

## **Annex 3**

# **Methodology for monitoring the performance and usage of the price coupling algorithm**

**in accordance with Article 8 of the Algorithm Methodology**

**31<sup>st</sup> May 2019**

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# **TITLE 1 - General provisions**

## **Article 1**

### **Subject matter and scope**

1. This algorithm monitoring methodology elaborates the principles and sets forth the indicators for:
  - a) monitoring the performance of the price coupling algorithm, as set out in Article 7 of the Algorithm Methodology;
  - b) monitoring the usage of the price coupling algorithm, as set out in Article 7 of the Algorithm Methodology;
  - c) monitoring the output produced by the price coupling algorithm, as set out in Article 7 of the Algorithm Methodology;
2. The principles and processes described in this methodology shall be further developed and detailed within the algorithm monitoring procedures defined in the relevant operational agreements among all NEMOs, between all NEMOs and all TSOs, and among TSOs, in the day-ahead framework.
3. All NEMOs and all TSOs shall ensure the update of the present Annex.

## **Article 2**

### **Type, Purposes and Use Cases for indicators calculation**

1. The indicators addressed in this Annex shall belong to different categories:
  - a) usage indicators envisaged in TITLE 4 shall quantify the average daily usage of a functionality and shall constitute the input of the price coupling algorithm. They shall be the basis for the quantification of effective usage, anticipated usage and usage range, and definition of dataset;
  - b) output indicators envisaged in TITLE 5 shall qualify the outcome of the price coupling algorithm and the algorithm computation process;
  - c) performance indicators envisaged in TITLE 3 shall measure the properties of the price coupling algorithm in terms of compliance with the CACM requirements of optimality (Article 7), repeatability (Article 8) and scalability (Article 9).
2. The indicator referred to in previous paragraph 1 shall be meant to support different purposes:
  - a) Monitoring of operations: monitoring the evolution of the actual performance of the price coupling algorithm (Article 3);
  - b) Request for change impact assessment: assessing the impact of request for change or of corrective measures, as described in the Algorithm Methodology (Article 4);
  - c) Scalability assessment: assessing the impact of the long term anticipated growth on the price coupling algorithm scalability (Article 5), considering also the usage of other functionalities of the algorithm whose use is expected to be increased;
  - d) Research and development assessment: ensure the capability of the price coupling algorithm to support in the medium and long term anticipated market growth and extension of requirements (Article 6).
3. The indicators under paragraph 1 above shall be calculated with a daily granularity over different temporal sets of trading days in order to build the scenarios to address the purposes described in paragraph 2 above. Specifically:

- a) The recent historical set shall comprise the trading days of the previous K months, starting from the Kth month before the assessment (M-K) up to the previous month (M-1) and may exclude for practical reasons the days on which a Daylight Saving Time change occurs and/or any days on which a partial/total decoupling occurs. The K value shall be defined in the operational procedures attached to the relevant operational agreement;
  - b) The rolling historical set shall comprise the previous year's trading days, starting from the 13th month before the assessment (M-13) up to the previous month (M-1) and may exclude for practical reasons the days on which a Daylight Saving Time change occurs and/or any days on which a partial/total decoupling occurs;
  - c) The whole year historical set will comprise the previous full years' trading days, counting only complete years, and may exclude for practical reasons the days on which a Daylight Saving Time change occurs and/or any day on which a partial/total decoupling occurs;
  - d) The near future set for the indicator calculation shall be defined by reference to the projected growth of the whole year historical set for the following year (Y+1) and taking into account all the forward-looking system information expected at the time of evaluation;
  - e) The distant future set for the indicator calculation shall be defined by reference to the projected growth for of the whole year historical set for the following three years (Y+3) and taking into account all the forward-looking system information expected at the time of evaluation.
4. Unless specified otherwise, all the values that are defined as parameters in this methodology, shall be defined in the operational procedures of the relevant operational agreements and their value will be shared in the public reports.

## **TITLE 2 - Indicators calculation and thresholds for price coupling algorithm**

### **Article 3**

#### **Monitoring of operations**

1. For Monitoring purposes under Article 2(2)(a) the following indicators shall be used:
  - a) the usage indicators defined under TITLE 4 (and as referenced under Article 2(1)(a),
  - b) the output indicators defined under TITLE 5 (and as referenced under Article 2(1)(b),
  - c) the performance indicators defined under TITLE 3 (and as referenced under Article 2(1)(c).
2. The indicators referred to under paragraph 1 shall be calculated as their actual values as recorded in the rolling historical set under Article 2(3)(b) and, for reporting purposes, as the mean of the respective actual values over the rolling historical set under Article 2(3)(b).
3. The usage indicators under paragraph 1(a) shall be assessed against the following threshold comparing the effective usage of the functionality calculated over the recent historical set of trading days under Article 2(3)(a) against the corresponding usage range, as calculated under following Article 5(4).
4. The performance indicators under previous paragraph 1(c), calculated as their actual values as recorded in the recent historical set under Article 2(3)(a), shall be assessed over the following thresholds:
  - a) economic surplus indicator under Article 7: the obtained values shall be assessed against the historical values, calculated as their actual values as recorded in the rolling historical set under Article 2(3)(b);
  - b) repeatability indicator under Article 8: the obtained values shall be assessed against the historical values, calculated as their actual values as recorded in the rolling historical set under Article 2(3)(b);
  - c) scalability indicator under Article 9: in x% of the cases the obtained values shall be lower than y minutes and its average value shall be smaller than z minutes.

## Article 4

### Request for Change impact assessment

1. For the request for change impact assessment purpose under Article 2(2)(b), the scalability indicator defined under TITLE 3 Article 9 and recalled under Article 2(1)(c) shall be used.
2. The scalability indicator under paragraph 1 shall be calculated simulating the run of the price coupling algorithm over two different scenarios:
  - a) historical scenario: using as inputs the actual usage of all the existing functionalities as recorded over the historical set under Article 2(3)(c) and the anticipated usage of the functionality under assessment calculated over the near future set under Article 2(3)(d);
  - b) near future scenario: using as inputs the anticipated usage of all the functionalities calculated on the near future set under Article 2(3)(d).
3. The scalability indicator under paragraph 2 shall be assessed against the following thresholds:
  - a) In x% of the cases the indicators under previous paragraph 2(a) shall be lower than y minutes, and its average value shall be smaller than z minutes;
  - b) In x% of the cases the indicators under previous paragraph 2(b) shall be lower than y minutes.

## Article 5

### Scalability assessment

1. For scalability assessment purposes under Article 2(2)(c) the scalability indicator defined under TITLE 3 Article 9 shall be used.
2. The scalability indicator under paragraph 1 shall be calculated simulating the run of the price coupling algorithm over two different scenarios:
  - a) a near future scenario: using as inputs the anticipated usage of all the functionalities calculated over the near future set under Article 2(3)(d).
  - b) a distant future scenario: using as inputs the increasing values of the anticipated usage of all the functionalities calculated on the distant future set under Article 2(3)(e).
3. The scalability indicator described under previous paragraph 2 shall be assessed against the following thresholds:
  - a) in x% of the cases the indicators under previous paragraph 2(a) shall be lower than y minutes and its average value shall be smaller than z minutes.
  - b) in x% of the cases the indicators under previous paragraph 2(b) shall be lower than y minutes and its average value shall be smaller than z minutes.
4. The usage range shall be calculated as the maximum usage of the functionalities supported by the price coupling algorithm adopted in previous paragraph 2(b) and complying with the threshold under paragraph 3(b).

## Article 6

### Research and Development assessment

1. For the research and development purposes under Article 2(2)(d), all performance indicators defined under TITLE 3 shall be used.
2. The performance indicators shall be calculated simulating the run of the price coupling algorithm using as inputs the usage range of all the functionalities calculated on the distant future set defined in Article 2(3)(e).
3. The performance values calculated under paragraph 2, shall be assessed against the following thresholds:
  - a) economic surplus indicator under Article 7: the obtained values shall be assessed against the historical values, calculated as their actual values as recorded in the rolling historical set under Article 2(3)(b)
  - b) repeatability indicator under Article 8: the repeatability indicators obtained values shall be assessed against the historical values for repeatability indicators calculated as the values as recorded in the rolling historical set under Article 2(3)(b)
  - c) scalability indicator under Article 9: in x% of the cases the obtained values shall be lower than y minutes and its average value shall be smaller than z minutes.

## TITLE 3 - Indicators on price coupling algorithm performance

### Article 7

#### Indicators on algorithm's ability to maximize economic surplus

1. The economic surplus is the sum of the consumer and producer surpluses plus the congestion income attributable to flows between bidding zones. Indicators to monitor the ability of the price coupling algorithm to maximize the economic surplus are:
  - a) **Increment of economic surplus with respect to the first OK solution** – This indicator is the difference between the economic surplus of the accepted solution and the economic surplus of the first OK solution found. This indicator is not valid for comparing two different versions of the price coupling algorithm. It should be used only as an indicative of the improvements of the solutions after first one is found. The existence of big outliers may indicate either the capacity of the price coupling algorithm to explore remote areas in the “Branch & Bound” process or a big change produced by the input data, for instance in situations with low liquidity that produces big impact after small changes in orders acceptance.
2. Indicators on the loss of economic surplus due to limited calculation time with respect to extended calculation time;
  - a) **Economic surplus gain after increasing calculation time in X minutes** – This indicator measures the gain in the economic surplus if the same trading day is run again in a similar machine than the used for published results, giving the price coupling algorithm T minutes more. This indicator needs to be calculated ex post price coupling algorithm calculation, in a different process.

## Article 8

### Indicators on price coupling algorithm repeatability

1. The indicators to monitor algorithm repeatability includes the indicators on the differences in the same relevant outputs from the price coupling algorithm due to repeated calculations on the same specific configuration of hardware and software and at the same iteration.
2. With reference to previous paragraph 1:
  - a) the relevant variables mentioned in are: clearing prices, net positions, and products output from the price coupling algorithm;
  - b) the weights shall be established in the Algorithm Market Monitoring Procedure attached to the relevant operational agreement.
  - c) the difference between clearing prices is calculated as the average, over the relevant MTUs and the zones, of the absolute value difference between same MTUs zonal clearing prices, weighted by the related net positions;
  - d) the difference between net positions is calculated as the average, over the relevant MTUs, the zones and the MTUs, of the absolute value difference between zonal net positions for each MTU;
  - e) the difference between individual bids/offers is calculated as the average, over the relevant MTUs and the orders, of the absolute value difference between accepted quantity of each product output from the price coupling algorithm.

## Article 9

### Indicators on Algorithm scalability

1. The indicator to monitor the algorithm scalability is the **Time to first solution**.
  - a) This indicator measures the time spent since the algorithm starts until the first “OK” solution is found. It considers the time required for reading input data from database, the creation of the model for the optimization problems and the resolution until the first “OK” solution has been found.

## TITLE 4 - Indicators on the price coupling algorithm usage

### Article 10

#### Indicators to describe the usage of SDAC products

1. Indicators on the evolution of the number of submitted orders of each product type per bidding zone over time, and the corresponding total volume;
  - a) **Number of points in curve orders at bidding zone level** – Total number of points in curves at bidding zone level, after the curves from NEMO Trading Hubs have been aggregated. One single value is provided per trading day. This indicator is calculated in the aggregation step by the price coupling algorithm.
  - b) **Total number of steps at bidding zone level** – This indicator counts the total number of steps in the curves at bidding zone level, after the curves from NEMO Trading Hubs have been aggregated. A step is a segment made of two curve points with the same price but different quantities, followed by another segment in which the point not shared with the previously mentioned segment has a different price. One single value is provided per trading day.
  - c) **Total number of block orders** – This indicator counts the total number of block orders per trading day and bidding zone.
  - d) **Total number of block order exclusive groups** – This indicator counts the total number of exclusive groups existing for the block orders per trading day.
  - e) **Total number of linked families** – This indicator counts the total number of families of linked block orders per trading day.
  - f) **Total number of complex orders** – This indicator counts the total number of complex orders per trading day and bidding zone.
  - g) **Total number of demand merit orders** – This indicator counts the total number of demand merit orders per trading day and bidding zone. These merit orders are not the PUN orders.
  - h) **Total number of supply merit orders** – This indicator counts the total number of supply merit orders per trading day and bidding zone.
  - i) **Total number of PUN orders** – This indicator counts the total number of PUN orders per trading day and bidding zone. That means the number of unique PUN prices regarding the input data.

### Article 11

#### Indicators to describe the geographical extension of the SDAC

2. Indicators on the evolution of the number of bidding zones;
  - a) **Number of bidding zones** – Total number of bidding zones. This indicator is obtained by counting all the bidding zones existing per trading day.
  - b) **Total number of flow-based bidding zones** – This indicator counts the total number of bidding zones in which there is flow based topology. This indicator is calculated by counting the number of PTDF matrixes that exist per trading day.
  - c) **Number of scheduling areas** – Total number of scheduling areas. This indicator is obtained by counting all the scheduling areas existing per trading day.
  - d) **Number of NEMO Trading Hubs** – Total number of NEMO Trading Hubs per trading day.
  - e) **Number of NEMOs** – Total number of different NEMOs in the trading day. One NEMO may be operating several NEMO Trading Hubs, each one in a different bidding zone and scheduling area.

## Article 12

### Indicators to describe the network constraints

1. Indicators on the evolution of the use of network constraints are:
  - a) **Total number of bidding zone lines** – This indicator counts the total number of lines between bidding zones.
  - b) **Total number of flow-based PTDF constraints** – This indicator counts the total number of PTDF constraints existing for all the flow-based bidding zones per trading day. It is the same as the number of rows in the PTDF matrixes.
  - c) **Total number of scheduling area lines** – This indicator counts the total number of lines between scheduling areas.
  - d) **Total number of NEMO Trading Hub lines** – This indicator counts the total number of lines between NEMO Trading Hubs.

## TITLE 5 - Indicators on the price coupling algorithm output

### Article 13

#### Indicators to describe the output of maximization of economic surplus

1. Indicators on the maximization of economic surplus:
  - a) **Economic surplus of the first OK solution found** - is the market surplus, calculated Due to price coupling algorithm works floating-point format numbers, the precision of the calculations is limited. Quality of the solution is the quality in term of tolerances, using as value the worst level of tolerance achieved among all the checks applied to the constraints. A solution is considered “OK” when there exists an acceptance tolerance problem in all the constraints up to a maximum value known as the technical limit. Price coupling algorithm provides the utility of each one of the solutions that improve the previously solutions found. This indicator can be obtained querying the utility of the first solution found with quality “OK”
  - b) **Economic surplus of the final solution** - This indicator is obtained as provided by the price coupling algorithm, querying the utility of the solution that the price coupling algorithm classifies as the accepted solution per trading day.
2. Indicators on the evolution of number of matched orders and paradoxically rejected orders of each product type over time, and the corresponding total volume;
  - a) **Total number of matched blocks** – This indicator counts the total number of matched blocks per trading day and bidding zone.
  - b) **Total number of matched complex orders** – This indicator counts the total number of matched complex orders per trading day and bidding zone.
  - c) **Total number of matched non-PUN merit orders** – This indicator counts the total number of matched merit orders (non-PUN merit orders) per trading day and bidding zone. It will be calculated as the count of non-PUN merit orders whose matching quantity is greater than 0.
  - d) **Total number of matched PUN orders** – This indicator counts the total number of matched PUN orders per trading day and bidding zone. That means the number of unique PUN prices regarding the input data. It will be calculated as the count of PUN orders whose matching quantity is greater than 0.
  - e) **Total matched volume from curves** – This indicator aggregates the total matched volume from supply and demand curves. It will be calculated as the sum of all “market time unit”-weighted unrounded volume matched at each relevant MTU and bidding zones for supply and demand curves.
  - f) **Total matched volume from blocks** – This indicator aggregates the total matched volume from blocks. It will be calculated as sum of all “market time unit”-weighted unrounded volume matched at each relevant MTU and bidding zones from blocks.
  - g) **Total matched volume from complex orders** – This indicator aggregated the total matched volume from complex orders. It will be calculated as sum of all unrounded volume matched at each relevant MTU and bidding zones from complex orders.
  - h) **Total matched volume from (non-PUN) merit orders** – This indicator aggregates the total matched volume from (non-PUN) merit orders. It will be calculated as sum of all unrounded volume matched at each relevant MTU and bidding zones from (non-PUN) merit orders.
  - i) **Total matched volume from PUN orders** – This indicator aggregated the total matched volume from PUN orders. It will be calculated as sum of all unrounded volume matched at each relevant MTU and bidding zones from PUN orders
3. Indicators on paradoxically rejected orders
  - a) **Number of PRBs in the final solution** – This indicator counts the total number of Paradoxically Rejected Blocks (PRBs) in the accepted solution per trading day and bidding zone.
  - b) **Number of PRMICs in the final solution** – This indicator counts the total number of Paradoxically Rejected MICs (PRMICs) in the accepted solution per trading day and bidding zone.

- c) **Maximum Delta P in the final solution** – This indicator reports the maximum delta P of the blocks for the accepted solution per trading day.
  - d) **Maximum Delta MIC in the final solution** – This indicator reports the maximum Delta MIC of the blocks for the accepted solution per trading day.
  - e) **PRB utility loss in the final solution** – This indicator reports the utility (economic surplus) loss due to paradoxically rejected blocks per trading day.
  - f) **PRMIC utility loss in the final solution** – This indicator reports the utility (economic surplus) loss due to paradoxically rejected MICs and MPCs per trading day.
  - g) **Volume of PRBs in the final solution** – This indicator sums the volume of all the Paradoxically Rejected Blocks (PRBs) in the accepted solution per trading day and bidding zone.
  - h) **Volume of PRMICs in the final solution** – This indicator sums the volume of all the Paradoxically Rejected MICs (PRMICs) in the accepted solution per trading day and bidding zone.
4. Indicators on the evolution of the use of network constraints along the time;
- a) **Number of periods for ATC/DC lines with flows at full capacity** – Total number of periods for which ATC/DC lines are utilized at full capacity in one of their directions. We consider a line fully utilized when the energy flow is equal to capacity.

## Article 14

### Indicators to describe the IT calculation process

5. Indicators on the time spent in every phase of the algorithm calculation process are:
- a) **Input data reading time** – This indicator measures the time the price coupling algorithm requires in order to read all the data needed for a trading day from the SQL database. Different methods exist for the calculation of this indicator:
  - b) **Input data trading day creation** – This indicator measures the amount of time the price coupling algorithm requires in order to create a trading day from the data read from the database.
  - c) **Time to solve the root node for the master computer** – This indicator measures the amount of time to solve the root node for the master tree.
  - d) **Time to solve the root node for the job that found first solution** – This indicator measures the amount of time to solve the first node of the job that lead to the first OK solution found. This time will not include the time to read the input data and create the solver models. It will neither include the time spent in the master computers root node.
  - e) **Number of successive improvements of the solution in the given timeframe** – This indicator measures the number of OK solutions that improve a previously found solution during the optimization process limited by the amount of time available for running the price coupling algorithm.
  - f) **Total number of nodes in the master branch and bound tree** – This indicator measures the number of nodes processed in the master branch and bound tree.