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To:
Stakeholders and respondents

Report on Public Consultation on amendments to the Algorithm Methodology for the price coupling algorithm and the intraday auction algorithm due to co-optimisation

Pursuant to Article 12 of the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management ("CACM"), All Nominated Electricity Market Operators ("NEMOs") conducted a Public Consultation on amendments to the Algorithm Methodology ("AM") in the period between July 31st and September 25th 2023. These amendments were subject to a relevant request of ACER to All NEMOs for introducing in the AM provisions relevant to the co-optimisation of Balancing Capacity and Energy products, taking into consideration all relevant ACER decisions on the Harmonized Methodology for cross-zonal Capacity Allocation for the exchanging of balancing capacity or sharing of reserves. At the same time, NEMOs also provided proposals for amending accordingly, the Algorithm Monitoring Methodology due to the introduction of Scalable Complex Orders (Scalable MIC/MP Orders) and some changes due to the introduction of the Intraday Actions (IDAs).

The following Market Participants ("MP") and Organizations provided feedback to NEMOs during this Public Consultation: CEZ, EDF, EFET, EnBW, ENGIE, Eurelectric, SPP, UFE, and All TSOs.

All NEMOs would like to thank the MPs for their feedback on this Public Consultation providing both valuable suggestions and concerns about co-optimisation and way forward on implementing a Single Day-Ahead Algorithm methodology.

This report provides a summary of the main topics raised by the MPs and the relevant reactions and suggestions by NEMOs. NEMOs are also coordinating with the TSOs for providing updates on the AM proposals in order to integrate TSOs requirements on co-optimization. The individual responses are published on NEMO-Committee website together with this report.

The summary of the MPs feedback and the responses by NEMOs are organized as follows.



A. Remarks raised in relation to the proposed amendments on AM for co-optimisation

The following areas of interest are commonly identified in general remarks provided by the MPs in their feedback for the SDAC co-optimisation.

I. Impact on SDAC Algorithm performance and calculation time

Considering the impact of the co-optimisation process for Balancing Capacity Market and Energy products, and incorporation of the relevant requirements, to the SDAC Algorithm performance, calculation time and publication deadlines, the majority of the MPs do not support any prolongation on calculation time and publication deadlines which could be considered due to co-optimisation. Taking into account the existing information on SDAC Algorithm performance and required prolongation of calculation/publication time for the 15min products introduction in the Day-Ahead Market the MPs consider that SDAC Algorithm is already at its capability limits and express their serious concerns on the Algorithm performance and on the SDAC. The MPs are seriously concerned about the impact that a complex project with huge and numerous challenges would imply to the algorithm and SDAC performance the possible efficiency loss also due to the increased bidding complexity. In terms of timing and complexity the impact of co-optimisation remains problematic. Beyond highlighting the relevant problems, NEMOs should provide potential solutions.

NEMOs clearly understand and support the concerns expressed by the MPs. The performance of the Algorithm in terms of calculation time, and the compliance with certain criteria set by CACM and the MCO Plan (in terms of publication deadlines and procedures applied) for SDAC is a top priority.

NEMOs also recognize that SDAC co-optimisation, together with the provisioned extension of the geographical scope of SDAC may potentially affect/jeopardize the main objectives of SDAC as reflected in CACM. Recent developments related to the incorporation of 15min products in the SDAC are a clear proof that NEMOs are continuously working on improving the Algorithm and SDAC performance via dedicated R&D, technological solutions and procedures refinement and deliver the expected quality and the compliance level for each requirement introduced in SDAC.

However, it should be noted that the development of reliable modeling is also dependent on the stability/volatility of the provided requirements/principles and the relevant R&D process assessment. Reduction of uncertainty in principles/requirements could be achieved by discarding or postponing some options, or even properly decide for others based on qualitative analysis and thorough R&D, being understood this is a lengthy process for providing also quantitative-based decisions for the MPs consideration on the overall economic surplus and efficiency of the market.

NEMOs fully agree that co-optimization should not be implemented unless some prerequisites are fulfilled: i)there are significant economic surplus gains, ii)the algorithm efficiency is maintained, iii)the anticipated usage of co-optimization made by TSOs is confirmed. Having succeeded on any proof-of-concept via R&D, publication deadlines and

SDAC procedures must be evaluated and be compatible with time-imposed limitations according to CACM.

II. Impact on product selection/availability in SDAC

The majority of the MPs is also strongly opposed to any limitation such as the reduction in the variety of the energy products and bidding flexibility currently offered in SDAC for accommodating the algorithmic complexity of the co-optimisation. Any negative impact of further evolutions of new products and services for the SDAC should also be considered.

The NEMOs clearly understand the point of view of market participants and recognize their need for available products expressing their necessities in terms of submitting Buy/Sell Orders to the SDAC under co-optimisation. The offered products in the Balancing Capacity and Energy markets are already established but the MTU selection for the co-optimization case has to be addressed clearly taking into consideration the required Algorithm efficiency and price signals formation. NEMOs strongly support that co-optimisation of balancing capacity and energy products should be addressed with proper selection of the relevant products MTUs, Order Types and their linking options taking into account the needs of the MPs under the Bidding Guide set-up process.

III. Complexity of Market Participants' bidding process

Another issue raised by all MPs is the complexity of the bidding process introduced by co-optimisation in comparison to the currently applied procedures. The bidding strategy of every MP, historic as newcoming in SDAC, will be much more complex. Many current national BC procurement processes (the same applies to future market-based implementations) are based on a sequential bidding process, where the SDAC happens after the procurement of balancing capacity. This allows MPs to prepare their energy bids with a deterministic view of their BC obligations. In order to replicate the current multi-stage decision process, market participants would need to use an infinite number of „if-then-clauses“, which would have to be modelled in their biddings and would hence require sophisticated linked-blocks products. The bidding considerations that are currently done in a reactive manner, responding to the previous auction result, would all need to be included into one super-strategy („policy“ in stochastic optimization terminology).

Portfolio bidding would become almost impossible, as interdependencies between different assets would be almost impossible to reflect in addition to the BC – energy interdependencies. This increased complexity may lead to a reduction of offered volumes or to risks mark-ups to compensate for an imperfect bidding strategy regarding the technical constraints of the assets, therefore to efficiency losses. It appears extremely complex to develop an efficient multi-product offer matrix for the two markets. The load and ancillary services offers cannot be exchanged 1:1 and exact dependencies have to be respected.

Even though co-optimisation with multilateral linking can in theory be seen as a long-term target, the development complexity of this project, huge and numerous challenges, maintains their doubts on the feasibility of co-optimization implementation and significative

deterioration in algorithm performance and efficiency loss due to the increased bidding complexity. Co-optimisation might prevent storage units (that are crucial for balancing services currently offering a significant fraction of the balancing services) to participate in both the DA and the Balancing Capacity Market. As facilitated with a market-based CZCA methodology, BSPs can adjust their DA bids in order to comply with the balancing capacity results. MW and MWh are not interchangeable for storage units, as restrictions on the energy capacity need to be respected by the generation schedules.

Co-optimisation will thus decrease the efficiency of the stepwise approach currently in place. If decided to move forward with co-optimisation, the MPs welcome a bidding guide in order, notably, to assess the complexity linked to co-optimisation from a BRP/BSP point of view. When estimating the welfare impact, the loss of market efficiency by increased complexity for market participants and unclear price signals needs to be taken into account.

NEMOs understand the issues raised by the MPs concerning changes on bidding process, bidding strategy formation and possible economic loss due to imperfect modeling. The resulting co-optimisation process of multiple balancing capacity products and energy products should favor in a coordinated manner, via economic surplus maximization, both markets and avoid any double allocation between balancing capacity and energy products. Considering the co-optimisation as a combined optimisation process for both balancing capacity and energy products and having proof-of-concept with measurable economic surplus gains, the whole concept, strategies, and procedures followed by MPs, NEMOs and TSOs should be adequately adapted. Interdependency of balancing capacity and energy schedules, portfolio bidding considerations and feasibility of schedules introduce considerable uncertainties to be further revealed also under the Bidding Guide set-up process were selection of Order types and the logical aspects of bid-linking of balancing capacity and energy products will be investigated, and issues raised by numerous BSPs/BRPs and types of production asset technologies will be considered.

IV. Bidding Guide and product features needed for co-optimisation

The MPs as considering the proposed set-up of a Bidding Guide as an absolute need for available links between both energy and balancing capacity markets in order to avoid inefficiencies due to the concomitance of both markets and for reflecting the technical constraints of interdependencies between them. If no multilateral linking was allowed, this would lead to high inefficiencies. The process would then be equivalent to a co-clearing which is definitely not the goal of co-optimisation. As mentioned by the NEMOs, the added complexity introduced by the multilateral linking has not been estimated yet, so its feasibility remains unsure. MPs strongly support the importance of the NEMOs and the TSOs proposal for seeking the MPs feedback on the Bidding Guide set-up as imperative to conclude on the ability of co-optimisation to deliver its theoretical gains. The expectations of the TSOs and NEMOs on the Bidding Guide need to be clarified and MPs should be provided with sufficient time and resources for evaluating the different linking options.

Developing the Bidding Guide together with MPs is considered a useful exercise. Further and relevant to the Bidding Guide some MPs proposing to consider the next steps on co-optimisation R&D on the basis where EUPHEMIA evolution due to 15min products introduction in SDAC is stabilized and at least two (2) TSOs have confirmed their interest to establish a co-optimisation process. Other MPs consider also possible support of having different MTUs for DAM and BCM where BCM MTU at least BCM MTU be twice longer than the DAM MTU (a 15min MTU on BCM understood being too short for the MPs).

Some MPs also consider the Bidding Guide relevant to the prioritization of the products of one market over the other. Such a prioritization, as for example provided under the "unilateral bid linking" (both one-step or two-steps) will not offer any gains compared to the current sequential process and most likely will lead to welfare deteriorations (mentioning explicitly the reduction of cross-zonal capacity for the clearing of energy in the majority of the MTUs and the relevant welfare loss of the SDAC). In the case of non-jointly clearing of energy and balancing capacity the co-optimized SDAC price formation will not deliver consistent prices and leave the MPs the task of forming expectations on the subsequent energy clearing. Even for the case of "multilateral bid linking" some MPs are considering that any applied heuristics (like the "inscribed boxes") fails to correctly integrate the welfare tradeoffs of allocating cross-zonal capacities between balancing capacity and energy and considerable favors the exchange of balancing capacity in a sub-optimal manner. Questions are raised on whether the current co-optimisation implementation path can really bring any benefits and whether it should not re-focus primarily on the joint clearing of energy and balancing capacities, suggested by international comparisons, and implement the sharing of cross-zonal balancing capacities in a second phase.

The NEMOs, as already proposed in the Explanatory Note, are strongly supporting the direct engagement and feedback of the MPs on the Bidding Guide set-up. To this end, the NEMOs are also in favor of a parallel, light R&D, with the support of the SDAC Algorithm provider, that should be time adequate, and to share the qualitative and quantitative results and assessment of possible bid-linking options with the MPs. Prioritization of one market's products clearing over another should be avoided by explicit co-optimisation requirements or bid-linking options. Support of different MTUs in an auction-based market already proved to be problematic for the case of energy cross-product matching between 60min, 30min and 15min products. Considering the targets of energy transition and delivery of balancing flexibility in an environment of high intermittency, MPs and market stakeholders should consider a simplification of requirements and usage of consistent MTUs both for energy and capacity markets also on the basis of proper price-signal formation and efficient resources scheduling. Relevant concerns for prioritization, as reflected also in the available options for unilateral/multilateral linking, will be addressed in the R&D process. The proof-of-concept model will be conditional on favorable outcome of R&D with regard to the assessment on economic gains impact, price signals and efficient cross-zonal capacity allocation.

V. Efficiency and benefit of the co-optimisation

When addressing the efficiency and possible benefits of co-optimisation MPs consider the complexity of the implementation and the concurrent process of estimations on balancing capacity and energy prices. Inefficiencies arising from inaccurate forecasts are considered a major factor. Some participants also consider that the allocation of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves defined through a market-based process has a beneficial intrinsic value. The quality of price signals in the co-optimized market should be properly addressed for market efficiency.

The adequacy of linking options for different kinds of BSP technologies (reference to storage) is also raised as a major factor for the efficiency and benefits of co-optimisation and the algorithm performance, stabilization and efficiency is also discussed. Some MPs are concerned for possible welfare loss due to reduced participation vs any potential welfare gain achieved by a joint DA/BCM clearing and process. The complexity of the co-optimisation project and bidding process is also mentioned in terms of implementation feasibility and solution efficiency. The better efficiency and added-value of the co-optimization implementation, in comparison with the market-based alternative as per Art.41 of the EB GL, remains uncertain as its efficiency relies heavily on the quality of the balancing capacity bids.

NEMOs clearly understand the issues raised by the MPs for the co-optimized allocation of balancing capacity and energy. The market participation in principle relies on forecasts of MPs on prices and resources availability. The co-optimisation of balancing capacities and energy will introduce new requirements and an environment to be considered for all Stakeholders. The purpose of the Bidding-Guide and relevant R&D is to showcase these different approaches and provide usable combinations/links of balancing capacity with energy products for different kinds of BSPs technologies so that the co-optimized SDAC would facilitate market liquidity and not set participation barriers to MPs. The efficiency and feasibility of this project is subject to Bidding-Guide/linking options, proper introduction of requirements and relevant proof-of-concept for economic gains assessment. The efficiency of an industrialized SDAC with co-optimisation will be considered in terms of algorithm performance, stability and procedures applied as a standard market set-up process by NEMOs and all stakeholders.

VI. Need for further R&D for co-optimisation

Most MPs are mentioning that the EPUPHEMIA prototypes presented for co-optimisation, currently taking into account the flow-based compatibility deterministic requirement, can perform with 60' MTU data and one additional Balancing Capacity product besides the Day-Ahead (DA). This initial simplified study did not provide answers to MPs doubts on the feasibility of the target model for co-optimisation and must be completed with 15min MTU data and balancing market capacity products for accessing EUPHEMIAs capability to incorporate co-optimisation for a proof-of-concept prototype. Some MPs also propose the postponement of new simulations until after the evolution so EUPHEMIA for 15min MTU are

fully stabilized and dedicate at least one year for the implementation of the methodology. Transparent R&D efforts should continue in order to demonstrate the feasibility of co-optimisation and the gains expected, without drawbacks on the SDAC performance. Additionally, R&D on multilateral linking options, as the only possible real co-optimisation implementation, should also be proved feasible and research should also focus on whether the process can be implemented without deteriorating the market functioning of both SDAC and balancing capacity markets. The introduction of a deadline for implementation is also considered premature and importunate.

NEMOS agree that a final set of co-optimisation requirements is needed, with R&D providing answers on the raised concerns for the introduction of the full set of balancing capacity products with relevant proper linking and modeling of flow-based compatibility. Any improvements in the SDAC algorithm due to 15min MTUs introduction should be also reflected in the co-optimisation R&D under proper timeline allowing assessment of MPs and Stakeholders. Therefore, considering current necessities on introducing 15min MTUs in SDAC and IDAs set-up, NEMOs support a prioritized approach for the implementation plan for co-optimisation, to be based on a proof-of-concept provided by extensive R&D and assessment.

VII. Implementation process and prioritization

Considering the implementation process and prioritization of co-optimisation implementation over other ongoing market development projects the MPs support that the indicative deadline of 1 January 2029, along with the anticipated timeline for implementation of a fully-fledged methodology in the SDAC algorithm, is very ambitious and implies burdensome requirements. Moreover, it preemptively assumes the outcome of the ongoing prioritization process at MESC level and contradicts the message from chapter 5 regarding the absence of a legal deadline. The MPs outline the clear necessity for extensive R&D estimated to take, as N-SIDE also outlines, between 1.5 and 2.5 years. Considering that the SDAC R&D pipeline is already fully occupied until the end of 2025, in practical terms, this timeline would only allow for one year for the actual implementation of the methodology. The co-optimisation implementation should therefore be put on hold until its feasibility and added value is proven, taking into account all constraints, including the bidding behaviors of market participants, besides the ones applying to TSOs.

NEMOs fully support that a proper prioritization approach, setting priorities between ongoing and future projects, should be followed allowing proper time for full R&D, taking into consideration their market participation needs in a fully transparent way. A certain level of consensus on project prioritization is required, setting proper and well consulted deadlines for delivering meaningful and standard quality results. Implementation of co-optimisation

should be based on a proof-of-concept approach. Industrialization of the co-optimized allocation and applied procedures is dependent on further R&D research but should take into consideration the required changes at the MPs level for their daily workload consideration. NEMOs are working closely with the TSOs to provide a meaningful R&D and implementation roadmap, including the development of a full-fledged Algorithm and Monitoring Methodology.



B. Remarks on monitoring indicators for SDAC and co-optimisation

Remarks concerning the introduction of monitoring indicators for the co-optimized balancing capacity and energy products are provided by the MPs. The "duality-gap" is proposed to be included as an indicator. MPs provide their preference of avoiding usage of indicators which heavily rely on heuristics and propose that indicators providing proof of the efficiency of the economic surplus maximization should be included. Providing more information and metrics for the different components of the economic surplus, in separate for balancing capacity and energy components, is also proposed. MPs raise concerns for the indicators measuring the usage of co-optimisation products and the usage of linking options for such need. Suggestions for the definition indicators providing description of the modification of the network domain, also applicable when using heuristics such as the "inscribed box" heuristics, are also provided. MPs also suggest for clarity on usage/introduction of terms "market side of co-optimisation".

NEMOs are of the opinion that a full set of algorithm monitoring indicators, which provide metrics for algorithm performance, economic surplus maximization, usage of balancing capacity and energy products/Orders and efficiency for co-optimisation is subject to the results of the required R&D as well. However, some of the highlighted clarifications could also be included in the updated AM and AMM texts already.

Considering proposals for including the Duality-gap as an AMM indicator the NEMOs would like to comment that the "Duality-gap" and "optimality-gap" are two different concepts that in some contexts might be similar, but this is not the case for the current SDAC Algorithm implementation.

The Duality-gap is the difference between primal and dual objective values in an optimization problem. The optimality gap, reported currently, is the difference between a best-known solution, e.g. the incumbent solution in mixed integer programming, and a value that bounds the best possible solution achievable in the branch-and-cut exploration heuristic.

As explained in detail in the Annexes B and C of the Euphemia public description, the gap is calculated as the difference between the best bound provided by the solver at the time this gap value is calculated (e.g. when a new solution is found or at the end of the calculation time) and the utility of the best solution found until that moment (e.g. the new solution found or the best solution found, respectively).

Additionally, it is also explained in the annexes that the primal and dual problems in EUPHEMIA are not exactly equivalent to each other (in the terms of the equivalence of variables-constraints duality) due to several reasons. Among them, we have the introduction of additional conditions to solve requirements such as the non-allowance of paradoxically accepted blocks.

Conclusion is that the "gap" (understood as optimality-gap) of the co-optimization could be provided for the sake of transparency, but it is required that several conditions are first met.

One of the conditions is that all the Complex Orders (MIC orders and MP orders) are replaced by Scalable Complex Orders (Scalable MIC orders and Scalable MP orders) and that no Complex Orders are used anymore. This is expected to be fulfilled at or slightly sooner than the 15' MTU go-live.

The other conditions require that there will not exist any new requirements that bind energy related elements such as products or network elements from primal problem with price conditions that are solved in the dual problem (the price problem). In other words, all the variables and constraints in the primal problem should consider all the economic conditions when optimizing economic surplus (welfare) and no additional economic conditions can be added in the dual problem that can condition the acceptance of variables in the primal problem.

If the conditions abovementioned are not met, the optimality gap value could still be extracted but the value will not be meaningful in the sense that it cannot be used to properly measure the true distance to the potential optimum, because the optimality gap is not able to take into account the additional economic conditions that are included in the dual (price) problem, causing that high values would be reported despite, in reality, the solution is already the optimum or very close to the optimum one. In such case, only the comparison of economic utility from the reference calculation and an ex-post calculation with extended time (e.g. with 10 minutes more) can be used as a proxy for assessing whether better solutions can be found in a reasonable amount of extra time.

Additionally, and independently of the existence of order linking between balancing and energy market products in the co-optimization, the optimality gap of the co-optimisation cannot be split for balancing and energy because they are sharing elements of the network such as the line capacities, making this separation of values impossible.

C. Remarks on algorithm methodology proposals due to the introduction of IDAs

Considering the implementation of IDAs and the introduction of relevant amendment proposals in the algorithm methodology, most MPs provide remarks on the efficiency of the IDAs in comparison to continuous trading and the number and timing of the auctions. Some MPs consider that alternative options for pricing intraday cross-zonal capacity, instead of adopting ID auctions, should have been selected.

Most MPs consider the execution of three intraday auctions and the interruption of continuous trading for providing meaningful prices to intraday cross-zonal capacities is jeopardizing the current liquidity of the intraday market. The timing of auctions, as the IDA₂ for example, is considered incompatible with normal working hours. Other MPs also consider the execution of IDA₃ of no actual benefit in comparison to the actual continuous trading model, which is considered the primary tool for the intraday market.

Proposals for regular review and assessment of the ID auctions are also considered by the MPs providing analysis on the effects of the IDAs in terms of efficiency, auctions number, cross-zonal capacity allocation and impact on liquidity of SIDC. An annual report based on relevant indicators should also be provided. Some MPs also provide proposals for improving the monitoring indicators and indicate some discrepancies between the requirements of the intraday auctions in comparison to continuous trading. Shortening the intervals of continuous trading interruptions and retaining limited ID auctions is also proposed by the MPs.

NEMOs are of the opinion that the current implementation of the IDAs is in line with relevant regulatory decisions concerning the number of auctions and execution timeline and they are not in a position to question these requirements. The timing of IDAs is duly set in the decision of ACER 01/2019 and their primary purpose is the pricing of cross-zonal capacity. For this purpose, and in order to increase the trading opportunities, NEMOs requested TSOs to be transparent on the methodologies of capacity calculation in Intraday. Interruption of continuous trading for the safe execution of IDAs is considered necessary for maintaining the integrity of implicit capacity allocation and NEMOs consider the minimum interruptions possible. Monitoring indicators for IDAs efficiency and relevant mark-ups could be incorporated also in the standard NEMOs Annual Report. Any additional periodic reporting, following the same principles as in the SDAC case, w

