# Proposal for a common set of requirements for the DA price coupling algorithm

13 November 2017

# 1. Background

(1) This document is a common proposal developed by all Transmission System Operators (hereafter referred to as "TSOs") and Nominated Electricity Market Operators (hereafter referred to as "NEMOs") for a common set of requirements for the price coupling algorithm (hereinafter referred to as "DA Algorithm Requirements") in accordance with article 37 of Commission Regulation (EU) 2015/1222 establishing a guideline on capacity allocation and congestion management (hereafter referred to as the "CACM Regulation").

(2) According to Article 37: "*1. By eight months after the entry into force of this Regulation: (a) all TSOs shall jointly provide all NEMOs with a proposal for a common set of requirements for efficient capacity allocation to enable the development of the price coupling algorithm and of the continuous trading matching algorithm. These requirements shall specify functionalities and performance, including deadlines for the delivery of single day-ahead and intraday coupling results and details of the cross-zonal capacity and allocation constraints to be respected;"*

(3) In addition to the above common proposal for the TSOs Algorithm Requirements, Article 37 of the CACM Regulation requires that *"all NEMOs shall jointly propose a common set of requirements for efficient matching to enable the development of the price coupling algorithm and of the continuous trading matching algorithm" (hereinafter referred to as "NEMOs Algorithm Requirements") within the same deadline.*

(4) When both proposals are prepared and after the deadline of eight months, all Nominated Electricity Market Operator (hereafter referred to as "NEMO") and all TSOs shall cooperate to finalise the sets of the TSOs and NEMOs Algorithm Requirements. Based on the above two sets of requirements, TSOs and NEMOs Algorithm Requirements, *"all NEMOs shall develop a proposal for the algorithm in accordance with these requirements. This proposal shall indicate the time limit for the submission of received orders by NEMOs required to perform the MCO functions in accordance with Article 7(1)(b)."* This NEMOs proposal for the algorithm shall be prepared no later than three months after the submission of the TSOs and NEMOs Algorithm Requirements.

(5) In accordance with Article 37(3) of the CACM Regulation the NEMOs proposal for the algorithm *"shall be submitted to all TSOs. If additional time is required to prepare this proposal, all NEMOs shall work together supported by all TSOs for a period of not more than two months to ensure that the proposal complies with paragraphs 1 and 2.*

(6) According to Article 37(4) "*The proposals referred to in paragraphs 1 and 2 shall be subject to consultation in accordance with Article 12*". The consultation on all proposals, i.e. TSOs and NEMOs algorithm requirements and the NEMOs proposal for the algorithms was prepared in cooperation between all TSOs and all NEMOs and was consulted upon together to ensure efficient assessment of their content by market participants.

(7) In accordance with Article 37(5) of the CACM Regulation the all NEMOs' proposal for the Algorithm Proposal, incorporating the TSOs' and NEMOs' DA and ID Algorithm Requirements and taking into account the comments from the consultation, has been submitted to the regulatory authorities for approval no later than 18 months after the entry into force of the CACM Regulation - i.e., 14 February 2017.

(8) This Proposal is complemented by the back up and fallback procedures that are referred in the proposal for the back-up methodology. The clearing prices will be calculated taking into account the harmonized maximum and minimum clearing prices Proposal for Single Day Ahead Coupling.

(9) The timeline for the implementation of the Initial and Future DA requirements and Other DA Functionalities mentioned in this document is settled in the Algorithm Proposal, Article 5.

## 2. Definitions

For the purpose of this proposal, terms used in this document have the meaning of the definitions included in Article 2 of the CACM Regulation and Regulation 543/2013, definitions included in Section 2 of MCO Plan and the definitions included in Article 2 of the Algorithm Proposal.

In addition, hereafter following definition applies:

1. **Algorithm:** means the price coupling algorithm**.**

## 3. Approach

The table below sets out the DA Algorithm Requirements. Each requirement has been classified according to the following criteria:

1. **State**:
    a. Initial Requirement: a requirement that must be complied with at the point the Single Day-Ahead Coupling (SDAC) first commences operation. Such requirements are normally already incorporated into the already agreed solution for price coupling algorithm.
    b. Future Requirement: a requirement that must be complied with at a point after the SDAC first commences operation, as further specified in the timeline for implementation of the price coupling algorithm. Such requirements shall need to be properly specified and implemented via a Request for Change (which shall include technical feasibility and performance impact assessment).

2. **Owner:** owner of the requirement (TSOs, NEMOs, or joint TSOs and NEMOs) with meaning as defined in the MCO Plan.

3. **Nature**:
    a. MCO Function: a requirement that relates to the joint responsibility of NEMOs to carry out MCO functions in accordance with Article 7(2) of the CACM Regulation.
    b. Scheduled Exchange Calculation ("SEC") Function: a requirement that relates to the joint responsibility of TSOs to calculate and publish scheduled exchanges on borders between bidding zones in accordance with Article 8(2)(g) of the CACM Regulation, where such requirement shall be supported by the price coupling algorithm. In many cases these requirements are not yet specified ("Future") and it may be that the calculations will be performed outside the price coupling algorithm – e.g., as a separate post-matching process, or a local/regional process. The solution shall be agreed between the relevant NEMOs and TSOs.

At the end of the document, some other possible future functionalities for the price coupling algorithm are mentioned. Those functionalities are not part of the price coupling algorithm requirements.

# 4. Price coupling algorithm requirements

| | State | | Owner | | Nature | |
|---|---|---|---|---|---|---|
| | Initial Requirement | Future Requirement | TSOs | NEMOs | MCO Function | SEC Function |
| **Title 1: Requirements on functionalities and performance** | | | | | | |
| 1. General requirements. | | | | | | |
| a. For each bidding zone the Algorithm shall be able to: | | | | | | |
| i. facilitate orders for several Market Time Units (hereafter referred as "MTUs"), such as 15 minutes, 30 minutes and hourly; | | X | X | X | X | |
| ii. support the products as defined in the DA Products Proposal, in-accordance with Article 40(2) of the CACM regulation; | X | | | X | X | |
| iii. facilitate configurations with more than one NEMO for a given bidding zone, meaning several day-ahead trading hubs within a bidding zone; | X | | X | X | X | |
| iv. support multiple scheduling areas within a bidding zone as requested by TSOs; | X | | X | | | X |
| v. allocate cross-zonal capacities on a bidding zone border with one or multiple TSOs on one or both sides of the concerned bidding zone border. | X | | X | | X | |
| b. The Algorithm shall maximize economic surplus (as defined in Article 2(46) of the CACM Regulation) for single day-ahead coupling for the next trading day, consistent with time limitations, conditions and requirements established by NEMOs and TSOs. | X | | X | X | X | |
| c. The Algorithm shall be able to deal with multiple bidding zones by country and shall be scalable to cover all Europe. | X | | X | X | X | |
| d. The Algorithm shall apply deterministic rules in case of solutions with equivalent social welfare in order to define prices and net positions for each bidding zone. | X | | X | X | X | |
| e. The Algorithm shall be reliable, thus able to find a solution within the allowed time limit, including the potential to extend the processing time in case allowed calculation time is exceeded. | X | | X | X | X | |
| f. The Algorithm shall be able for each MTU to provide the net position per NEMO trading hub and the input for the calculation of the Scheduled Flows between bidding zones. | X | | X | X | X | |
| g. The Algorithm shall be able to calculate the Scheduled Flows per bidding zone. | X | | X | | | X |
| h. For each bidding zone the result from application of the Algorithm shall be one price and one net position for each MTU. For the bidding zones containing several NEMOs, the net position for each MTU shall be calculated for each NEMO trading hub. | X | | X | X | X | |

| | State | | Owner | | Nature | |
|---|---|---|---|---|---|---|
| | Initial Requirement | Future Requirement | TSOs | NEMOs | MCO Function | SEC Function |
| i. For each bidding zone the result from application of the Algorithm shall be one price and one net position for each MTU. For the bidding zones containing several TSOs separating their scope in different scheduling areas, the net position for each MTU shall be calculated for each scheduling area. | X | | X | | | X |
| 2. Qualitative requirements with precision and price ranges. | | | | | | |
| a. The Algorithm shall apply to all orders of market participants providing non-discriminatory access to cross zonal capacity in accordance with Article 3 of the CACM Regulation. | X | | X | X | X | |
| b. In case of tie rules (between two or more orders) and for branching decisions (if any), deterministic rules shall be implemented. Such choices shall be logged. | X | | X | X | X | |
| c. The Algorithm shall allow for partial decoupling, including per bidding zone that belong to a predefined set of bidding zones. | X | | X | X | X | |
| d. The Algorithm shall be able to deal automatically and easily with leap years, i.e. 366 days in a year. | X | | X | X | X | |
| e. The Algorithm shall be able to deal automatically and easily with day-light savings related to winter and summer time changes, i.e. algorithm shall support 23, 24 or 25 hours for a trading day. | X | | X | X | X | |
| f. The calculation process of the Algorithm, including prices and Scheduled Flows resulting from this calculation process, shall be transparent, auditable, and explainable. This requirement applies also to all deterministic rules and applied algorithm heuristics and occurrence rate of these rules and heuristics. | X | | X | X | X | |
| g. The Algorithm source code shall be well structured and well documented. | X | | | X | X | |
| h. The Algorithm shall be able to deal with negative prices for each bidding zone. | X | | X | X | X | |
| i. The Algorithm shall be able to round calculated prices and volumes according to bidding zone specific ticks and rounding rules. | X | | X | X | X | |

| | State | | Owner | | Nature | |
|---|---|---|---|---|---|---|
| | Initial Requirement | Future Requirement | TSOs | NEMOs | MCO Function | SEC Function |
| 3. Performance. | | | | | | |
| a. The Algorithm shall be robust and reliable and it shall be resilient to pretested data configurations such as, but not limited to, non-crossing of bids and offer curves, orders' curtailment, maximum and minimum prices, price and volume indeterminacy. | X | | X | X | X | |
| b. The Algorithm shall always produce a unique result, i.e. price and volume indeterminacy shall be resolved. | X | | X | X | X | |
| c. The Algorithm shall use proven IT technology, e.g. proven third party software. | X | | X | X | X | |
| d. The Algorithm shall be available at all times when required and shall perform according to requirements. | X | | X | X | X | |
| e. The Algorithm shall scale well when the number of bidding zones increases: The Algorithm shall cope with new markets that need to be incorporated in the price coupling, either corresponding to geographical extensions, or with additional NEMOs in existing bidding zones. | X | | X | X | X | |
| f. Price taking orders are buy (respectively sell) limit orders submitted at the maximum (respectively minimum) prices. The failure to accept these price taking orders corresponds to a curtailment situation:<br>i. In case of over-supply, not all price taking supply orders can be accepted;<br>ii. In case of under-supply, not all price taking demand orders can be accepted.<br>Curtailment can be partially mitigated by exporting excess energy or importing deficit energy. In case more than one bidding zones faces a curtailment situation, when we increase the curtailment of one, the curtailment of the other will decrease. Per bidding area, it should be possible to either:<br>i. Prevent sharing of curtailment: the local curtailments remain local: no support is received from adjacent zones, nor support is provided to adjacent zone;<br>ii. Share curtailment: the difference in relative (percentage) curtailment between the different bidding zones is minimized.<br>The latter option of sharing curtailment also applies in a Flow-based setting, where sharing curtailments may be at the cost of the economic surplus.<br>The Algorithm shall provide a mechanism that allows for a sharing of curtailment between bidding zones in a Flow-based capacity allocation. | X | | X | X | X | |

## Title 2: Requirements related to Cross-zonal capacities

| | State | | Owner | | Nature | |
|---|---|---|---|---|---|---|
| | Initial Requirement | Future Requirement | TSOs | NEMOs | MCO Function | SEC Function |
| | | | | | | |
| 1. The Algorithm shall be able for each MTU to: | | | | | | |
| a. allow setting cross-zonal capacity value for each bidding zone border in accordance with the CACM Regulation in case coordinated net transmission capacity is applied; | X | | X | | X | |
| b. constrain Scheduled Flows to the respective cross-zonal capacity value for each bidding zone border for each direction, in case the coordinated net transmission capacity approach is applied; | X | | X | | X | |
| c. where applicable, allow TSOs setting a default value for cross-zonal capacity for each bidding zone border and for each direction in case coordinated net transmission capacity approach is applied; | X | | X | | X | |
| d. constrain, where appropriate, an aggregated set of cross-zonal interconnectors with one global cross-zonal transmission capacity limit (cumulative ATC), i.e. a general boundary constraint. This constraint shall be applicable also to a predefined set of bidding zone borders in order to limit, for example, the net position of a bidding zone(s); | X | | X | | X | |
| e. allow to define a positive and a negative bound to the net position for each bidding zone; | | X | X | | X | |
| f. process Flow-based parameters, if provided at the defined MTU, when allocating cross-zonal capacities for each bidding zone border; | X | | X | | X | |
| g. allow definition and application of the following Flow-based parameters for each network element of a given bidding zone for Flow-based approach: | | | | | | |
| i. power transfer distribution factor (PTDF) as the contribution of 1 MW of a net position change to the Scheduled Flow over the network element; and | X | | X | | X | |
| ii. remaining available margin (RAM) or the remaining allowable Scheduled Flow on the network element; | X | | X | | X | |
| h. ensure that PTDF multiplied by net position is less or equal to than RAM for each network element and net positions concerned by the Flow-based parameters for Flow-based approach; | X | | X | | X | |

| | State | | Owner | | Nature | |
|---|---|---|---|---|---|---|
| | Initial Requirement | Future Requirement | TSOs | NEMOs | MCO Function | SEC Function |
| i. receive the Flow-based parameters as: | | | | | | |
| i. "zero balanced" meaning that the remaining available margin of critical branches applies from zero exchanges and that pre-existing exchanges are transmitted aside; or | | X | X | | X | |
| ii. "not zero balanced" meaning that the remaining available margin of critical branches applies from pre-existing exchanges; | X | | X | | X | |
| j. allow the coexistence of both Flow-based and coordinated net transmission capacity approaches within the coupled regions, i.e. hybrid coupling; | X | | X | | X | |
| k. facilitate the Standard hybrid coupling, where cross-zonal capacity values and Flow-based parameters coexist implying that TSOs shall reserve margins ex-ante. | X | | X | | X | |
| 2. Multiple Flow-based approaches, i.e. plain, bilaterally intuitive, may be used for different capacity calculation regions. | X | | X | | X | |
| **Title 3: Requirements related to allocation constraints** | | | | | | |
| 1. The Algorithm shall be able to: | | | | | | |
| a. for direct current ("DC") interconnectors constrain increase/decrease of Scheduled Flows over one interconnector and/or a combination of interconnectors from a MTU to the following MTU or between the last MTU from the day before and the first MTU of the following day; | X | | X | | X | |
| b. for direct current ("DC") interconnectors constrain increase/decrease of Scheduled Flows over one interconnector and/or a combination of interconnectors from a MTU to the following MTU or between the last MTU from the day before and the first MTU of the following day taking into account the nominations of long term capacity allocations, i.e. physical transmission rights, where applicable. The constraint shall be handled on a single DC interconnector and multiple DC interconnectors in combination; | | X | X | | X | |
| c. constrain increase/decrease of net positions of a single bidding zone from a MTU to the following MTU within a day or between the last MTU from the day before and the first MTU of the following day; and | X | | X | | X | |
| d. incorporate losses functionality on interconnector(s) between bidding zones during capacity allocation, and activate this functionality during allocation, if requested by relevant owner of the interconnector after approval by relevant NRAs. | X | | X | | X | |

| | State | | Owner | | Nature | |
|---|---|---|---|---|---|---|
| | Initial Requirement | Future Requirement | TSOs | NEMOs | MCO Function | SEC Function |
| 2. The Algorithm shall allow to set a minimum price difference between adjacent bidding zones when DC interconnector is used for power exchange. For this requirement, the Algorithm shall model the costs incurred for each MWh passing through a DC interconnector as a "flow tariff". The "flow tariff" shall be treated as a threshold for the price between the bidding zones connected by the DC interconnector. If the price difference between the relevant bidding zones is less than the "flow tariff" the Scheduled Flow shall be set to zero. If there is a Scheduled Flow, the price difference shall equal the "flow tariff", unless there is congestion. Once the price difference exceeds the "flow tariff" the congestion income becomes positive. This functionality shall be incorporated in the Algorithm and activated during allocation if requested by the owner(s) of the interconnector after approval by relevant NRAs. | X | | X | | X | |
| 3. The Algorithm shall allow for adverse Scheduled Flows, i.e. Scheduled Flows from higher price bidding zone to lower price bidding zone, to materialize if this leads to an increase in overall economic surplus. The Algorithm shall enforce intuitive Scheduled Flow in Flow-based areas, i.e. Scheduled Flow from lower price bidding zone to higher price bidding zone, where requested by the relevant party for a bidding zone border. | X | | X | | X | |
| | | | | | | |
| **Title 4: Requirements related to balance constraints** | | | | | | |
| 1. For overall balance of all bidding zones, the Algorithm shall ensure that the sum of unrounded net positions and transmission losses, where applicable, of all bidding zones shall be zero. | X | | X | | X | |
| 2. For overall balance of a bidding zone, the Algorithm shall ensure for each bidding zone the sum of unrounded net position and transmission losses, where applicable, shall be equal to the sum of import and export of this bidding zone resulting from the day ahead capacity allocation. | X | | X | | X | |
| | | | | | | |
| **Title 5: Requirements on algorithm output and deadlines for the delivery of single day-ahead coupling results** | | | | | | |
| 1. Regarding the prices for each MTU the output of the Algorithm shall be: | | | | | | |
| a. rounded and unrounded price in Euros for each bidding zone; | X | | X | X | X | |
| b. shadow prices of critical branches as needed for Flow-Based (FB) capacity allocation; and | X | | X | | X | |

| | State | | Owner | | Nature | |
|---|---|---|---|---|---|---|
| | Initial Requirement | Future Requirement | TSOs | NEMOs | MCO Function | SEC Function |
| c. regional reference prices, in a network in which the cross-zonal capacity constraints are relaxed - e.g., Nordic region. | X | | X | X | X | |
| 2. Regarding the quantities for each relevant MTU the output of the Algorithm shall be: | | | | | | |
| a. rounded and unrounded net position for each bidding zone, which is defined as the difference between matched supply and demand orders within a bidding zone, where rounding shall follow the rounding rules defined for each bidding zone; | X | | X | X | X | |
| b. Where there are multiple NEMOs within a bidding zone, the rounded and unrounded net position for each NEMO trading hub in a bidding zone; | X | | X | X | X | |
| c. number and volume of matched block orders for each bidding zone and paradoxically rejected orders, if any; | X | | | X | X | |
| d. Scheduled Flows into and out of individual Relevant DC Network Elements (difference in Scheduled Flows in/out reflecting losses where applicable); | X | | X | | | X |
| e. Scheduled Flows on Relevant Bidding Zone borders (Scheduled Flows in/out reflecting losses where applicable); | X | | X | | | X |
| f. Scheduled Flows on Relevant Scheduling Area borders (Scheduled Flows in/out reflecting losses where applicable); | X | | X | | | X |
| g. remaining available margin (RAM) or the remaining allowable Scheduled Flow on the network element under FB capacity allocation. | | X | X | | X | |
| 3. Where required, regarding the quantities for each relevant MTU, with the output of the Algorithm, a process which shall not interfere with the market coupling results calculation, shall provide Scheduled Flows, resulting from day ahead market coupling, in the form of: | | | | | | |
| a. Bilateral and Multilateral Scheduled Flows between Scheduling Areas; | X | | X | | | X |
| b. Bilateral and Multilateral Scheduled Flows between Bidding Zones; | X | | X | | | X |
| c. Bilateral and Multilateral Scheduled Flows between NEMO trading hubs; | X | | X | | | X |

| | State | | Owner | | Nature | |
|---|---|---|---|---|---|---|
| | Initial Requirement | Future Requirement | TSOs | NEMOs | MCO Function | SEC Function |
| | | | | | | |
| and pursuant to the Methodology for calculation of scheduled exchanges resulting from market coupling. This is to support the scheduled exchanges calculation and/or multi-NEMO arrangements function. | | | | | | |
| | | | | | | |
| 4. Regarding the calculation results the output of the Algorithm shall be: | | | | | | |
| a. overall economic surplus and economic surplus for each bidding zone; and | X | | X | X | X | |
| b. output necessary for monitoring in accordance with Article 82(2) and (4) of the CACM Regulation. | X | | X | X | X | |
| 5. The Algorithm shall provide NEMOS and TSOs with information necessary to comply with monitoring of REMIT regulation where the Algorithm is the only feasible source. | X | | X | X | X | |
| 6. The Algorithm shall be able to implement a change of bidding zone configurations following the Change Control Procedure referenced on Article 10 of the Algorithm Proposal. | X | | X | | X | |
| 7. The Algorithm shall be capable of finding results normally within the time limit that is established in the operational procedure referenced in the Algorithm Proposal article 4(15). | X | | X | X | X | |
| 8. The Algorithm shall be able to deliver the volume of matched orders and not-matched orders of each NEMO for the bidding zones of the control area if requested by TSOs locally and approved by relevant NRAs. | X | | X | | X | |
| **Title 6: Currency** | | | | | | |
| 1. The Algorithm shall for Single Day Ahead Coupling only accept matching in Euro, i.e. all input and output currency data shall be in Euros. This should not prevent local currency orders and settlements. | X | | X | X | X | |

## 5. Other functionalities

These functionalities are not part of the requirements for the price coupling algorithm. They shall need to be properly specified and implemented via Request for Change (which shall include technical feasibility and performance impact assessment) following the Change Control Procedure referenced in Article 10 of the Algorithm Proposal. They will be included in the enduring solution only in case the adequate optimality, repeatability and scalability of the price coupling algorithm is preserved:

| | Owner | | Nature | |
|---|---|---|---|---|
| | TSOs | NEMOs | MCO Function | SEC Function |
| 1. For each bidding zone the Algorithm shall be able to cross-match between orders with different MTUs. | X | X | X | |
| 2. For each bidding zone the Algorithm shall be able to facilitate different MTUs which shall be configurable in each bidding zone; | X | X | X | |
| 3. For the DC interconnectors the Scheduled Flow shall not be below the minimum stable flow ("MSF"), other than at zero. The MSF shall be given for each DC interconnector and activated during allocation, if requested by the owner(s) of the interconnectors after approval by relevant NRAs. The allocation shall take into account the nominations of long term cross-zonal capacity and day ahead cross-zonal capacity, where applicable. The constraints shall be handled on a DC interconnector-by-DC interconnector, multiple DC interconnectors and on a net position (regional) basis. | X | | X | |
| 4. The Algorithm shall be able for each MTU to facilitate the Advanced hybrid coupling, where realized cross-zonal capacity transactions are taken into account in the margin of the Flow-based critical branches (using virtual bidding areas). | X | | X | |

The timeline for these functionalities is included in the Article 5 of the Algorithm Proposal.