European Network of
Transmission System Operators
for Electricity

entsoe

Amendment of the Methodology for Calculating Scheduled Exchanges resulting from single day-ahead coupling - Explanatory note

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Disclaimer

This explanatory document is submitted by all TSOs to the Agency for the Cooperation of Energy Regulators for information and clarification purposes only accompanying the "All TSOs' proposal for a Methodology for Calculating Scheduled Exchanges resulting from single day-ahead coupling in accordance with Article 43 of the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management".

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I. Introduction

Article 43(1) of the Commission Regulation 2015/1222 establishing a Guideline on Capacity Allocation and Congestion Management (hereinafter referred to as 'CACM Regulation') requires that, by 16 months after the entry into force of CACM Regulation, all Transmission System Operators ("TSOs") which intend to calculate Scheduled Exchanges resulting from single day-ahead coupling shall develop a proposal for a common methodology for this calculation.

The common Methodology for Calculating Scheduled Exchanges resulting from single day-ahead coupling (hereinafter referred to as "DA SEC Methodology") developed by all TSOs in coordination with all NEMOs has been approved by all National Regulatory Authorities ("NRAs") on 14 February 2019 in line with Article 9.7(d) of the CACM Regulation.

After more than three years of MNA experience and application of the DA SEC Methodology, NEMOs identified some improvements that could be made to the Calculation of Scheduled Exchanges between NEMO trading hubs.

In Accordance with Article 9(13) of the CACM Regulation all TSOs in coordination propose an amendment to the DA SEC Methodology, which is described in more detail in this Explanatory Note. The proposal for amendment has been developed by all TSOs in close cooperation with all NEMOs.

Capitalised terms used in this document are understood as defined in CACM Regulation, Regulation (EC) No 2019/943of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity (hereafter referred to as "Regulation (EC) No 2019/943"), Commission Regulation (EU) 543/2013, Article 3 of Regulation (EU) 2017/1485 and the DA SEC Proposal.

II. Main changes - Amendment of the inter-NEMO flow calculation part

Currently calculation of inter-NEMO flows is done based on a two-step approach. In the first step, the inter-NEMO flows are calculated in such a way that sum of squared values of Net Financial Exposure between pairs of CCPs is minimized. Moreover, if any indeterminacy is remained after this step, in the second step, a minimization problem is applied using linear and quadratic cost coefficients to avoid any indeterminacies and define a solution consistent with the Scheduled Exchanges between scheduling areas calculated. The main issue that is addressed by this amendment proposal is the fact that in case of low volumes being traded in one NEMO trading hub, the existing DA SEC Methodology allows for high transit flows through these NEMO trading hubs which can lead to high financial exposures of concerned central counter parties (CCPs). This is unnecessary and should therefore be avoided.

In the proposed amendment, the principle of minimizing financial net exposures between CCPs survives, but specific implementation details change:

- Rather than minimising the squared net exposures, the amended proposal suggests to minimize the (linear) absolute net exposures. This should help reduce some unnecessary money transfers that can occur today, and the associated collateral requirements;
- Two new terms are added to the objective:
  - A volume penalty that penalizes directly the flows between NEMO trading hubs and should avoid transit flows between the CCPs;
  - A MinMax term of intra zonal NEMO flows that penalizes only the largest of the internal NEMO flows. This expresses a preference for solutions where NEMO flows are distributed more uniformly;

- The introduction of these additional terms allow the secondary inter NEMO flow objective that exists in the original MNA design to be discarded;

NEMOs empirically tested a pre-implementation of the changes to the NEMO flow calculations. After detailed analysis in the ANDOA community the conclusion was the proposed changes indeed bring the expected improvements.

An important consequence of the changes introduced is that the new objective is a linear rather than a quadratic one. This change to a linear objective mitigates performance problems observed in the Euphemia algorithm that materialize in 15’ MTU test instances. Since SEC is managed by Euphemia, and Euphemia is the algorithm responsible for the calculation step in the DA market coupling process, this makes a meaningful contribution to improve this process and eventually support the transition to 15’ MTU.

In the following Annex 1 we outline the amended Inter-NEMO flow calculation in more detail.

ANNEX 1 - Functioning principles of the SDAC under MNA, Description of the Inter-NEMO Flow Calculation

Disclaimer: the definitions in this document may deviate from the ones used in the DA methodology.

Functioning principles of the SDAC under MNA **Euphemia Release 11.1 / PMB 12.0** **Coupling Part** **Description of the Inter-NEMO Flow Calculation (INFC)**
Version– Shared for Information with TSOs

Version	Date	Description on change	Author
1.0	15/01/2018	Version approved by INC on 15/01/2018	A. Viaene
2.0	31/07/2022	Version approved by ANDOA MSD	ANDOA MSD

Description Flow Calculation between NEMO Trading Hubs (NTHs)

The Flow Calculation between NTHs, also called INFC (for Inter-NEMO Flow Calculation), aims at determining the proper quantities to be exchanged between NEMO trading hubs. It is required for:

- Physical shipping as it shall equilibrate with cross-border exchanges
- The determination of cross-clearing exchanges at financial settlement stage

The INFC model takes into account several types of input data:

- The set of NTH net position values, already computed
- The zonal clearing prices, already computed
- The set of scheduling area flow values, already computed
- The topology connecting NTHs together, i.e. the set of inter-NTH lines and their associated properties (cost coefficients), provided as input data

Optimization principle

Using a prototype version of Euphemia several simulations have been made to test the reliability of the linear method and to check if the expected improvements could really be obtained:

- 351 days with operational MRC data (without 4M MC) for delivery day June 5 2020 till May 21 2021
- Five simulation runs based on data availbale form the external parallel run of the CORE FB MC project for the period from February 17 2021 till August 8 2021 (71 days available).
  - Two simulations with adaptations of the topology to check if also in such situations the reaults are as expected.
  - Three simulations with the real CORE FB MC external parallel run topology; but with different EUPHEMIA parameters to guarantee that the simulations with the linear method are based on the same starting points (prices and cross border flows) as the simulations with the old quadratic method.

In each of these simulations the exposure risk with the proposed alternative (linear) method was reduced. In the simulation with parameters to guarantee the same starting point of the INFC the exposure risk was reduced by 9.71% (for MNA CCPS) or 7,27% (for all CCPs).

The INFC aims at determining the **optimal** flows between NTHs. To do so, it considers a criterion called *financial exposure* between NEMOs (or more precisely between their associated central counterparty clearing houses[1], or CCPs). The exposure minimization approach aims at securing the day-ahead market coupling by limiting the effective financial exchanges between distinct CCPs.

This change proposal replaces the optimization of a quadratic function (based on squared financial exposures) by a linear optimization. The goal of this change is to minimize the financial flows between NEMOs (or more precisely between their associated central counterparty clearing houses, or CCPs) instead of distributing the risks (and therefore collateral requirements) as done by quadratic optimization. Moreover, the current squared net exposures do not correctly represent the real exposure and risk of the NEMOs.

Using linear optimization also improves the performance of the algorithm which will help to ensure the stability of the system in the coming extensions expected for the Day Ahead Market Coupling.

[1] CCPs are financial institutions associated to PXs/NEMOs and responsible for managing the counterparty credit risk related to all exchanges operated in the context of the day-ahead market coupling.

First, the net exposure term *NFE* between each pair of CCPs (A, B) is expressed as follows:

$$NFE_{A|B} = \sum_{t \in T} \sum_{(n1,n2) \in L_{A,B}} \left[p_{n_2}^t \cdot (1 - loss_{n1,n2}) \cdot flow_{n_1,n_2}^t - p_{n_1}^t \cdot (1 - loss_{n2,n1}) \cdot flow_{n_2,n_1}^t\right]$$

$$L_{A,B} = \{(n1, n2) \in L^d | ccp(n1) = A \wedge ccp(n2) = B\}$$

Where t is the market time unit, L^d is the set of directed inter-NTH lines, p_n^t is a shorthand for the zonal clearing price applying on NTH n at period t and $flow_{n_1,n_2}^t$ is the flow from NTH n_1 to NTH n_2. $ccp(n)$ is a function which provides the CCP associated to NTH n.

The net exposure $NFE_{A|B}$ of a CCP A with regards to a CCP B expresses the financial risk that B will induce on A. As can be seen, it is netted over all NTHs and all market time units of one day. A net exposure can either be positive or negative. Also, it can be shown that $NFE_{A|B} = -NFE_{B|A}$ (therefore, as soon as it is non-null, they shall have opposite signs). The sum of all net exposures among all pairs of CCPs shall always be zero (financial balance).

To solve the exposure minimization problem, the INFC is defined in a single linear objective function with three terms with following key principals **where the prioritization is imposed by the parameter α**:

1. Minimization of the overall absolute net exposures – the total financial exchange amongst CCPs. ($\sum_{c \in CPP} \sum_{c' \in CPP \setminus \{c\}} |NFE_{c|c'}|$)
2. Minimization of weighted sum of flows in order to avoid transit flows between NTHs ($\sum_{t \in T} \sum_{(n,n') \in NTH^2} |flow_{n,n'}^t|$)
3. Minimization of maximum flows in order to have more uniform volume distribution in MNAs – by reduction of max scheduled exchange between two NTHs. It is applicable to the exchange between NTHs with no strictly predefined flows with SA constraint (1)

   ($\sum_{t \in T} \sum_{sa \in SA} \max_{(n,n') \in NTH(sa)^2} |flows_{n,n'}^t|$)

<u>*Notational conventions*</u>

When indexing variables or parameters we use set notation to constraint indices. We use lower case for indices, upper case for sets. E.g. $n \in NTH$ to indicate all NEMO trading hubs;

Where pairs of indexes are used we constrain them by cartesian products of sets. E.g. $(z_1, z_2) \in BZ \times BZ$ for all pairs of bidding zones. We can even simplify $BZ \times BZ = BZ^2$.

<u>*Sets and Parameters*</u>

$\overline{flows}_{sa_1,sa_2}$	The flow from scheduling area $\boldsymbol{sa_1}$ to scheduling area $\boldsymbol{sa_2}$
NTH	The set of all NTHs
c, c′	c is a CCP, c′ is other CCP different than CCP c
CCP	The set of CCPs $CCP = \{ccp(n) \forall n \in NTH\}$)
$\overline{NP}_n$	The net position of NTH
L^d	The set of directed inter-NTH flows

$SA(n)$	The function returning the scheduling area associated to NTH n
α	A numeric parameter (in €/MW), which ensures that financial exposures are minimized before volume terms and at the same time guarantees algorithmic stability. The lower α is chosen, the more financial exposures are minimized before volume terms; however, a too small α can lead to numerical problems in the algorithm. The value for α shall be between 0 and $\frac{0.01}{4}$ €/MW (1 cent over 4), i.e. one cent reduction in total net exposures is preferred to the total 4 MWh reduction in Volume terms (2 MWh in term 2. And 2 MWh in term 3.).

Variables (output of the optimization problem)

$flow_{l=(n_1,n_2)}^{t}$	The flow from NTH n_1 to NTH n_2, at time unit t $\forall l \in L^d$

Optimization Model (exposure minimization)

$$\mathbf{min} \overbrace{\sum_{c \in CCP} \sum_{c' \in CPP \setminus \{c\}} |NFE_{c|c'}|}^{\text{Absolute Exposures}} + \alpha \left(\overbrace{\sum_{t \in T} \sum_{(n,n') \in NTH^2} |flow_{n,n'}^{t}|}^{\text{Scheduled Exchanges}} + \overbrace{\sum_{t \in T} \sum_{sa \in SA} \max_{(n,n') \in NTH(sa)^2} |flows_{n,n'}^{t}|}^{\text{Max Volumes}} \right)$$

subject to

$\overline{flows}_{sa_1,sa_2}^{t} = \sum_{l=(n,n') \in L^d \mid SA(n)=sa_1, SA(n')=sa_2} flow_l^t$	for $\forall sa_1 \in \mathbf{SA}, \forall sa_2 \in \mathbf{SA} \setminus \{sa_1\}, \forall t \in T$	(1)
$\overline{NP}_n^t = \sum_{l^-=(n,n') \in L^d} flow_{l^-}^t - \sum_{l^+=(n',n) \in L^d} flow_{l^+}^t$	for $\forall n \in NTH, \forall n' \in NTH \setminus \{n\}, \forall t \in T$	(2)

The first equation ensures that the sum of all inter-NTH exchanges associated to an exchange between two scheduling areas is balanced. The second equation ensures that the sum of exchanges entering/leaving an NTH is balanced with its related net position.

It is assumed that there can be no inter-NTH flow going into opposite direction than an associated cross-border flow.