operating conditions. The generating units on the island of Ireland normally have a governor droop setting of 4%. The coordination of droop settings ensures that generators share the requirement for regulation in proportion to their size. As a result of governor action, uninstructed imbalances will arise under the current rules of the Single Electricity Market (SEM). To recognise that frequency regulation is correct behaviour, the uninstructed imbalance calculations in SEM adjust the tolerance band around the dispatch quantity, with the intention that the more punitive penalties outside of the tolerance band do should not apply to imbalances that arise as a result of frequency regulation.

The I-SEM ETA Markets Decision (SEM-15-065) which stated that Physical Notifications (PNs) submitted for a period should be: "the Participant's best estimate of its intended level of generation and/or consumption, reflecting its intended metered quantities (excluding any accepted offers and bids) and technical characteristics, given also the requirement that the metered quantities (excluding any accepted offers and bids) reflect also the ex-ante contract position at gate closure". In order to incentivise this, the decision introduces an Information Imbalance Charge, which is a charge that can be levied on particular periods during the Trading Day where a Participant can update their PNs to incentivise Participants to submit PNs throughout the day which most accurately reflect their final intended running (their FPNs).

1.2 Parameters for Imbalance Settlement Calcualtions

Under section F.9.1 of Part B of the draft Single Electricity Market Trading and Settlement Code (referred to as "the Code"), the SOs are required to report to the Regulatory Authorities proposing parameters to be used in the calculations of Uninstructed Imbalance Quantities and Charges at least four months before the start of the Trading Year if requested by the Regulatory Authorities. This document provides the SOs' recommendations, and the rationale used in determining the SOs' recommendations, for the following parameters considered under section F.9.1 of the Code:

- Engineering Tolerance;
- MW Tolerance;
- System per Unit Regulation Factor;
- Discount for Over Generation Factor; and
- Premium for Under Generation Factor.

Under section F.5.1 of Part B of the Code, the Market Operator (MO) is required to report to the Regulatory Authorities proposing parameters to be used in the calculations of Ex-Ante Quantities as required from time to time if requested by the Regulatory Authorities. This document provides the MO's recommendations, and the rationale used in determining the MO's recommendations, for the following parameter considered under section F.5.1 of the Code:

- Imbalance Weighting Factor.

Under paragraph B.19.3.1 of Part B of the Code, the MO is required to report to the Regulatory Authorities proposing parameters to be used in determining the occurrence of Settlement Reruns as required from time to time. This document provides the methodologies to be used in determining the MO's proposals for the following parameter considered under paragraph B.19.3.1 of the Code:

- Settlement Recalculation Threshold.

Under section F.10.1 of Part B of the Code, the SOs are required to report to the Regulatory Authorities proposing parameters to be used in the calculation of Information Imbalance Charges at least four months before the start of the Trading Year if requested by the Regulatory Authorities. This document provides the SOs' recommendations, and the rationale used in determining the SOs' recommendations, for the following parameters considered under section F.10.1 of the Code:

- Information Imbalance Price;
- Information Imbalance Quantity Weighting Factor; and
- Information Imbalance Tolerance.

In all cases, any changes in context between the SEM and I-SEM arrangements were considered in developing these recommendations.

Where no change to the current values was suggested through the analysis and consideration of a parameter, it has been recommended in this report that the previous value used in the SEM should be maintained until such a time as any further analysis or considerations of new context indicate otherwise. This was the case with the MW Tolerance, Engineering Tolerance, System per Unit Regulation Factor, Discount for Over Generation and Premium for Under Generation parameters. Previous detailed design decisions have also outlined the initial values for certain parameters in the I-SEM, and where this was the case the values outlined in the decisions were recommended without further consideration or analysis. This was the case with the Information Imbalance Price, Information Imbalance Tolerance, and the Information Imbalance Quantity Weighting Factor parameters. Where analysis and considerations has identified that a parameter is new and needs consideration of the values to be recommended, the rationale for these recommendations has been outlined. This was the case with the Imbalance Weighting Factor.

2. MW Tolerance and Engineering Tolerance

2.1 Background

In operation, even at constant steady state frequency, a Generator Unit instructed to a given MW value is unlikely to be able to maintain its output at exactly the dispatched MW level for any period of time. This may be due to tolerances in machine design, precision of measurements, the provision of reactive power, varying instantaneous calorific quality of fuel input and deviations in general thermodynamic conditions. However, over a period of time the average output of the Generator Unit should be manageable within a small tolerance within which a Generator Unit should be deemed to be complying with its Dispatch Instruction.

Two parameters are used to create tolerance between the Dispatch Quantity of a Generator Unit, and the Metered Quantity of the unit, without accounting for frequency deviations, within which the Generator Unit is deemed to be operating in accordance with its Dispatch Instruction. At nominal system frequency, the tolerance band which is used in the calculation of Uninstructed Imbalances is the maximum of:

- the Engineering Tolerance, known as TOLENG in the Trading and Settlement Code (where $0 \leq TOLENG \leq 1$) multiplied by the Dispatch Quantity; and
- the MW Tolerance for each Trading Day, known as $TOLMW_t$ in the Trading and Settlement Code (where $0 \leq TOLMW_t$).

These parameters should be set to values which represents a tradeoff between being sufficiently high and sufficiently low that it:

- Does not result in Uninstructed Imbalance Charges for typical imbalances resulting from the normal operation of a generator to match a dispatch instruction which do not have an impact on system costs;
- Reflects the increased challenges in maintaining frequency control for the Irish and Northern Irish systems over large interconnected systems, and therefore the increased importance for generators to follow Dispatch Instructions.
- Reflects the impact of being in imbalance by that amount on system security and system costs;
- Allows for the Engineering Tolerance to differentiate the between the impacts of units dispatched to a larger output versus units dispatched to a smaller level of output (i.e. not having a MW Tolerance so large or Engineering Tolerance so small that the Engineering Tolerance is never used);
- Accounts for the cost reflectiveness of the impact of imbalances, acknowledging that there may typically be small imbalances through the normal operation of a generator to meet an instructed output level which are not directly related to frequency response;

- Is not such a large value that it removes completely the incentive to generate close to an instructed output level from those Generator Units with a small registered capacity;
- Is large enough that those imbalances which have negligible cost-based impact on system actions are ignored in the calculation of Uninstructed Imbalance Charges.

2.2 Considerations

The MW Tolerance for a Trading Day, t, representing a minimum tolerance used in calculating Tolerance Bands for Uninstructed Imbalance Charges within which a Generator Unit is deemed to be complying with its Dispatch Instruction, before consideration of frequency response. The value for this parameter is dependent on a number of factors including the size of the power system, the settlement mechanism for the deviation, the timeframe across which the deviation is calculated and the prices applicable for deviation outside of the tolerance band.

A value of 1 MW has been used for the MW Tolerance in the SEM to date and was also applied in the settlement of the electricity market in Ireland prior to the start of the SEM.

The Trading and Settlement Code allows the MW Tolerance parameter value to vary on a Trading Day basis. The reasons for having a value per Trading Day could include the need to have tighter control / smaller tolerances on deviations from instructed output levels for different system conditions, such as periods where the system margin is tighter around the winter peak. The introduction of a value per Trading Day would need to be based on forecasting the conditions which drive the incentive to generate close to the instructed output level. Since the exact information would not be known a year in advance, and there may be changes to information over time (such as changing timings of outages) this forecast would need to be quite general, perhaps considering general trends in seasonal differences as opposed to the impacts on individual days. Even with this general parameter, there would be a strong possibility that the forecasts don't align with the actual conditions on the day. There are also other mechanisms in place which incentivise generating to instructed levels in conditions where greater control would be considered needed, such as the Capacity Market Difference Charge arrangements.

Therefore, although the Trading and Settlement Code allows the MW Tolerance parameter value to vary, the SOs are of the opinion that there are insufficient benefits to justify introducing a varying value, which would increase the complexity of the Uninstructed Imbalance mechanism.

When the system frequency deviates from the Nominal System Frequency, it is expected that Generator Units vary their output to compensate – this is known as frequency regulation. The relationship between frequency and the output response of units acting under frequency regulation on the Uninstructed Imbalance mechanism is addressed through the System per Unit Regulation Factor (FUREG). However the Engineering Tolerance parameter recognises that the governor response of a unit is related to the level of generation output of that unit. A unit with a larger generation output could respond by a greater absolute MW amount to frequency events than a unit with a smaller generation output, which needs to be taken into account in determining the tolerances for allowed deviations from dispatched positions. A percentage value of the generation output level to which the unit was dispatched, represented by the Dispatch Quantity, QD, would represent this. A value of 1% has been used for the Engineering Tolerance in the SEM to date.

2.3 Recommendation

These parameters are largely based on fundamentals of the power system, such as the average size of the units in the market, the overall size of the market, and the operation of units to meet dispatch instructions, and these fundamentals are not changing with the change in the market arrangements. Therefore it is proposed that the values for MW Tolerance and Engineering Tolerance are retained from go-live of the I-SEM at 1MW and 0.01 (representing 1%) respectively. The SOs believe that this minimum tolerance band continues to be reflective of the acceptable practical limits within which dispatchable generation is required to follow its instructions.

3. System per Unit Regulation Factor

3.1 Background

The System per Unit Regulation Factor (known as FUREG in the Trading and Settlement Code) is the parameter reflecting the automatic response of a generating unit, due to their governor droop settings, to variations in the system frequency which is used to calculate the Tolerance for Over Generation and the Tolerance for Under Generation for use in the calculation of Uninstructed Imbalance Charges.

3.2 Considerations

In the past, the SOs proposed that UREG be set at 0.04 based on an assumption that all generating units typically have a 4% speed droop. This assumption is based on Grid Code requirements for governor/droop operating characteristics. The EirGrid Grid Code states that Generator Units must be able to provide Frequency response using governor control systems (CC.7.3.7). This states that it must be operated to European Standards, and will normally be operated with regulation (i.e. with a droop speed characteristic) between 3% and 5%. The SONI Grid Code states that Generator Units must similarly be able to provide Frequency Control using governor controls systems (CC.S1.1.5.2, CC.S2.2.4.2). For gas turbine Generating Units the nominal droop operating characteristic must be 4%. The European regulation for Requirements for Grid Connection of Generators (EU 2016/631) states that droop shall be specified by the SOs (Article 13(2)(a), Article 15(2)(c)(i)), and that the settings shall be in the range of 2-12% (Article 13(2)(d), Article 15(2)(c)(i)). Therefore there is no signal from integrating with the European arrangements requiring a change in droop operating characteristics for Ireland or Northern Ireland.

3.3 Recommendation

Since the Grid Code provisions relating to values of governor settings in normal operation have not changed, and a single value of FUREG is required, it is proposed that a value of 0.04 (representing 4%) is maintained from go-live of the I-SEM.

4. Discount for Over Generation Factor and Premium for Under Generation Factor

4.1 Background

The Discount for Over Generation Factor for each Generator Unit in each Imbalance Settlement Period (known as $FDOG_{u\gamma}$ in the Trading and Settlement Code) and the Premium for Under Generation for each Generator Unit in each Imbalance Settlement Period (known as $FPUG_{u\gamma}$ in the Trading and Settlement Code) are the parameters which form the basis for the Uninstructed Imbalance Charges. The basis for the charges is a fraction of the price at which the unit would be settled for the volume which was outside of the tolerance band around their instructed dispatch level. The Discount for Over Generation and the Premium for Under Generator Factors are the fractions which are applied to the price to determine the additional adjustment for this volume. The fraction of the price chosen should be set such that it acts as a clear economic signal to be balance responsible with respect to matching physical generation with instructed generation, while being cost reflective to the extent possible.

This application of Uninstructed Imbalances is different between the SEM and the I-SEM arrangements. In the SEM, all cash flow for imbalances which were not caused by SO instructions are handled through payments for Uninstructed Imbalances. The price at which these payments are made is adjusted (reduced for payments to the generator from the market, increased for payments from the generator to the market) as part of that process. Therefore this can result in a positive or a negative amount to the Participant. In the I-SEM, all cash flow for imbalances, including the Imbalance Settlement Price aspect of those caused by SO instructions, are handled through the Imbalance Component Payment or Charge, the Premium Component Payment, and the Discount Component Payment. Under these arrangements there is a separate Uninstructed Imbalance Charge which acts as an “adjustment” charge which applies the FPUG and FDOG to the price at which the volume outside of tolerance was settled. When considering net settlement across all settlement amounts, the net price the unit receives or pays for the volume outside of tolerance reflects the adjustment by FDOG or FPUG. Therefore the Uninstructed Imbalance Charge will always be a negative amount.

4.2 Considerations

Over generation outside of tolerance by a market Participant results in the need to instruct other market Participants from their dispatched levels to lower levels in order to balance system resources. The Participants dispatched downward will be at generation cost that is lower than the SMP. Similarly, under generation outside of tolerance by a market Participant results in the need to instruct other market Participants from their dispatched levels to higher levels or may even result in starting additional units in order to balance system resources. The Participants dispatched upwards or on will be at generation cost that is higher than the SMP. The economic signal to date has been based on the following principles, established during the initial analysis for the determination of values for these parameters (AIP-SEM-07-430):

- A Generator Unit that over-generates should be entitled to no more than the average costs of the resources dispatched down to displace the over-generated volumes; and
- A Generator Unit that under-generates should, generally speaking, pay back at least the average costs of the resources dispatched up and on to replace the under-generated volumes.

On the basis of this principle, analysis could be carried out which determines, based on historic data:

- The average price considering the cost of units dispatched up or on, under the assumption that they would be at a generation cost which is greater than the cost would be at average Imbalance Settlement Price;
- By comparing average Imbalance Settlement Price with the average price considering the cost of units constrained up, determine a fraction which could be used in an Uninstructed Imbalance Charge for under generation to ensure that the net settlement of the unit results in them paying an amount which reflects the cost of resources dispatched up or on for the volume outside of tolerance;
- The average price considering the cost of units dispatched down or off, under the assumption that they would be at a generation cost which is less than the cost would be at average Imbalance Settlement Price; and
- By comparing average Imbalance Settlement Price with the average price considering the cost of units dispatched down or off, determine a fraction which could be used in an Uninstructed Imbalance Charge for over generation to ensure that the net settlement of the unit results in them being paid amount which reflects the cost of resources dispatched down or off for the volume outside of tolerance.
- In the methodology, the average price of generating reflecting the costs of all units is calculated based on the average running prices of each unit and also the average running volume of the unit, rather than just purely calculating the average running prices over all units. This is important, as it removes those units with high running costs but which were not dispatched on in reality, i.e. it removes the potential of units which were not dispatched influencing the average price of generating over all units, which would not be an accurate reflection of the cost reflectivity of generation costs. This approach weights the average price of generating towards those units which are more regularly dispatched, being more reflective of the actual average costs of dispatch.

This analysis approach is outlined in in previous papers proposing values for the Discount for Over Generation and Premium for Under Generation, in particular the original paper proposing values for such parameters (AIP-SEM-07-440). There are differences between the structures of the SEM and the I-SEM which would need to be incorporated into such an approach.

Because Accepted Offers and Accepted Bids are increases or decreases respectively in generation with regard to the Final Physical Notification Quantity (qFPN) of a unit as opposed to the previous generation level of the unit, dispatching down a generator may not be the acceptance of a bid in practice – it may be the reduction in acceptance of an offer. Therefore it may be a simplification to assume that Decremental Price Quantity Pairs only should be used in the analysis for determining a value for the Discount for Over Generation Factor (as over generation results in the need to dispatch a unit down or off), and that Incremental Price Quantity Pairs only should be used in the analysis for the Premium for Under Generation Factor (as under generation results in the need to dispatch a unit up or on). However it may be an appropriate assumption to make, given that the purpose of allowing Decremental prices to be submitted differently to Incremental prices is to allow Participants to reflect the fact that generating costs when decreasing output may be different to generating costs when increasing output over the same output range. This would mean that in applying this methodology, Decremental Prices would be compared with the Imbalance Settlement Price for determining the FDOG, and Incremental Price would be compared with the Imbalance Settlement Price for determining the FPUG.

In the current SEM arrangements, Participants can submit a single set of COD, including a single set of Price Quantity Pairs, applicable for all relevant periods in a Trading Day (i.e. for the Ex-ante 1 and Ex-ante 2, EA1 and EA2, Gate Closures the whole Trading Day is applicable, and for the Within-day 1, WD1, Gate Closure half the Trading Day is applicable). In the I-SEM arrangements, Participants can submit multiple types of sets of COD, including Complex and Simple COD, the variable component of which can comprise separate Incremental and Decremental Price Quantity Pairs, and which can be updated multiple times within-day so that multiple sets of COD are applicable for a Trading Day. Therefore if analysis using I-SEM data were to be carried out, it would need to consider the Incremental and Decremental Price Quantity Pairs for both Simple and Complex Bid Offer Data, taking only the data which was active at the final Gate Closure Time for that Imbalance Settlement Period.

It may not be appropriate to use analysis of historical data as the basis for determining these factors, as they rely on a comparison of the market price and the offer prices. In the I-SEM arrangements, the basis for calculating the market price (the Imbalance Settlement Price) is very different to the basis for calculating the System Marginal Price (SMP) in the SEM. Also the basis for the offer prices submitted by Participants is very different, in that the Imbalance Settlement Price would largely be determined by Simple Bid Offer Data with prices which would not have bidding controls applied to them, and the prices used in constraining units up or down would be a mixture of Complex Bid Offer Data (to which bidding controls will apply) and these Simple Bid Offer Data.

It would be possible, with operational data, to carry out an analysis which would more accurately determine the average price of constraining up or down units relative to the average Imbalance Settlement Price, and therefore determine the adjustment factors (FPUG and FDOG) which could apply to uninstructed imbalance charges to ensure those units with uninstructed imbalances outside of tolerance receive or pay the constrained costs rather than their average costs. However, in the absence of operational data, it may be more appropriate to retain the current signals. There has been operational experience to date of these signals being sufficient to create the desired incentives, and as the primary drivers for these incentives remain the same in the I-SEM (i.e. ensuring Technical Offer Data for dispatch instructions can be accurately matched in generation; keeping generation close, within a tolerance, to the instructed level), the current values would be sufficient to maintain the incentives in the I-SEM. Once more operational experience of the I-SEM has been gained, it may be possible to tweak these values to reflect the other drivers of the incentive, primarily the average price of constraining up or down generation which represents the costs of dispatching units out of merit, and the average Imbalance Settlement Price which represents the costs of dispatching units in merit.

The parameters may differentiate between different units and different Imbalance Settlement Periods. To date, the only differentiation which has been made has been for Interconnectors under test, where the Interconnector Error Unit has historically been designated a value of zero for FPUG and FDOG. This is because the market design has not provided for an interconnector test profile to be submitted, and in the absence of the unit's test profile being considered by the market systems as it would be for Generator Units, it would be unduly penal to apply discounts and premiums for imbalances arising from the unit following flows required for testing. This has been previously described in the SOs' published paper SEM-12-001a. This situation remains under the I-SEM design: Generator Units can submit a test profile through their PN Data, but the PN Data for interconnectors is created by the SOs to reflect the flows scheduled in the ex-ante markets and therefore do not consider test profiles. Therefore it is recommended that this treatment is maintained in the I-SEM.

4.3 Recommendation

In the absence of operational data, it may be most appropriate to retain the current signals. Therefore it is recommended from go-live of the I-SEM that a value of 0.2 is used for both $FPUG_{u\gamma}$ and $FDOG_{u\gamma}$ for all situations, with the exception of Interconnectors under test, in which case the value for these parameters for the relevant Interconnector Error Unit should be 0.

5. Imbalance Weighting Factor

5.1 Background

The Imbalance Weighting Factor for each Imbalance Settlement Period (known as $WFPIMB_{\gamma}$ in the Trading and Settlement Code) is a parameter which is used under one of the two approaches for the calculation of the Ex-Ante Quantity (QEX) of each unit. One approach, which will be active for go-live of the I-SEM, settles on the basis of the Imbalance Settlement Price in each individual Imbalance Settlement Period. It does not use this parameter. An alternative approach is also outlined in the Trading and Settlement Code, which settles on the basis of a weighted average of the Imbalance Settlement Prices over the period chosen. It does use this parameter. The parameter is used to result in a weighted average Imbalance Settlement Price which is most representative of the prices over the period of averaging and results in the most efficient balancing price signal.

The Ex-Ante Quantity calculation approach expected to be active for go-live of the I-SEM does not require the Imbalance Weighting Factor parameter. It would divide evenly into each relevant Imbalance Settlement Period any ex-ante market trade quantity with a Trading Period Duration greater than the Imbalance Settlement Period Duration. This is on the basis that there will be ex-ante market products with a Trading Period Duration equal to the Imbalance Settlement Period Duration available, in particular in the intraday market, which Participants can use to adjust their ex-ante position to ensure they are balanced against their Metered Quantity in each half-hour Imbalance Settlement Period. In the Trading and Settlement Code rules, this approach is used on the basis that the Aggregated Settlement Period and the Imbalance Settlement Period are both equal to 0.5 hours.

The alternative approach for calculating the Ex-Ante Quantity, which requires the Imbalance Weighting Factor parameter, can be introduced if required due to a change in circumstances, such as no longer having products of the same granularity as the Imbalance Settlement Period available. Under this approach, the total position from ex-ante market products with Trading Period Durations greater than the Imbalance Settlement Period, and the total metered quantity over the Trading Period Duration, are used to calculate the total imbalance over the Trading Period. This imbalance is then used to calculate Ex-Ante Quantities for each Imbalance Settlement Period which would reflect the imbalance over the Trading Period.

5.2 Considerations

For go-live, the timings to be considered would be half hour Imbalance Settlement Periods, and hourly Trading Periods for ex-ante market products, although the approach in the rules is generalised for different combinations of periods. Taking these timings, the alternative approach profiles the hourly imbalance into each half hour, and combines this with the metered quantity to calculate the ex-ante quantity in that half hour. Using these Ex-Ante Quantities should result in calculating imbalance cash flows with the imbalance quantities times the Imbalance Settlement Prices in each half hour which are equivalent to calculating imbalance cash flows with the hourly imbalance times the hourly (weighted) average of the Imbalance Settlement Prices. For example, if a unit was not in balance in each individual half-hour, but was in balance over the whole hour, the ex-ante quantity would be calculated such that it is equal to the metered quantity in each period, and the unit would be seen as being in balance in each half hour.

The profiling of these imbalances from the hour level into each half hour is the component of the approach which uses the Imbalance Weighting Factor parameter. It can be thought of as equivalent to settling the total imbalance over the hour at the average of the Imbalance Settlement Prices in each of the half hours. Therefore the Imbalance Weighting Factors, while weighting imbalance quantities, could be thought of as the weighting of the average Imbalance Settlement Price to be applied.

In the Trading and Settlement Code rules, this approach could be enacted through changing the Aggregated Settlement Period to equal 1 hour. In their I-SEM ETA Markets Decision paper the SEMC stated that this functionality would not be used in the event that there is a route for Participants to manage their exposure to imbalance prices through the ex-ante markets. On the basis that half hourly products will be available in the intraday market for go-live of the I-SEM, this functionality will not be used unless a decision is taken in the future to do so based on changes in circumstances.

5.2.1 Evaluation Methods, Criteria and Metrics

Despite the approach which will be active for go-live of the I-SEM not needing this weighting factor, the rationale for the establishment of this parameter should be explored, in order to ensure the process of introducing the alternative approach is as seamless as possible should it be required.

The metrics to consider in developing the value / source for this parameter include the following:

- How easy it would be to forecast the Imbalance Settlement Prices / Ex-ante Quantities arising in settlement;
- How reflective the resulting average Imbalance Settlement Price is of the real-time cost of balancing the system and the other market signals;
- Whether any of the approaches systemically distort the price, i.e. dampening the effects of scarcity, reducing the volatility in the half hourly prices, whether these effects are beneficial or not, etc.;
- Whether any of the approaches systemically benefit different Participant types, i.e. if the weighting of their ex-ante quantities tends to match with ramping profiles over the hour (either in terms of generator ramping between two half hours, or increasing/decreasing customer consumption between adjacent half hours), such that it is beneficial (e.g. if a unit has an imbalance over the hour, it systemically appears in the period with the more beneficial settlement outcome, i.e. the larger imbalance volume in the period with the largest price if the volume is positive and therefore a payment, the smaller

imbalance volume in the period with the largest price if the volume is negative and therefore a charge);

- If the approach results in imbalance cash flows which are reflective of the periods in which an uninstructed imbalance occurs. For example, if a unit was balanced over an hour in comparing their FPNs with their Ex-Ante Market trades, but they were out of balance by virtue of their metering by more in one period than in another, the relationship between the actual half-hour imbalances and the weighting of hourly imbalance volumes into each half hour could be an assessment for comparing different options.

An important consideration in deciding between different options is what the weighting is intended to prioritise. This could include:

- Prioritising imbalances appearing in the period with the largest price (i.e. to have an average price which is consistently weighted towards the period with the highest price. This could be done through a simple average, or the influence of the larger price on the average could be strengthened through a weighting factor which consistently coincides with the larger price period. This would result in maximising the payments to those Participants who have positive imbalances, and maximising the charges to those Participants who have negative imbalances);
- Prioritising imbalances appearing in the period with the smallest price (i.e. to minimise the charges on those Participants who have negative imbalances, but also resulting in minimising the payments to those Participants who have positive imbalances);
- Prioritising imbalances appearing in periods where demand is largest, on the basis that as demand increases the scarcity on the system increases (i.e. the generation margin on the system decreases), and therefore the price in the period with higher demand is a better signal for balance responsibility as it is more representative of the value of balancing energy during times of scarcity;
- Prioritising imbalances appearing in periods where net imbalances are highest and therefore reflecting the impact of overall cash flow in the weighting of the average price as opposed to purely the magnitude of the prices in each period (for example there could be high price event in a period where imbalances were low – this approach would dampen the impact of the high price on the average price reflecting the fact that units were generally balance responsible in that period, resulting in a low Net Imbalance Volume).

5.2.2 Options for Parameter Values

Examples of potential values (or sources of values) to consider for the Imbalance Weighting Factor include:

- A value of 1 to result in a simple, unweighted average;

- The total system demand in each Imbalance Settlement Period. With the data available in the settlement systems, this can be represented by the sum of the Loss-Adjusted Metered Quantities of all Supplier Units in an Imbalance Settlement Period ($\left|\sum_v QMLF_{v\gamma}\right|$). Forecasts of system demand are published by the SOs.
    - Despite always reflecting the same sign convention in each period, the absolute value of this sum should be used to ensure there are no unintended effects from introducing negative quantities into the settlement equations.
- The Net Imbalance Volume Quantity in each Imbalance Settlement Period. With the data available in the settlement systems, this can be represented by $\left|QNIV_\gamma\right|$ which is a value published by the MO after the Imbalance Settlement Period representing the average of the Net Imbalance Volumes calculated for each Imbalance Pricing Period in the Imbalance Settlement Period. The MO will also be publishing a forecast of the Net Imbalance Volume at an Imbalance Settlement Period granularity.
    - The absolute value of the variable should be used, as using the actual values could result in very odd outcomes, for example where the total imbalance over the aggregated settlement period is close to zero due to imbalances of different sign in different imbalance periods. Using the signed values could result in the “divide by zero” problem in the equation – where the weighting factors considered in each half hour are equal but opposite in sign it would lead to an infeasible result. This could also result in cases where the ex-ante quantities in each half hour do not reflect the sign of the hourly traded quantity being divided into each period, for example a positive trade of +100MWh compared with a Metered Quantity of +105MWh could result in a split of imbalance of -250MWh in one period and +245MWh in the following period to result in the -5MWh imbalance if the signs of the Net Imbalance Volume Quantities were almost equal but opposite in those periods (in the example given, period 1 being +50MWh, period 2 being -49MWh).
- The Imbalance Settlement Price in each Imbalance Settlement Period With the data available in the settlement systems, this can be represented by $\left|PIMB_\gamma\right|$. As a forecast of this price would not be centrally published, this variable would be a major concentration of forecasting effort for most Participants.
    - Again the absolute value of the variable should be used to avoid the “divide by zero” problem and other problems associated with potentially opposite signs appearing. This could be seen as weighting the effective average Imbalance Settlement Price by the price in each period itself, thereby strengthening the influence of the larger price in the average.

The options considered are common across all units, for example using system-wide metrics such as the Net Imbalance Volume Quantity or System Demand.

5.2.3 Assessment of Options

The Imbalance Settlement Price is an important signal for incentivising balance responsibility, and therefore it is important that any average effective Imbalance Settlement Price (such as that over an hour in the functionality which uses these weighting factors) reflects the signals provided in each of the Imbalance Settlement Prices used to calculate the average.

Some of the weighting factors considered could strengthen the signal to be prioritised. For example, in the event of system stress, system demand will tend to be high rather than low, and hence a system demand weighted average would be likely to dampen the price less, not more, than a simple average. In this case an average weighted by system demand is likely to be more representative of prices over the period of averaging.

It may be possible with operational data to determine if there is some relationship between the weighting factors and the actual half-hourly imbalance. An example of such an assessment could include analysing past Imbalance Settlement Prices, what the effective average Imbalance Settlement Price would have been under each of the options of averaging considered, comparing these with different metrics such as the Net Imbalance Volume in each period, followed by a subjective assessment about which option most correctly reflects the costs of balancing and the signals desired to incentivise balance responsibility.

However before the go-live of the I-SEM, there is no operational experience to use in assessing which metric best reflects the cost of balancing over a half hour or over an hour. For example, options are put forward which may make logical sense, i.e. that the cost of balancing in a half hour (reflected through the Imbalance Settlement Price in that half hour) may be a function of the Net Imbalance Volume in that half hour or a function of the Demand in that half hour. However there is currently no means by which to assess which has the closest relationship to reflecting the value of balancing in that half hour.

Implementing an approach where there is no relationship between the weighting factor for an Imbalance Settlement Period and the signal to be prioritised in the Imbalance Settlement Price should not be pursued. Take, for example, if the signal to be prioritised was the magnitude of the larger Imbalance Settlement Price in the periods averaged, and that Net Imbalance Volume had no relationship with this signal (as stated before, it is not yet possible to determine this relationship, this scenario is presented for descriptive purposes only). While it may result in an average Imbalance Settlement Price which is more reflective of the cost of balancing in those periods where the larger NIV occurs in the same period as the larger of the weighting factors, it would result in the opposite when the larger actual half-hourly imbalance occurs in the same period as the smaller of the weighting factors. Having no weighting may be preferable, because while it would potentially dampen the signal which would be strengthened in periods where a weighting factor coincides with the unit being in imbalance, it would not dampen the signal in periods where a weighting factor does not coincide with the period in imbalance by as much as the weighting factor approach does. A weighting factor with a weak, or no, relationship to the desired signal could be a bigger distortion due to the times it creates the “incorrect” prioritising of signals in the average price.

In the absence of operational data to carry out such analysis, the only metric which would be guaranteed to maintain in the average price the relationship with an important market signal, that being the magnitude of the Imbalance Settlement Price in each Imbalance Settlement Period, is the Imbalance Settlement Price itself. This would point to either a simple average, or an average weighted by the Imbalance Settlement Price, as being potentially appropriate for this functionality.

Although it may appear odd to have the Imbalance Settlement Price as a weighting factor, as it would be the equivalent to calculating the weighted average Imbalance Settlement Price with the prices themselves as the weighting, there may be merit in considering it. The Imbalance Settlement Price is an important signal for balance responsibility as it indicates the cost of balancing the energy on the system in a period. Therefore it reflects much of the fundamentals of the market, and in itself would be somewhat a function of the system demand and the Net Imbalance Volume in the period. Through the fact that Simple Commercial Offer Data (to which no Bidding Code of Practice is expected to apply) would be used in the price setting, the prices may not be just cost-based but also value-based. At the very least it would reflect not only the fuel costs of generating but also the cost of starting the units for the purposes of balancing energy in that period, and would have scarcity signals included through the Administered Scarcity Price. Through a simple average approach, if the magnitude of the prices in both periods are very different, for example one very low and one very high, the signal from the high priced period is dampened more than it would be if an approach of weighting the average by the magnitude of the Imbalance Settlement Price.

This would mean that there would be a strong relationship between the weighting factors and the balancing signal and the market fundamentals. However it could be argued that this weighting causes a bias of higher imbalance charges for those Participants with negative imbalances, albeit it would also have a bias of higher imbalance payments for those Participants with positive imbalances. Similarly, if a variant of the Imbalance Settlement Price were used such that it consistently weighted imbalances into the lower priced period, it would have a bias of lower imbalance charges for those Participants with negative imbalances, but with a bias of lower imbalance payments for those Participants with positive imbalances. Approaches which maximise the payments and charges on Participants could be seen as enhancing the signal for balance responsibility. However, depending on whether Participants would prioritise their payments or their charges for imbalances in their views, either option for this weighting could be seen as less fair than a simple average approach.

Using a value of 1 for the parameters, and therefore resulting in a simple average of the prices, would ensure that the signal of magnitude of the prices would be maintained in the average, albeit the relative magnitude of each could dampen the signal provided by the other. One advantage using a simple average would have over strengthening the signal of higher prices in the average through weighting by the Imbalance Settlement Price would be that correctly forecasting the weighting factor would not rely on the ability of each Participant to correctly forecast the Imbalance Settlement Price for an Imbalance Settlement Period. This could lead to a distortion in the market due to the different trading behaviour of Participants acting on different forecasting assumptions, and therefore having different basis for calculating the forecast of the ex-ante position of their unit in an Imbalance Settlement Period, or the effective average Imbalance Settlement Price for their unit. These forecasted quantities are important for the formulation of subsequent ex-ante market trades and balancing market offers, therefore having different basis for these could lead to distortions in their formulation with knock on impacts for the respective markets.

There may be differences in the inputs to calculating the forecast data for the imbalance weighting factor, and the actual outturn weighting factor which could introduce complexities. For example, if the system demand is calculated on a gross demand basis, but the Metered Quantity of Supplier Units used as the value for this parameter is on a net basis such that some of the volume of demand customers is offset against some generation under that supplier, then the forecast would only be partially representative of the outturn parameter value. This uncertainty could impact on Participant forecasting and therefore create distortions in the trading which relies on this forecasting.

If the alternative approach to calculating the Ex-Ante Quantity which uses this weighting factor were to be implemented despite Imbalance Settlement Period granular products being available in the ex-ante markets, there could be situations where the sum of all ex-ante quantities over the averaging period are equal to the sum of the metered quantities over the averaging period, but there would still be imbalances in each of the Imbalance Settlement Periods. This could arise because the averaging approach is taken on the larger-granularity products, and the Imbalance Settlement Period-granular products are not considered in this averaging approach – they are used to directly hedge against the imbalance in these periods. If this case were to arise, the predictability of the weighting factor would be of extra importance as it could affect the liquidity and effectiveness of trading the half-hourly products:

- If a weighting factor which is not known in advance is used (e.g. actual demand in real-time), a Participant could be trading an Imbalance Settlement Period granular product in the Intraday Market thinking they are reducing their imbalance in that period, but when the volumes are actually calculated they could have caused an imbalance in both Imbalance Settlement Periods through the Intraday Market trade;
- If the most predictable weighting factor was used (one, i.e. even split of the imbalance between the two periods), then it would be possible to know in advance what the imbalance due to larger-granularity products would be so an accurate assessment of the volume which should be traded in the Imbalance Settlement Period-granular product to hedge against this imbalance would be easier to do.

5.3 Recommendation

It is recommended that the value of $WFIMB_{\gamma}$ shall be equal to 1 for all Imbalance Settlement Periods from go-live of the I-SEM, on the basis of the rationale outlined previously, in particular that:

- It would be the easiest to forecast ahead of time, and because there would be no difference between forecast and actual values it would not distort the ability of Participants to forecast their effective Imbalance Settlement Price;
- It would allow for the easiest assessment of the ex-ante position of a generator in each Imbalance Settlement Period while ex-ante trading is still open so that it would not represent an element of uncertainty which would be present from other weighting factors, which could have impeded liquidity;
- There being a lack of operational data to draw conclusions about the relationships between cost reflectivity and different weighting factors;
- It most consistently prioritises weighting the average price towards the higher priced period, maintaining the balancing signal provided by that price; and
- It does not increase the influence of the highest price period in the average such that it could be seen as unfair to those Participants who were balanced in those periods, as could be the case by weighting by the Imbalance Settlement Price itself.

6. Settlement Recalculation Threshold

6.1 Background

The Settlement Recalculation Threshold is a parameter which determines whether the MO will include a corrected data input value (following a query or dispute) into a Settlement Rerun or if the final timetabled Settlement Rerun has been completed, whether a new Settlement Rerun is required. As such, the Settlement Recalculation Threshold applies to elements that are not normally considered as part of the Settlement processes. For example, updates to metered data are part of normal Settlement processing and any errors would be considered with respect to the materiality threshold and the Settlement Recalculation Threshold would only apply where the query has been raised after the last timetabled Settlement Rerun. However, instruction profiling which creates Dispatch Quantities is not part of normal Settlement Processes and, as such, any queries with respect of these inputs would need to be assessed against the Settlement Recalculation Threshold to determine whether the corrected data should be included or not.

From the draft Trading and Settlement Code, the threshold is used to test when a change in input data resulting from an upheld dispute "changes to the relevant Settlement Statement or Settlement Document are greater than the Settlement Recalculation Threshold". When the threshold is exceeded, the changes will be made to the next relevant Settlement Rerun (i.e. if the value of the change is below the High Materiality threshold, then at the next timetabled Settlement Rerun, and if the value is above the High Materiality threshold, then at the next ad hoc Settlement Rerun).

6.2 Considerations

To date in the SEM the Settlement Recalculation Threshold was used as a parameter for determining whether both recalculation of the SMP and a Settlement Rerun should occur. The I-SEM arrangements split these functions into two separate parameters. The Pricing Materiality Threshold is used to determine if a recalculation of the Imbalance Settlement Price should occur, while the Settlement Recalculation Threshold is now used only to determine if the queried data items should be included in the next Settlement Rerun.

Therefore this is now only relevant to the individual unit / Participant who raised the query, as opposed to all units in the market. In the I-SEM arrangements, the change in data would not result in these large commitment changes, and the majority of the impact of the change would result with the Participant who raised the query. Therefore it may no longer be required to take into account the impact of exceeding the Settlement Recalculation Threshold on the whole market. Even if the value for the Settlement Recalculation Threshold is quite low, it would not result in an ad hoc Settlement Rerun unless it is in excess of the High Materiality threshold, therefore the value for the Settlement Recalculation Threshold does not directly result in increased overhead due to Settlement Reruns.

This is the case prior to the Month + 13 timetabled Settlement Rerun. After this, the Settlement Recalculation Threshold will be the sole threshold for determining whether an ad hoc Settlement Rerun will be required and therefore would have an impact on additional overheads across the whole market. After the final timetabled Settlement Rerun most of the large impact changes would likely have been addressed, meaning that having the Settlement Recalculation Threshold at a lower value may not result in additional overheads from requiring ad hoc resettlements.

The test for whether the threshold is exceeded (i.e. the use of the threshold in operation) should therefore only take into account the settlement amounts of the Participant who raised the query, but the determination of a value of the Settlement Recalculation Threshold parameter should take into account the impact the resulting Settlement Rerun would have on the Participant in question and the whole market. Previous reports on the Settlement Recalculation Threshold parameter (for example SEM-08-108b) have outlined the approach to testing whether the threshold is exceeded which is applied in operations. Such an approach would need to be updated for the I-SEM considering the changes in the market structure and settlement amounts, which can be advised closer to go-live of the I-SEM.

6.2.1 Sources for Relevant Changes in Settlement Amounts

Changes in input data which could result in changes to settlement amounts that are not normally considered as part of the settlement processes include:

- Changes in Accepted Offers and Accepted Bids. This could arise for a number of reasons, some of which could result in relatively large volume changes (such as a dispatch instruction being missing from the instruction profiling process) and some relatively small volume changes (such as changing the timing around instruction issue or instruction effective times). How this volume change would translate into a settlement change would depend on the relationship between the Imbalance Settlement Price, the Bid Offer Price, and Uninstructed Imbalance Charges. The influence of the Accepted Offer or Bid would be seen in the Metered Quantity, so that if the unit was otherwise balanced they should have this quantity settled at the Imbalance Settlement Price. Since it would not be reflected through the Dispatch Quantity, an Uninstructed Imbalance Charge may apply to the volume which is, at that time, seen to be out of tolerance. Ignoring this charge, if the Bid Offer Price for the unit is the same as the Imbalance Settlement Price, then a change in this volume would not result in a change in the overall settlement amount. The change in volume may also be concentrated on a single band, meaning there would not be a one-to-one relationship between a change in volume and a change in settlement amounts. This all highlights that large volume or price changes concentrated on this area may not result in large changes in settlement amounts;
- Price information for an accepted offer and bid could change also based on updated information such as the timing of COD submissions or the timing of the issuance and effectiveness of dispatch instructions. These changes may

not result in a one-to-one change in settlement amounts, as the price change may be concentrated on the offer or bid in a single band as opposed to the whole output range, so that an X% difference in price in a band would not result in an X% difference in the total settlement amounts when the unit has offers accepted across multiple bands.

The testing for whether a query would result in changes to settlement for amounts greater than the threshold would apply in the I-SEM for greater numbers of cases than those which resulted in the tests for the current SEM process, as considered in the report carried out for the 2010 analysis of the Settlement Recalculation Threshold parameter (SEM-09-097b). For example, the large number of Instruction Profiling queries highlighted in Figure 1 of that report, while not impacting MSP and therefore not requiring the analysis under the current arrangements, would have an impact on settlement amounts in the I-SEM Imbalance arrangements and therefore should be taken into account in the application of the threshold under the new arrangements.

6.2.2 Percentage versus Cash Flow Value

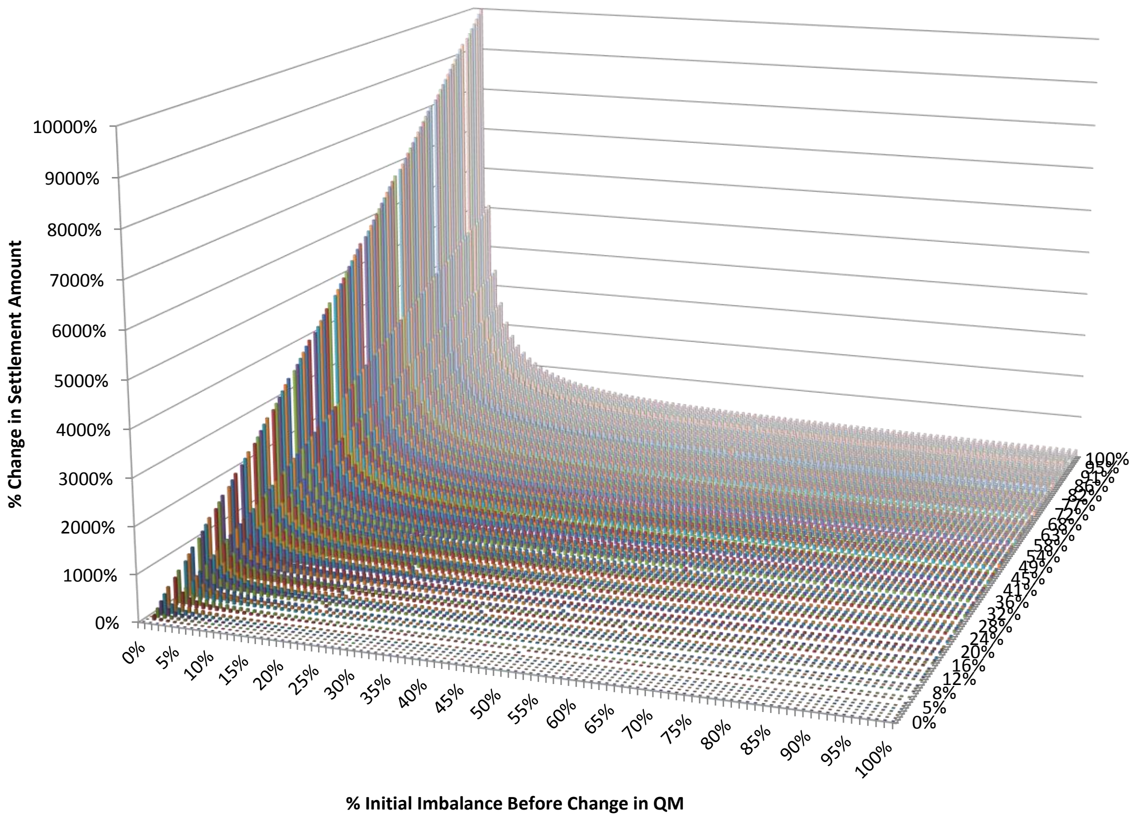
A percentage value in the current market is chosen based on a value of change in settlement amount versus the overall typical market value in the same period. The typical market value is not as easy to assess in the Imbalance Settlement arrangements as it is in the SEM. This is because imbalance cash flows are not based on the fundamentals in the market, such as the scheduled output of Generator Units to meet demand times the market price. The fundamentals in different settlement days could be the exact same, but the Imbalance cash flows can be very different depending on the extent to which ex-ante market trading matched the outturn energy demand requirement, whether the units chosen reflected those needed for non-energy reasons, constraints on the system requiring SO adjustment actions, etc. This presents a problem for calculating a percentage value for this parameter.

Also, due to this fundamental difference in the drivers for cash flows between the current SEM and the Imbalance arrangements in the I-SEM, it would not be possible to use assessment of past experiences of the number of incidences of queries, the absolute amounts of settlement changes which would result from these queries, and the relationship between this level of change versus the value of the overall cash flow of the market, as a solid basis for proposing a value for the first year of operation of the I-SEM.

Another problem for calculating a percentage value for this parameter is that a percentage change in settlement amount will be larger the closer the Metered Quantity (QM) is to the Ex-Ante Quantity (QEX). For example, if the incorrect value for QM was equal to QEX, meaning that there is no imbalance to settle and therefore no cash flow, and the correct value for QM is something different, it would not be possible to determine a percentage difference between the settlement amounts.

The following graphs illustrates this effect, showing the change in settlement amounts (% Change in Settlement Amount, with settlement amounts simplified as (QEX – QM) x PIMB) for different magnitudes of changes to the metering data (%

Change in QM) arising at different initial conditions of imbalance (% Initial Imbalance Before Change in QM) which is the difference between QEX and the initial QM before being updated following a query/dispute. For the illustrative example, a value of 100MWh is taken for QEX, a value of 51€/MWh is taken for the Imbalance Settlement Price (PIMB) used to calculate the settlement amount. Different levels of imbalance are created by increasing the initial value for QM from an initial balanced position of 100MWh to create a range of 0% - 100% initial imbalance. Different changes in settlement amounts are created by increasing the updated value for QM from its initial position to create a range of 0% - 100% for that case of initial imbalance.



The main point of these graphs is to illustrate that a relatively small volume change, resulting in a relatively small absolute settlement amount change, can result in a very large percentage settlement amount change, with this effect being greatly amplified as the initial percentage imbalance position becomes smaller. This highlights that using a percentage value for the Settlement Recalculation Threshold may not be appropriate, as it may not work for all cases of initial imbalance.

If an absolute monetary amount was chosen as the unit for the parameter instead of a percentage amount, this would prevent a number of the potential issues highlighted. A monetary amount would mean that it would be possible to set the parameter so that it can reflect the trade-off between the value of the amount resulting from the Settlement Rerun to a Participant versus the overhead of such a Settlement Rerun. It would not be susceptible to the potential problems a percentage value would, for example needing to set a percentage value high enough that it would not trigger Settlement Reruns when the absolute value of the change in settlement amounts is small but the initial settlement amount was also small resulting in a large percentage difference, but not being so high that it would prevent the triggering of resettlement when the absolute value of the change in settlement amounts is large and the initial settlement amount was also large, resulting in a small percentage difference.

6.2.3 Trade-offs and Determining Cash Flow Value

The main drivers for determining the Settlement Recalculation Threshold include:

- The value to the Participant who raised the query of the change in settlement amount; and
- The value of changes after the Month + 13 Settlement Rerun being large enough to warrant an ad hoc Settlement Rerun which outweigh the overheads of undertaking the rerun; and
- The likelihood of changes in excess of the amount arising after the Month + 13 Settlement Rerun.

This could be summarised into a single question: what absolute monetary amount represents a change which is large enough to consider worth a Settlement Rerun? There is a trade-off here which requires an element of subjectivity, considering financial and administrative burden of the Settlement Rerun to the whole market (or an individual Participant) versus the value of the change in settlement amount to the Participant who raised the dispute or query.

The Settlement Recalculation Threshold also needs to reflect the difference in value of the change in settlement amount to different Participants. The value of the change to Participants depends largely on their relative size (in terms of settlement amounts): for smaller Participants, smaller changes in settlement amounts have greater impact and value than for larger Participants. Therefore it would be sensible to have a Settlement Recalculation Threshold value which is sufficiently low that it reflects the value to smaller Participants of the change in settlement amounts, while being sufficiently high that it reflects the additional costs incurred through the administration of a Settlement Rerun which would result if the change in settlement amount exceeded the threshold. As this considers both Participant-specific and market-wide impacts it is unlikely that there is a universal value that will automatically achieve the correct balance.

In the past, a value of 3% was selected for this value to reflect the fact that it was also acting as the threshold for recalculating the SMP, and in an attempt to achieve a balance between the resettlement of a material data error and the operational overhead. In the current market, the 3% Settlement Recalculation Threshold was based on an approximate value of €250,000 change in settlement amounts across the whole market. The process for the use of the Settlement Recalculation Threshold in the I-SEM arrangements will be based on assessment of a single Participant, i.e. the Participant who raised the query, however it the threshold is exceeded then it will trigger a Settlement Rerun which would impact on all other Participants. Therefore a value based on an assessment of changes in settlement amounts across the whole market may not be an accurate representation of the new arrangements. However, every Participant would be subject to similar costs for the administration, and therefore a value based on an assessment of these costs would be more suitable.

In the BETTA market in GB, Balancing and Settlement Code Procedure 11 states a materiality threshold (the "materiality of the Trading Dispute) of £3,000 for taking corrective action in the case of a valid Trading Dispute (BSCP11 Section 6.14). The value was based on the cost of performing the equivalent of a Settlement Rerun following the final timetables rerun, and excluded all the other associated costs. The Trading Disputes process Review Group's view was that the current value does not reflect the true costs involved in investigating and rectifying Disputes (CP1337, in 2004). This amount was deemed the most reflective of the true ELEXON costs associated with rectifying and investigating disputes. The amount was derived on the basis that it took ELEXON an average of 12 Man Days (at a rate of £220 per man day) working on a Dispute from start to finish, and Trading Disputes Committee (TDC) running costs were £580 per month.

A similar analysis could be carried out to determine the cost impact on the market from initiating a settlement rerun. As one of the primary drivers for the parameter is whether or not the benefits would outweigh the costs of carrying out a Settlement Rerun after the M+13 run, an estimate of the order of magnitude of the costs to the market of administering such a rerun across all Participants would indicate a minimum level for the value of this parameter. Consider the following assumptions for such a rough estimate of the costs of a Settlement Rerun resulting from a change in Meter Data:

- A resource costing €300 per day;
- 60 invoices being issued to Participants in the market;
- The following activities being carried out by External Data Providers, with an estimate of the time required:
    a. Provide Corrected Data (4 hours).
- The following activities being carried out by the Market Operator, with an estimate of the time required:
    a. Settlement runs (20 hours for energy settlement, 20 hours for capacity settlement);
    b. Corporate finance checks (1 hour);
    c. Authorisation of payments (3 hours);
    d. Bank charges (€5 by 60 invoices);
    e. Funds transfer processing (12 hours).
- The following activities being carried out by each Participant, with an estimate of the time required:
    a. Downloading settlement documents (1 hour);
    b. Reconciling invoices (2 hours);
    c. Create and authorise payments (1 hour);
    d. Bank charges (€5 by 60 invoices).

With the assumptions stated, the following costs would result across the market:

- External Data Provider, €150;
- Market Operator, €2,400;
- Participants, €9,300.

This gives a total cost across the market of €11,850, excluding the costs of running the dispute/query process which would have resulted in this assessment needing to be made. While this is a rough estimate, and the actual timing and cost could vary from the assumptions made (especially as there is not yet operational experience of the I-SEM arrangements), this shows the potential cost to the market of a Settlement Rerun, and therefore the minimum value for the Settlement Recalculation Threshold parameter, is around €10,000 in magnitude.

This parameter would also have an interaction with the materiality threshold and whether a Settlement Rerun should be ordered following the final timetabled Settlement Rerun. If the Settlement Recalculation Threshold value is higher than the value which determines that the upheld dispute has a “High Materiality”, then every upheld query or dispute in this circumstance will result in an ad hoc settlement rerun.

Therefore it would make sense to have a value for the Settlement Recalculation threshold in the range between the cost of administering the Settlement Rerun and the High Materiality threshold, i.e. in the range €10,000 - €50,000. Given that the other primary driver ensuring that settlement reruns which would be of value to smaller Participants are carried out, this would suggest that a value at the lower end of this range, while still exceeding the cost to the market of administering a rerun, should be chosen.

6.3 Recommendation

A value of €15,000 is recommended as a value for the Settlement Recalculation Threshold from go-live of the I-SEM. This is a value which:

- Is in excess of the likely costs to the market of administering a Settlement Rerun (with a value larger than the estimated amount to recognise that individual reruns would have varying costs, some below and some above the estimated amount; and
- Is at the lower end of the range of acceptable values, recognising the value to smaller Participants of corrections to smaller settlement amounts.

7. Information Imbalance Price

7.1 Background

The Information Imbalance Price for each Generator Unit in each Imbalance Settlement Code (known as $PII_{u\gamma}$ in the Trading and Settlement Code) is used to calculate the Information Imbalance Charge for a Generator Unit. The intention of the information imbalance charge is to compare the PN submissions for a period at one time with the submissions for the same period at another time, and if it is thought that there are differences that fall outside an agreed tolerance band, additional charges will be levied on the Participant.

Due to the nature of the settlement equation in the Trading and Settlement Code which uses this parameter, the value of any non-zero price must be a negative number in order to ensure a charge results. The price can be a different value for different units and for different periods, reflecting the potential for unit types may have different abilities to respond to the signal given by such a price, that different units may have different impacts on costs through their PN submissions, and that it may be more important to have a strong signal certain periods over others so that higher prices can be proposed for those periods than in other periods.

Given the decision in the I-SEM ETA Markets Decision paper to initially set the value of the Information Imbalance Charge to zero, it is proposed that a value of zero for all Generator Units, u, for all Imbalance Settlement Periods, γ, be used for this parameter until such a time as a decision is made to have non-zero Information Imbalance Charges. It is further proposed that a detailed methodology for the determination of this parameter is not required at this stage. However in the following paragraphs a number of aspects which would need to be considered in the development of such a methodology have been outlined in order to give direction for such a methodology should one be developed.

7.2 Considerations

The overall intention of the functionality is to calculate the change in PN volume for a period between that submitted earlier in the day and the FPN, if it is large enough to cause issues (i.e. if the change in volume between earlier-submitted PN and FPN is large enough to have a portion outside of an allowed tolerance) so that a charge could be applied to incentivise Participants to submit PNs throughout the day which most accurately reflect their final intended running (their FPNs). The ideal scenario would be where a unit knows its most accurate expectation of its expected position at the end of all ex-ante market trading, and reflects this in its PN Data submissions throughout the Trading Day.

Because the PNs are the start point for scheduling and dispatch of the power system under the I-SEM arrangements, the accuracy of information from PN Data submissions would be an important driver for the efficiency of decisions taken in operating the system.

Depending on the timing of the change in PN data (which is incorporated into the Information Imbalance Charge approach through the Information Imbalance Quantity Weighting Factor) and the magnitude of the volume change in the PN data (which is incorporated into the approach through the Information Imbalance Tolerance), changes in PN data could result in higher cost actions needing to be taken than what would have been taken if the accurate information was known in time.

The SOs can only take actions using the information available to them at the time the decisions are being made. If the information known at important decision times with respect to Imbalance Settlement Periods is different to the final accurate information at gate closure, this could result in the SOs needing to take more uneconomic actions than the economic energy balancing actions it would have taken in advance of gate closure had it known the actual PNs and therefore actual energy imbalance it would have to correct after gate closure. It could also potentially result in the SOs needing to take actions such as reducing reserve margins or load-shedding if it results in system security issues.

For example, a unit who has stated they are providing a certain level of generation through a PN throughout the day would be taken as providing that power in scheduling runs where the PN is the initial start point. Based on this the schedule with this PN may indicate that there is sufficient plant to meet demand, and there would be no forecast of an imbalance for that period. However if the unit then updates their PN to state they are providing a much lower level of generation, a shortfall imbalance would be created. This has the unwanted impact of foreclosing the intraday market early as any short position in trading is masked by any overstated PN submission until close to gate closure when other Participants are unable to act and the revised information. This would result in the SOs needing to take potentially uneconomic actions than those it would have been able to take with the different set of units which could have been available through intraday market trading if this short position was not masked.

Non-energy actions could be affected in particular when the difference in information between QPN during the Trading Day, and the accurate QFPN, could be the difference between that unit being scheduled on or scheduled off. This would have implications for meeting security constraints such as Transmission Constraint Groups for the minimum number of units in an area to be synchronised. If the schedule throughout the day is signalling that the market position of units satisfies these constraints, the SOs would have no need to dispatch units prior to gate closure for the provision of these constraints. However, if this position then changes, the SOs would have to dispatch units for the provision of these constraints – depending on the timing of the change in PN, the SOs may not be able to dispatch cheaper units with longer notice times, and will have to accept a more expensive offer than they would have been able to accept if they had known earlier in the scheduling process that the unit who changed their PN was actually not going to be available.

One potential disadvantage identified in the I-SEM ETA Markets Consultation paper (SEM-15-026) of levying an Information Imbalance Charge on PN submissions earlier in the Trading Day may be that it could discourage trading in the Intraday Market, as it will be Intraday Market trades that will be the most likely cause of Participants changing their PNs. It may be the case that Generator Units don't have accurate information of their running for the coming day given the level of priority dispatch generation, etc. It would not be fair to penalise a generator on something they had no control over. For example, if wind forecasting at the day-ahead stage is less accurate on a certain day then there may well be significant changes in the PNs of thermal generators that were not known earlier.

Therefore if such a charge were to be introduced through a non-zero price, the other parameters chosen to implement the charge (in terms of the periods to which the charge applies through weighting factors, and the tolerance of the magnitude of volume change allowed) must be fair and proportionate to the level of information Participants know and control Participants have. The price parameter can then focus on the trade-off between:

- The cost to the system and being a signal to incentivise the most accurate data possible; and
- The potential for inefficiency in trading through building this cost into trade offers/bids, and into the cost for consumers.

There is a potential that if the price results in costs that are too low, Participants may not change their behaviour in terms of how they provide PN data to the SOs, and instead only absorb this charge into their offer and bid prices. If Participants consistently only submit PN data which reflects the latest ex-ante position for the unit, updating it based on the latest cleared trades, as opposed to submitting PN data which reflects their expected running after all ex-ante market trading, they would be likely to incorporate any such information imbalance charge into their trade offer or bid in order to recover the cost incurred through this approach for submitting PN Data. This would mean that while the Participant would be directly compensating for some of the increased costs to balancing the system this behaviour caused, it could be seen as an arbitrary charge which does not achieve the intended results. It also has the effect of increasing the cost to consumers, as it is incorporated into trade prices which, if low enough to not change the merit order, may only increase cleared prices.

If the price is set higher, it may strengthen the signal to change behaviour. Above a certain threshold it may not be possible for a Participant to incorporate this additional charge into their offers/bids without changing the merit order and affecting their competitive position in the ex-ante markets. This could result in Participants taking the alternative approach of changing their behaviour in their PN submissions so that they would not likely incur this cost, therefore removing the need for them to incorporate it into their bids and offers. This would mean that the Participant’s competitive position is maintained, and the signal has incentivised the desired behaviour of having the most accurate PN data available for accepting efficient offers and bids in the balancing market through scheduling and dispatch of the system.

However if the price is prohibitively high it may result in a dampening effect on intraday market liquidity, where Participants have identified an opportunity for efficient trading which they did not forecast when submitting their PN data earlier in the day, and so are incentivised not to pursue it because the additional charge they would incur through changing their PN data would not be recoverable through the trade itself. It may also result in less accurate information to the SOs, where a

Participant may know that they are not in a position to generate to the PN level they have submitted previously in the day (for example due to a trip), but are incentivised not to update this information due to the additional charge they would incur.

Therefore in the setting of this parameter, analysis would need to be carried out to set it at a sufficiently high level that should incentivise a change in the behaviour of Participants submitting PN data, that if it does not result in this change in behaviour it would at least cover the increased costs of balancing the system caused by this behaviour, and not so high that it would cause unintended changes in behaviour such as dampening liquidity in the intraday market. A cost benefit analysis could be carried out to ensure the price would result in a charge which is cost reflective. A number of aspects which could be considered include:

- detailed assessment of the scale of information imbalance seen in the market to that point;
- the impacts of this information imbalance on the system operation;
- the benefits/costs that introducing the charge may bring if change in PN submission behaviour occurs or does not occur; and
- scenarios around Participants incorporating the charges into bid and offer prices, and around impacts to intraday market liquidity.

7.3 Recommendation

Given the decision in the I-SEM ETA Markets Decision paper to initially set the value of the Information Imbalance Charge to zero, it is proposed that a value of zero for all Generator Units, u, for all Imbalance Settlement Periods, γ, be used for this parameter from go-live of the I-SEM until such a time as a decision is made to have non-zero Information Imbalance Charges.

8. Information Imbalance Quantity Weighting Factor

8.1 Background

The Information Imbalance Quantity Weighting Factor (known as $WFQII_{u\beta\gamma}$ in the Trading and Settlement Code) is a factor which determines the extent to which the change in volume between the PN Data active at a particular PN Submission Period in respect of an Imbalance Settlement Period and the FPN Data for that Imbalance Settlement Period would be considered under the Information Imbalance Charge. Each settlement period (γ) has associated with it previous periods (β) where PNs could be supplied for it, and the FPN which is the last possible PN supplied at gate closure. The values for this parameter can vary across all periods across the relevant trading day to reduce or increase the value of the charge being applied in that period.

Given the decision in the I-SEM ETA Markets Decision paper to initially set the value of the Information Imbalance Charge to zero, it is proposed that a value of zero for all Generator Units, u, for all PN Submission Periods, β, for all Imbalance Settlement Periods, γ, be used for this parameter until such a time as a decision is made to have non-zero Information Imbalance Charges. It is further proposed that a detailed methodology for the determination of this parameter is not required at this stage. However in the following paragraphs a number of aspects which would need to be considered in the development of such a methodology have been outlined in order to give direction for such a methodology should one be developed.

8.2 Considerations

Initial PN submissions must be completed by 13:30, and this must cover the market day from the hour 23:00 for the following 24 hours. It follows that there are only opportunities to provide a PN submission for the first Imbalance Settlement Period of the Trading Day (23:00-23:30) between 13:30 and 21:59, which is an hour smaller of a window of opportunity than for the second Imbalance Settlement Period of the Trading Day (23:30-00:00) between 13:30 and 22:29, and so on so that the largest window of opportunity is available for the final hour in the market day.

This weighting factor would have a value of zero in those periods which are desired not to be considered in the calculation of charges. The sum of the weighting factors across all PN Submission Periods in respect of an Imbalance Settlement Period should be equal to a value of 1. This means that if it is desired to only consider certain PN Submission Periods as having greater influence/consideration in the calculation of Information Imbalance Charges, higher values for this parameter could be decided for those PN Submission Periods which are close to the Gate Closure 2 of the relevant Imbalance Settlement Period.

Large changes between PN and FPN submitted very early on, closer to Gate Closure 1, may not have an adverse impact on scheduling of the system and therefore could be given a weighting factor of zero so those periods are ignored. However large changes between PN and FPN arising very close to Gate Closure 2 may have adverse impacts, as the scheduling runs using PNs as the start point for scheduling and dispatch close to gate closure interact with the timing of the issuance of dispatch instructions, and therefore the potential for impacting the efficiency of balancing market actions. Having weighting factors which focus charges for deviations outside the tolerance volume towards relatively late PN submissions (i.e. changes closer to Gate Closure 2) may incentivise Participants to avoid overestimating or underestimating their PNs close to gate closure.

Therefore this parameter, which determines the timing of the application of such a charge and the influence of the charge in each period, would need to be subject to analysis which should take into account the timing of:

- Gate Closures for submission of PN data;
- Timing of intraday activity, in particular if there are any “pockets” of increased liquidity due to time of the day relative to the Imbalance Settlement Period (this could be described in the terms required for Information Imbalance settlement as the PN Submission Period for the Imbalance Settlement Period), due to Intraday Auctions being run, etc.;
- Timing of updated forecasts, particularly wind and demand;
- Timing of Indicative Operating Schedule determination;
- The notice times of units, for example as considered in issuing a dispatch instruction to a unit to run to their FPN, or as considered in issuing an dispatch instruction to run a unit to replace another unit which was previously thought of as being on through their PN submissions but then declare themselves off through their PN submissions;
- The ramping or notice times of units which would be required to replace the energy imbalance (upward or downward) of a unit created through the difference between their PN and FPN.

8.3 Recommendation

Given the decision in the I-SEM ETA Markets Decision paper to initially set the value of the Information Imbalance Charge to zero, it is proposed that a value of zero for all Generator Units, u, for all PN Submission Periods, β, in respect of all Imbalance Settlement Periods, γ, be used for this parameter from go-live of the I-SEM until such a time as a decision is made to have non-zero Information Imbalance Charges.

9. Information Imbalance Tolerance

9.1 Background

The Information Imbalance Tolerance ($TOLII_{u\beta\gamma}$) is a MWh value parameter calculated to reflect the difference in volume between QPN and QFPN which is deemed to be allowed, so that Information Imbalance Charges are only calculated for changes in volumes above this tolerance.

Given the decision in the I-SEM ETA Markets Decision paper to initially set the value of the Information Imbalance Charge to zero, it is proposed that a value of zero for all Generator Units, u, for all PN Submission Periods, β, in respect of all Imbalance Settlement Periods, γ, be used for this parameter until such a time as a decision is made to have non-zero Information Imbalance Charges. It is further proposed that a detailed methodology for the determination of this parameter is not required at this stage. However in the following paragraphs a number of aspects which would need to be considered in the development of such a methodology have been outlined in order to give direction for such a methodology should one be developed.

9.2 Considerations

The Information Imbalance Tolerance can be defined as a different value by Generator Unit, for example being defined for as the same value for all Generator Units, different values for individual Generator Units, or different values for logical groupings of Generator Units. This may be useful in terms of accounting for the impact of the relative magnitude of changes in PN. The effect of PN changes on the system may be based solely on the absolute magnitude of the change in certain situations, and may be based on the magnitude of the change relative to the capacity of the unit in other situations.

In most situations, the absolute magnitude of the change would result in a direct requirement for different, more expensive energy and non-energy balancing actions being taken than would have happened if the SOs had known of the final PN value earlier. For example, a unit who has stated they are providing 400MW of generation through a PN throughout the day would be taken as providing that power in scheduling runs where the PN is the initial start point. Whether the unit then updates their PN close to Gate Closure 2 to state they are only going to provide 399MW or 200MW of generation would have an impact on the economics of intraday trading and balancing market actions using that output. a 1MW shortfall may not have resulted in any extra efficiency in balancing actions through different intraday market outcomes. However, if a 200MW shortfall imbalance had been known in time, multiple units could have traded in the intraday market to try and meet this large imbalance volume, the outcome of which could have resulted in potentially more economic balancing actions being taken.

In some situations, a small PN change from a Participant with a small capacity (and therefore a large change relative to its capacity) may result in requirements for different, more expensive energy and non-energy balancing actions being taken than would have happened if the SOs had known of the final PN value earlier. This particularly refers to the fact that a change of small magnitude to the overall system, while large relative to a unit's capacity, could be the difference between that unit being scheduled on or scheduled off, which can drive uneconomic non-energy balancing actions to be taken.

In the analysis determining the values of the tolerance, metrics which can be used to determine whether the absolute magnitude of PN change, or the magnitude of PN change relative to the size of the unit, is the main driver of additional costs should be investigated. Using these metrics it could be determined whether a single tolerance value for all units, different tolerance values for different units (either individual or by categorisation), should be used in a non-zero Information Imbalance Price scenario.

Also the examples highlight that the timing of this change in PN amount would be important to the impact it has on additional costs. For this reason, the tolerance can have different values for different PN Submission Periods, β, relevant for the Imbalance Settlement Period. If the PN changes, even large in magnitude, were to happen earlier in the scheduling timeline there may be little to no impact on the actions taken. For example this could be the case if the notice times of available units are such that the same actions would have been considered before or after a value for QPN in a PN Submission Period which reflects the QFPN at Gate Closure for that period is known.

9.3 Recommendation

Given the decision in the I-SEM ETA Markets Decision paper to initially set the value of the Information Imbalance Charge to zero, it is proposed that a value of zero for all Generator Units, u, for all PN Submission Periods, β, in respect of all Imbalance Settlement Periods, γ, be used for this parameter from go-live of the I-SEM until such a time as a decision is made to have non-zero Information Imbalance Charges.

10. Conclusions

The recommended values for the Imbalance Settlement Parameters are proposed in the table below, taking into account operational experience since the start of the SEM in November 2007, changes in context through the introduction of the I-SEM arrangements, and the criteria for the signals from the new parameters introduced in the I-SEM arrangements including values proposed in previous market design decisions:

Parameter	2017 Approved Value (or Equivalent)	I-SEM Go-Live Proposed Value
Engineering Tolerance, TOLENG (where 0 ≤ TOLENG ≤ 1)	0.01	0.01
MW Tolerance for each Trading Day, t, $TOLWM_t$ (where 0 ≤ $TOLMW_t$)	1	1
System per Unit Regulation Factor, FUREG	0.04	0.04
Discount for Over Generation Factor for each Generator Unit, u, except for Interconnector Error Units, in each Imbalance Settlement Period, γ, $FDOG_{u\gamma}$ (such that $0 \leq FDOG_{u\gamma} \leq 1$)	0.2	0.2
Discount for Over Generation Factor for each Interconnector Error Unit, u, in each Imbalance Settlement Period, γ, $FDOG_{u\gamma}$ (such that $0 \leq FDOG_{u\gamma} \leq 1$)	0	0
Premium for Under Generation Factor for each Generator Unit, u, except for Interconnector Error Units, in each Imbalance Settlement Period, γ, $FPUG_{u\gamma}$ (such that $0 \leq FPUG_{u\gamma} \leq 1$)	0.2	0.2
Premium for Under Generation Factor for each Interconnector Error Unit, u, in each Imbalance Settlement Period, γ, $FPUG_{u\gamma}$ (such that $0 \leq FPUG_{u\gamma} \leq 1$)	0	0
Settlement Recalculation Threshold	3%	€15,000
Imbalance Weighting Factor for each Imbalance Settlement Period, γ, $WFIMB_{\gamma}$	N/A	1
Information Imbalance Price for each Generator Unit, u, in each Imbalance Settlement Period, γ, $PII_{u\gamma}$	N/A	0
Information Imbalance Quantity Weighting Factor for each Generator Unit, u, for each PN Submission Period, β, in respect of each Imbalance Settlement Period, γ, $WFQII_{u\beta\gamma}$	N/A	0
Information Imbalance Tolerance for each Generator Unit, u, for each PN Submission Period, β, in respect of each Imbalance Settlement Period, γ, $TOLII_{u\beta\gamma}$	N/A	0

