ALL NEMO COMMITTEE

CACM Annual Report 2020

In coordination with entsoe

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Please, check the All NEMO Committee and ENTSO-E websites where you can find further background information on SDAC and SIDC as well as a glossary with clarifications about the acronyms used in this report.

ALL NEMO COMMITTEE

Letter to stakeholders

Dear Stakeholders, NRAs, ACER and Commission,

The energy transition and the COVID-19 pandemic are triggering unprecedented transformations and challenges for the power sector. This twin challenge adds to a very fast changing energy landscape characterised by deepening EU integration, a growing penetration of renewable energy and new regulatory requirements.

Despite the difficulties faced by all sectors of the economy last year, NEMOs succeeded in rapidly adapting to the evolving environment and ensuring the stable and safe operation and performance of their functions. Since April 2020, soon after the first wave of the pandemic swept across Europe, NEMOs adopted a wide variety of measures to safeguard continuity of all operations both in the context of Single Day Ahead Coupling (SDAC) and Single Intraday Coupling (SIDC) while ensuring a safe environment for their staff. In its 2020 Annual report CEER acknowledged that "Overall, the fundamental regulatory principles worked well as markets and grids functioned well and absorbed the shock successfully, and the energy system proved to be resilient".

" Transparency and stakeholders' involvement is key to support an effective EU market integration"

ALL NEMO COMMITTEE

In addition to the developments and changes already implemented in SDAC and SIDC, the CACM review process initiated in 2020 opens the door to new changes to the current design of both coupling projects.

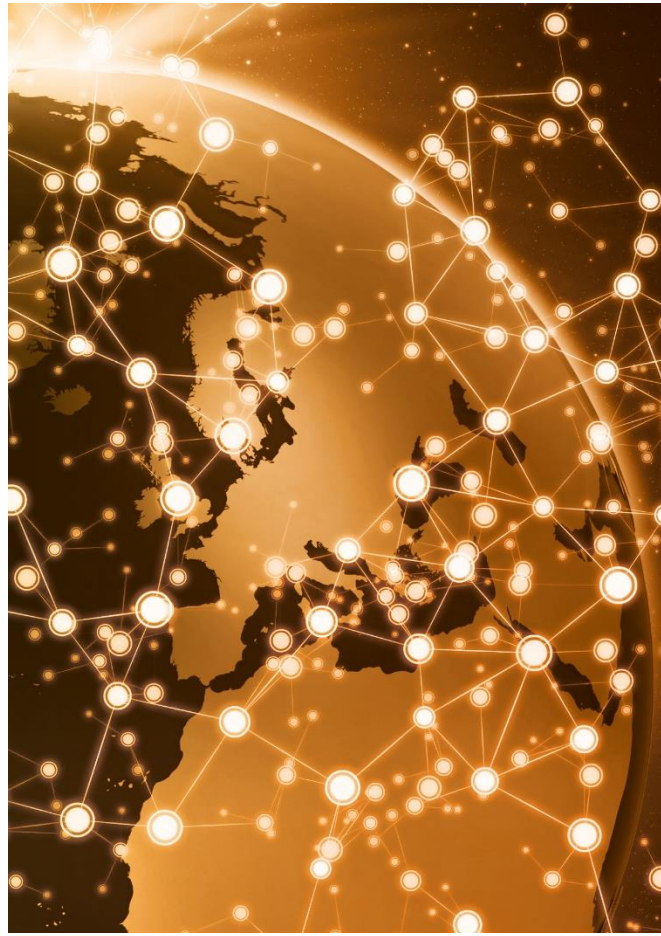
We are certain that these developments further increase the need for and the value of information and data. Information and data allow stakeholders to monitor the progress of existing initiatives, to have better visibility of the next steps needed and ultimately to allow them to take better informed decisions. In this context, the CACM Annual Report is an essential tool providing relevant information to all stakeholders. Although this third issue of the CACM Annual Report follows the structure of the second issue, it contains additional information and data. Furthermore, following the feedback received on previous editions, improvements have been implemented throughout the report.

The year 2020 was the last one in which Great Britain (GB) was part of the SDAC. Although the impacts of Brexit continue to be felt, Great Britain is no longer part of the EU internal energy market. Therefore, it cannot participate in either SDAC and SIDC through GB interconnectors anymore. NEMOs call on the relevant authorities to ensure that alternative models for managing these interconnections will not have a negative impact on SDAC and SIDC operations.

To further improve governance arrangements of SDAC and SIDC, NEMOs and TSOs are implementing a solution built around agreed joint governance principles. The establishment of a joint governance structure is expected to be launched in early 2022.

In 2020, two key elements were added to the regulatory framework: in January 2020, ACER published Decision 04/2020 on Algorithm methodology and Decision 05/2020 on Intraday products methodology. Additionally, following a public consultation, ACER published its Decision 37/2020 on Day-Ahead products methodology on 22 December 2020, this followed a year of review of the methodology by NEMOs.

NEMOs also worked with TSOs and ACER in the development of co-optimisation following ACER Decision 12/2020.



*In the **SDAC**, the most significant milestone reached in 2021 is the entry into force of the so-called SDAC enduring phase, where the whole SDAC geographical scope is coupled. This was achieved by the merging of the MRC and the 4M MC region.*

Furthermore, in December 2020 the SDAC, further extended its reach when the Greek day-ahead market was integrated via the Greek-Italian border. A further step towards a fully integrated pan-European electricity market was the coupling of the Bulgaria – Greece market implemented in May 2021.

The next big step in the SDAC is the implementation of the flow-based market coupling in the Core CCR by February 2022.

With regards to the evolution of the algorithm, we are facing several challenges, to ensure it is fit for the upcoming market design changes, such as the implementation of 15 min MTU in a stepwise manner as requested by NRAs. The implementation of the 15/30 min MTU go-live in the day-ahead timeframe is planned in two waves in 2024. Regional Implementation Projects were established in order to prepare for the go live waves.

*In the **SIDC**, after the successful go-live of the "Second wave", in November 2019, the next couplings were divided into more waves than initially planned. The third wave including Italy is foreseen for Q3 2021, while Greece is expected to go live in Q1 2022 as a fourth wave and Slovakia will joint in the fifth wave. In this edition of the CACM Annual Report, we have included additional information and data to the SIDC chapter, not available in previous editions.*

In 2020, NEMOs and TSOs started the discussion on how to develop and implement IDAs. Some basic elements of the design have already been decided. Indeed, the launch of IDAs will be challenging for several reasons, such as the stringent requirements set forth by the Regulation and ACER Decisions. In addition, although the use of SDAC assets for IDAs will bring efficiency and consistency, the launch of IDAs will be dependent on the evolution of Euphemia.

In the years to come, we will endeavour to continue providing greater insights and status of advancements on the elements above. We plan to include in the relevant sections the various steps and key milestones needed for the implementation of the different elements described above, paying special attention to the changes in CACM.

We reiterate our commitment to work with stakeholders, NRAs, ACER and the Commission in a transparent manner towards achieving a fully integrated, well-functioning and efficient European Electricity Market.

Rafael Gómez-Elvira González

Chairman of the All NEMO Committee

Regulatory framework

Annex I to the ACER Decision 04/2020 on the Algorithm Methodology of 30 January 2020 (hereinafter referred to as *Algorithm Methodology*) provides the regulatory framework for this CACM Annual Report. It includes the methodology for the price coupling algorithm, the continuous trading matching and the intraday auction algorithm also incorporating a common set of requirements in accordance with Article 37(5) of the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management (CACM).

The reporting obligations to comply with CACM Annual Report are listed in the Algorithm Methodology. This report is elaborated in cooperation with TSOs and is structured in the following manner, for both ex-ante market timeframes:

1. **OPERATIONS REPORT,** consists of:

   a) **Report on incidents:** According to article 4(17) and 5(17) of the Algorithm Methodology, it provides a list of incidents in the operation of the relevant algorithm and the application of back-up and fall-back procedures. It includes an explanation for their occurrence, as well as remedies applied or anticipated to prevent their recurrence;

   b) **Report on the decisions on requests for change:** According to article 19(11) of the Algorithm Methodology, it indicates the decision for each request for change, the criteria and the principles behind such decision as well as the assessment report as required under article 17(12) of the Algorithm Methodology; and

   c) **Report on the application of corrective measures:** According to article 12(13) of the Algorithm Methodology, it indicates the corrective measure applied, the reasons for applying it and provides additional information on plans for future measures to address these problems.

2. **REPORT ON THE OUTCOME OF THE MONITORING OF THE ALGORITHM PERFORMANCE:** According to article 8(3) of the Algorithm Methodology, it contains the items listed in Annex 3 and Annex 4 to the Algorithm Methodology, all cases of performance deterioration or non-compliance with an implemented functionality, an analysis on the usage of each product and its impact on algorithm performance (for SDAC only), a description of the reasons for these occurrences and remedies or future improvements (as referred to in article 5 of Annex 3 and article 5 of Annex 4 to the Algorithm Methodology) and a presentation of the conclusions made in cooperation with the relevant stakeholder fora.

3. **SCALABILITY REPORT:** According to article 9(4) of the Algorithm Methodology, it provides the outcome of the assessment of the estimated level of scalability for the coming years and an explanation as to whether this level meets adequate scalability requirements. This section also includes the assessment of the effective usage, anticipated usage and usage range. Finally, it provides the prospective projects scoped as part of research and development with estimated workloads.

4. **REPORT ON RESEARCH AND DEVELOPMENT ACTIVITIES:** According to article 11(8) of the Algorithm Methodology, it provides the status of the research and development activity and the planning of the future research and development activity, including an estimation of the identified workload and the associated budget.

In addition, article 20(3) of the Algorithm Methodology sets the obligation to publish all the above-mentioned reports.

NEMOs & NEMO Committee

NEMOs are the **N**ominated **E**lectricity **M**arket **O**perators designated by the competent national authorities to run the Day Ahead and Intraday markets according to CACM. Currently there are 16 NEMOs designated for both DA and ID, with the exception of Nasdaq and EXAA which are designated only for the Day Ahead market.

The **All NEMO Committee** is the body established by NEMOs to facilitate their cooperation in the delivery of common European tasks. It manages the presentation of the Terms Condition and Methodologies expected under CACM (the so called MCO Plan, the relevant Methodologies and the contractual framework among NEMOs and with TSOs) and ensures NEMO representation, stakeholder's involvement and legal compliance.

Further info about NEMOs and the NEMO Committee can be found at www.nemo-committee.eu

NEMO Committee Activities

REPORTING: Publication of 2019 Cost Report, 2019 CACM Report

COMMUNICATION: a free, live webinar was held on 8 July 2020 about the CACM Annual Report 2019 together with ENSTO-E.

NEMO REPRESENTATION: preparation and representation of NEMO positions in public fora (including among others the Florence Forum and the MESC) and in institutional fora (including the EC Governance Working Group and the Trilateral Coordination Group)

METHODOLOGIES:

- **Algorithm Methodology.** Amendments requested by previous version of Algorithm Methodology, including binding provisions related to algorithm change control, algorithm performance monitoring, introduction of intraday auctions as a solution to provide intraday capacity pricing according to ACER's decision No. 014/2019. Submitted for approval to ACER on July 2019, according to new ACER Regulation, and approved by ACER decision No 04/2020 of 30 January 2020 with amendments. Delivered in cooperation with TSOs.
- **ID product methodology:** Amendment of previously approved ID product methodology, which includes descriptions of the products being supported in IDAs, approved by ACER decision No 05/2020 of 30 January 2020.
- **DA product methodology:** in every two years, all NEMOs shall consult in accordance with Article 12 of CACM Regulation on products that can be taken into account by NEMOs in the single day-ahead coupling. The justification document was published in June 2020 and later approved by ACER decision No 37/2020 of 22 December 2020

NEMO Committee Activities

CONSULTATIONS:

Launched: Public consultation on products that can be taken into account in the SDAC

Replied:

- Response to ACER consultation on its proposed amendments to the all TSOs proposal for a methodology for a co-optimised allocation process of cross-zonal capacity for the exchange of balancing capacity or sharing of reserves
- Response to EC public consultation on amendments to procedural provisions in electricity network codes and guidelines

OPEN CALL FOR PAPER:

- All NEMO Committee issued a call for papers on 6th of July 2020 for new and disruptive ideas on the day-ahead market coupling algorithm. The submission deadline was 31 October 2020. The most promising contributions were presented in a dedicated session of a workshop on the "Future of the algorithm", organised in March 2021, in collaboration with TSOs, NRAs and ACER.

GOVERNANCE:

- **Joint governance: The** high level design of the day-to-day management of the SDAC and SIDC between the TSOs and NEMOs, according to Article 10 CACM is completed. The lean implementation process has started, the go live of the new governance structure is expected in 2022.

FURTHER TASKS:

- **IDA:** All NEMOs in collaboration with all TSOs are working on the finalisation of a high level design for the implementation of Intra Day Auctions, complying with ACER's decision on Intraday Cross Zonal Capacity Pricing. The elaboration of the Terms of reference of IDA commenced in 2020.

ALL NEMO COMMITTEE

ENTSO-E

Enabling the European energy transition through:

- European long term grid planning
- European security analysis
- Technical/market rules
- European platforms
- Standardisation & research
- Regional & global cooperation

ALL NEMO COMMITTEE

Executive summary

SDAC Single Day-Ahead Coupling

High level market data	The SDAC covered a large proportion of the EU, including 27 Countries. Its traded volumes grew to 1 530 TWh with clearing prices heavily declining with respect to 2019, ranging from around 30 €/MWh to 40 €/MWh, with the exception of Nordic Countries, which show annual average prices around 15 €/MWh.
Operations report	SDAC operations continued to show great reliability despite the increase in the number of incidents when compared to previous years. These incidents were mainly related to technical issues belonging to local NEMO or TSO systems and they were not caused by the SDAC algorithm or its procedures. The most critical incident in SDAC led to a decoupling in February 2020. The incident was also due to a local IT issue. Many RfCs of increasing complexity went live, including the Nordic MNA, NordNed MNA and the inclusion of Greece into SDAC. There has been no need to trigger corrective measures.
Performance Monitoring report	The SDAC algorithm continues to perform well. The usage of products experienced a stable growth with respect to 2019 (+ 9%) while the Time To First Solution (TTFS) decreased to -6%, remaining well below the limit of 12 minutes TTFS allowed. Optimality and Repeatability continued to perform well from 2018 to 2019. The individual impact of products study indicates that no product on its own seems to have a disproportionate key impact on performance. Increase of the number of sessions in the scenarios (size of the sample) used seems not to impact significantly to the outcome of the individual impact of products study.
Scalability report	For the period 2022–2024, the demand for scalability is expected to increase significantly. Beyond 2022 the simulated performance seems not to be adequate with the current industrialized versions of the algorithm, but this widely reflects an overestimation of some usages due to the algorithm methodology provisions to calculate growth. Furthermore, the outcome of the R&D shows promising results that can deliver or at least improve significantly the scalability of the algorithm before the distant future scenarios challenge scalability.
R&D report	In 2020 NEMOs and TSOs continued the R&D three year programme launched in 2019. The first set of the outcomes of the research was implemented into production. About 40% of the annual budget was dedicated to topics linked to the implementation of the 15 min MTU. To this respect, among the most significant outcomes, the simulations show that distributed computing along with the SCOs adoption and other performance improvements will allow improvement in TTFS up to 47%, enabling the run of all the simulated sessions within 22 minutes.

ALL NEMO COMMITTEE

Executive summary

Single Intraday Coupling

High level market data	Traded volume in the SIDC reached 82 TWh in 2020, in more than 40 million trades. Annual mean price per bidding-zone ranged from 9.09 €/MWh to 46.89 €/MWh.
Operations report	21 RfCs were implemented in 2020. There were new borders due to new interconnectors, product extensions and Multi NEMO implementation among others. There were 24 incidents in 2020, a figure slightly lower than the previous year. There were three incidents leading to halt in trading, a number significantly lower than in 2019.
Performance Monitoring report	After the go-live of the Second Wave at the end 2019, executed orders and trades have increased steadily confirming the importance of the continuous trading market for market participants. The number of daily orders reached up to 3 million on avarage, while concluded trades reached 175k. The time performance of the systems has been stable throughout the year. The liquidity is concentrated in the last trading hours before delivery with 36% of the volume traded in the hour before GCT and 68% in the last 3 hours before GCT.
Scalability report	Scalability is mainly affected by the growth in markets in combination with the geographical extension and functional changes. The performance indicators focused on processing of orders/trades show that there is a sufficient headroom for the extensions foreseen in coming years. SIDC still focuses on improving scalability in 2021 to ensure resilience and robustness for a number of upcoming RfCs, aimed at implementing requirements such as the cross-matching of different products and other functional changes.
R&D report	The major future changes subject of R&D are transit shipping (enduring solution), intraday auctions, losses and cross-product matching, extended use of 15/30 minutes level, and flow based allocation.

Single Day-Ahead Coupling

SDAC main features

NEMO requirements
- Block products (simple, linked, exclusive)
- PUN & merit orders
- Complex Orders
- Aggregated MTUs orders (curves)

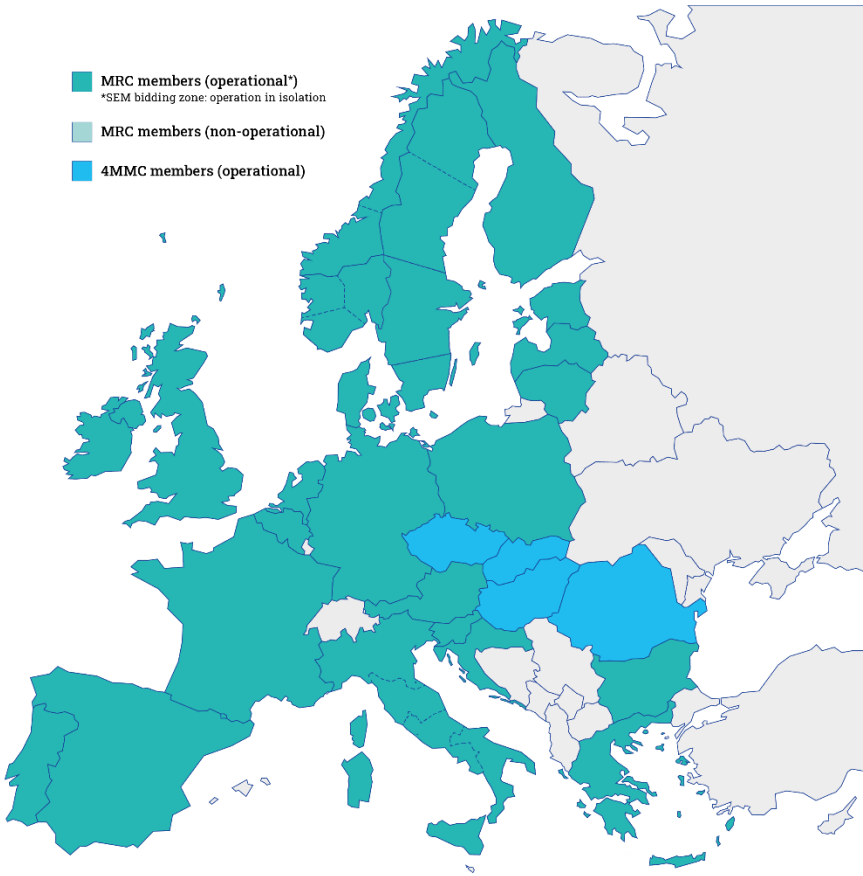
TSO requirements
- ATC and Flow based (PTDF constraints)
- Intuitive flow-based
- Network constraints: Ramping, losses, minimum stable flows...

CACM requirements
- Adequate optimality
- Adequate scalability
- Adequate repeatability
- MNA
- MTU: 60 min

Systems release(s)
- Euphemia 10.4 (18/06/2020 to 01/12/2020)
  - New features: Deterministic Time / parallel ATC lines / external constraints / previous allocations in ramping constraints
- Euphemia 10.5 (from 02/12/2020)
  - New features: LTA inclusion in Flow based regions / Scalable Complex Orders
- PMB 10.2 (from 03/04/2019)

Geographical scope
- MRC (PT, ES, FR, IT, DE, BE, NL, LU, UK, IE, AT, SI, HR, BG*, GR, PL, LT, LV, EE, FI, SE, DK, NO)
- 4MMC (HU, CZ, SK, RO)

The map reflects the situation in 2020. The go live of the Interim Coupling Project in June 2021 merged the MRC and 4MMC perimeters.



High level market data

In 2020, the SDAC covered most of the EU, despite still being divided in two regions (MRC and 4MMC), with Bulgaria being supported in isolated mode and Greece coupled to SDAC since mid December.

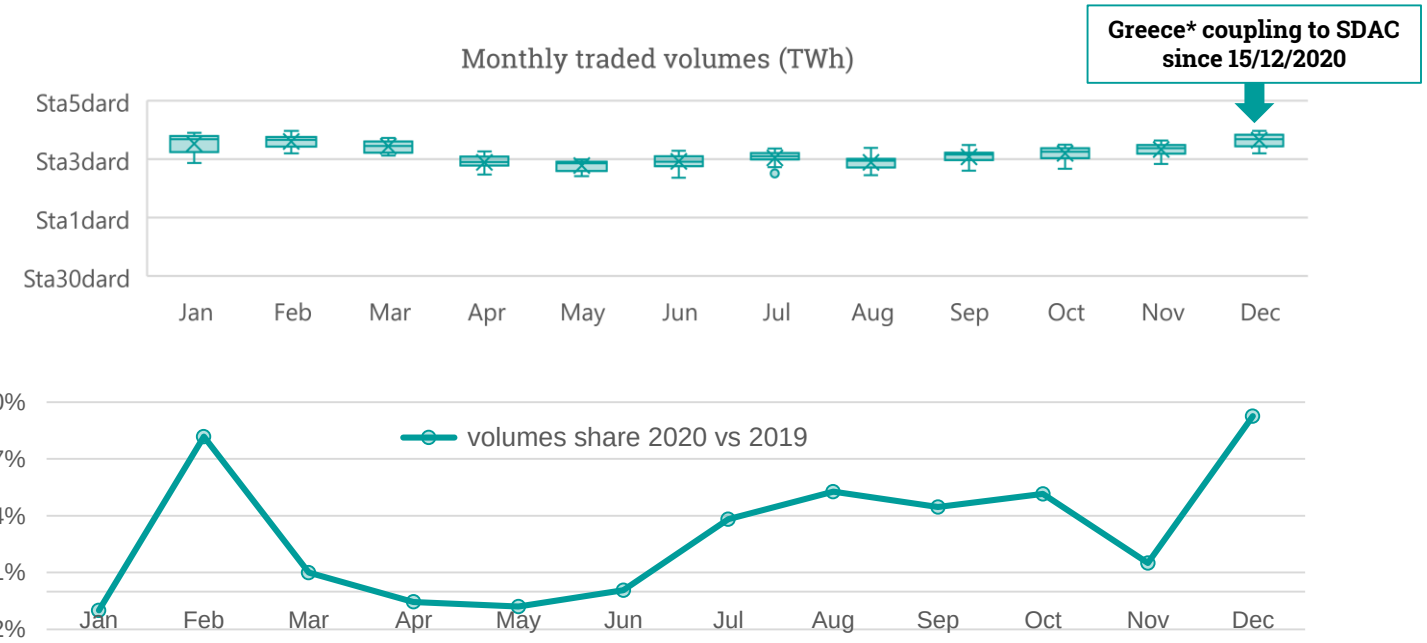
- The «topology» of the coupling included 27 Countries, 61 bidding zones, 35 TSOs and 16 NEMOs, stable with respect to the previous year.
- The «economic dimension» of the coupling, despite the impact of the pandemic, grew slightly (+3%) up to 1 531 TWh, with a downward trend month on month in the period April-May. The welfare managed by the algorithm increased up to an average of around 9B€ per session, of which 8.9B€ were from MRC and 96.4 M€ from 4MMC.
- The clearing prices declined significantly compared to 2019, mainly due to the pandemic situation. With the exception of Nordic Countries — with an annual average price around 15 €/MWh — the average prices converge among 30 €/MWh and 40 €/MWh. Hourly prices ranged between -115 and 1 700 €/MWh, significantly less than the absolute min and max prices set in the related methodology.

Price indexes are computed excluding hourly prices in zones with no traded volume on a daily basis. Yearly prices are computed as simple averages of hourly prices.

Traded volumes are computed based on purchase volumes in each bidding zone.

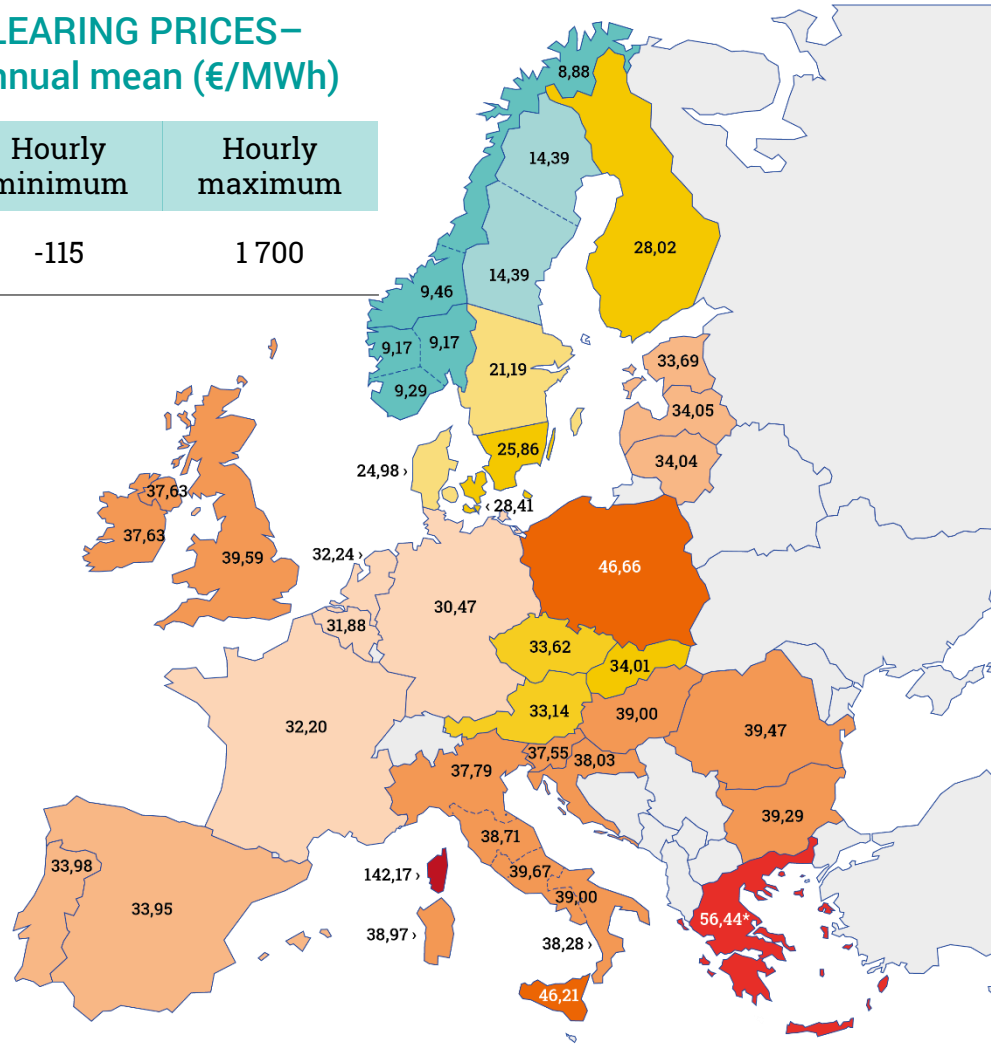
TRADED VOLUMES (TWh)

Annual	Daily average	Daily minimum	Daily maximum
1 531.07	4.19	3.36	4.97



CLEARING PRICES– Annual mean (€/MWh)

Hourly minimum	Hourly maximum
-115	1 700



ALL NEMO COMMITTEE

Operations report

In this section, 2018-2020 SDAC operational events are reported, including: the incidents, requests for changes and corrective measures. Such events are separately reported for both the MRC and 4MMC regions, at the level of the two coupled areas, not at NEMO, TSO or country level.

INCIDENTS

As for the past year reports, incidents are classified according to two criteria (severity and causes), with a classification in SDAC which is similar but not identical to that applied in SIDC (given the differences in the two technical solutions).

- The incidents in 2020 experienced an increase with respect to the past two years, both in MRC and in 4MMC.
- As regards severity, the most critical incident in SDAC was the one that lead to a partial decoupling, which occurred on 04/02/20. The incident was not caused by the SDAC algorithm or procedures, which performed as expected, but by an internal IT issue at EMCO (more details are provided in dedicated paragraph on Decoupling incident 4 February 2020).

"During 2020:

— the Nordic MNA went live,

— a decoupling event occurred, due to local issues."

- In MRC 46% of the incidents were visible to market participants but risk of partial decoupling message was not sent, while in 4MMC the share of incidents not visible to the market participants was 63%. The incidents in which a message of risk of decoupling was sent represent a share of 19% in MRC and 27% in 4MMC.
- In MRC the totality of the incidents fell in the category "Other", that is incidents that are mainly related to technical issues belonging to local NEMO or TSO systems. In 4MMC, interface issues and configuration were the type of incidents with higher occurrence.

REQUESTS FOR CHANGE (RfC)

RfCs are classified per type of requirement, the same classification is used in SDAC and SIDC despite the differences of the two technical solutions.

- Many important RfCs went live in 2020, in particular the implementation of two MNAs: the Nordic which went live on 03/06/2020 and the NordNed on 17/11/2020. Two system releases went live: Euphemia 10.4 (supporting Deterministic Time / parallel ATC lines / external constraints / previous allocations in ramping constraints) on 17/06/2020 and Euphemia 10.5 (supporting LTA inclusion in Flow based regions/Scalable Complex Orders) on 01/12/2020. Alegro cable went live on 3/11/2020, which lead to an increase of PTDF as shown in slide 38, subsequently reduced thanks to the LTA activation in CWE area, starting from mid December. Furthermore on 15/12/2020 the extension of SDAC to Greece was successfully launched.
- The comparison with the previous two years shows that, the SDAC project has managed a growing number of RfCs of increasing complexity, while maintaining a high level of reliability of the algorithm performance, as it will be shown in the next Performance Monitoring section.

CORRECTIVE MEASURE (CM)

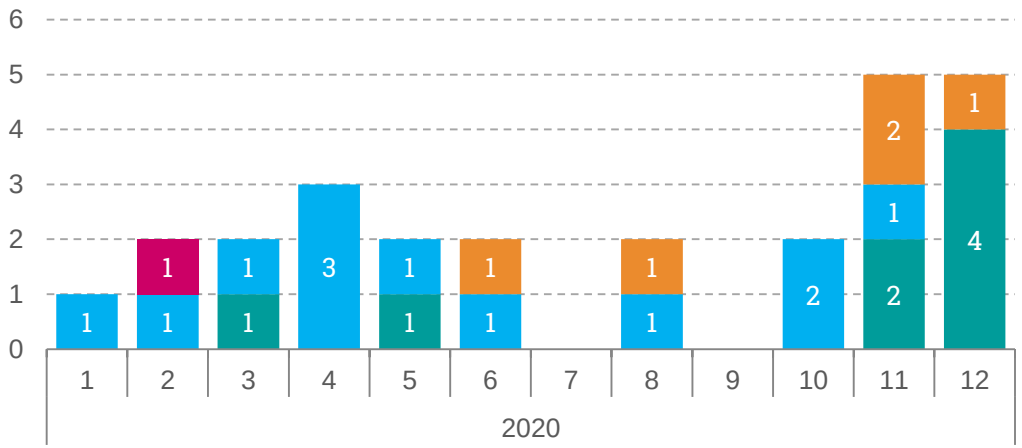
In 2020, no corrective measures were triggered.

DETAILED OPERATION REPORT

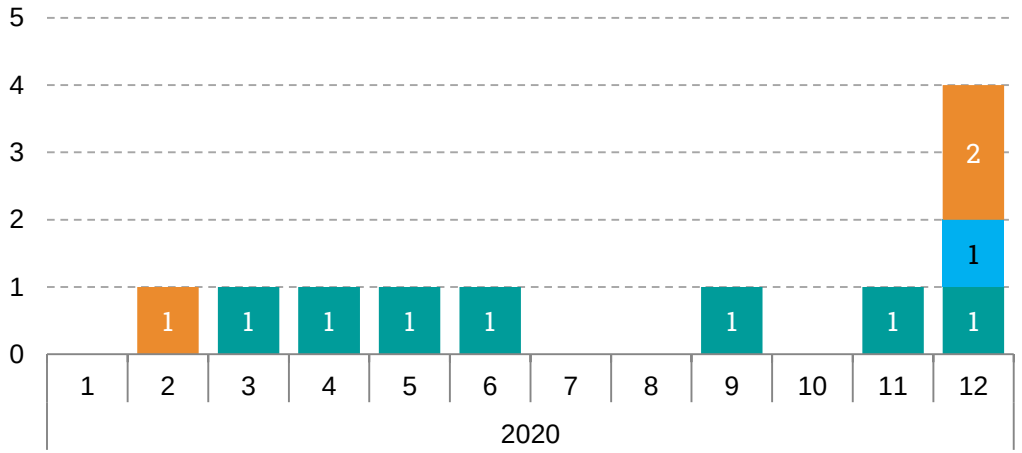
More information can be found in the Excel-file reported in the nemo-committee website at the publications section:
http://www.nemo-committee.eu/publications

Monthly

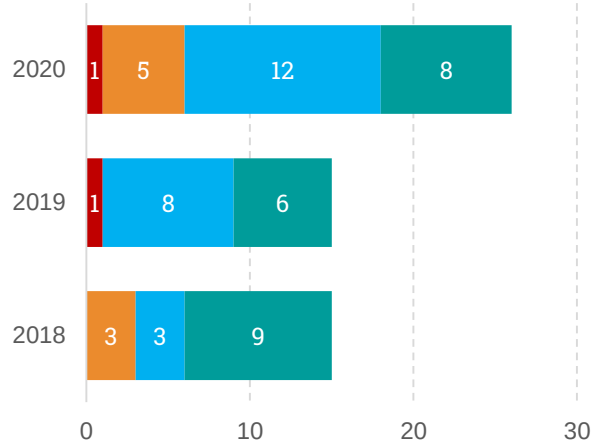
MRC

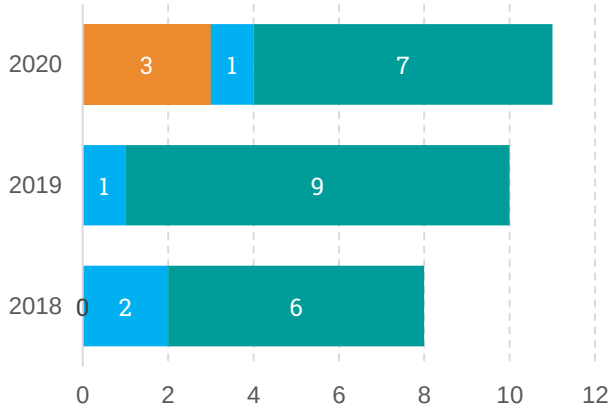


4MMC



Annual





Severity 1
Incidents that led to decoupling

Severity 2
Incidents where message of risk of decoupling was sent

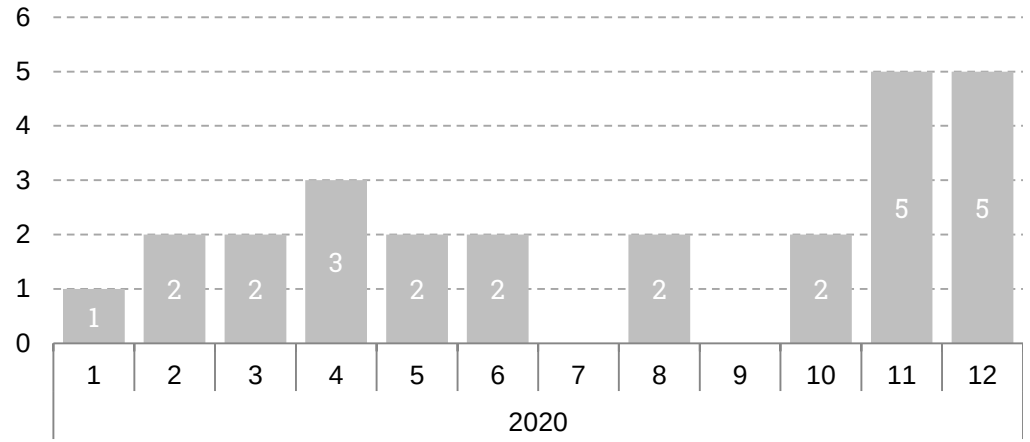
Severity 3
Incidents that were visible to market participants but risk of partial decoupling message was not sent

Severity 4
Incidents that were not visible to market participants

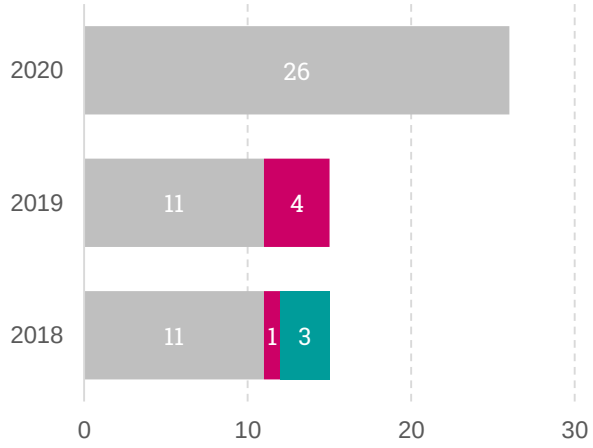
Operations Report: Incidents – causes [1)]

MRC

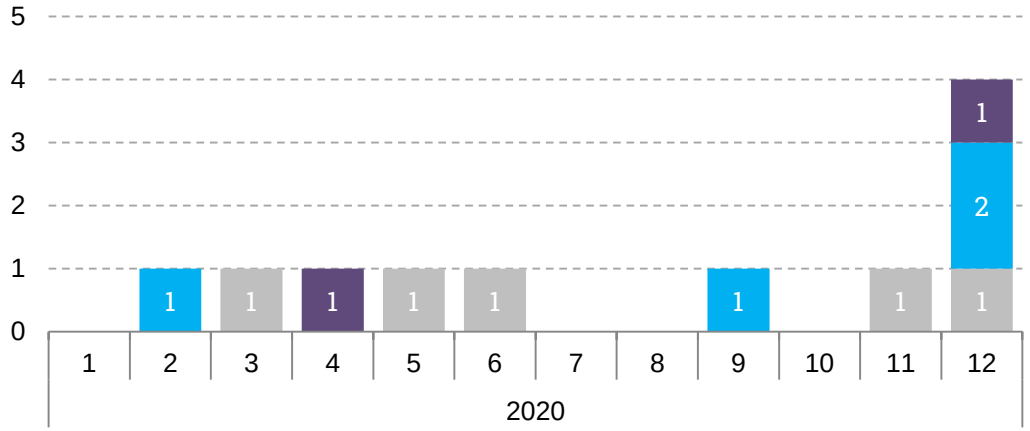
Monthly

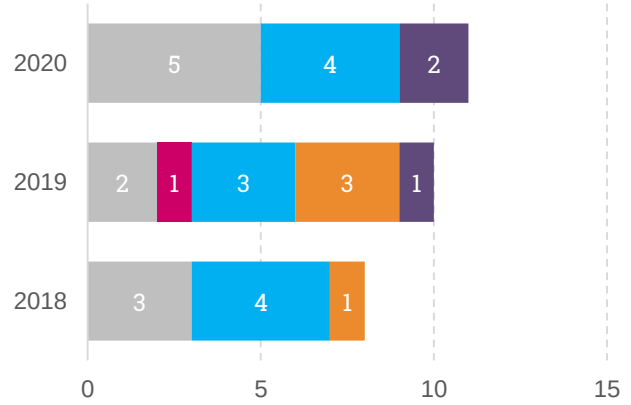


Annual



4MMC





Other

Human error

Unusual process

Interface issue

System bug

Configuration

Decoupling incident 4 February 2020

During the market coupling process on 4 February 2020 a technical issue was experienced that led to a partial decoupling of Nord Pool's CWE order book and the Kontek (DK2–DE), the Baltic (SE4–DE) and the COBRA (DK1–NL) interconnectors.

The incident was caused by a technical issue at Nord Pool and was not caused by the common market coupling algorithm. The beforementioned technical issue was triggered by EMCO Local Trading System's inability to successfully aggregate the purchase and sales curves. This prevented EMCO from submitting the aggregated order book to the central market coupling process.

The issue could not be fixed within the time allocated by the MRC procedures and at 12:43 CET the partial decoupling of Nord Pool's CWE order book was declared and shadow auctions were triggered for the impacted interconnectors.

The borders decoupled were:

- Sweden–Germany (Baltic Cable), for which the capacity was given back to the owners and not allocated in Day Ahead.
- Denmark–Germany (Kontek), for which the capacity was offered through shadow auctions
- Denmark–Netherlands (COBRA Cable), for which the capacity was offered through shadow auctions

The final market coupling results were published at 13:55 CET. The common coupling system worked as expected and ensured the coupling of the remaining part of MRC.

The JSC initiated an in-depth investigation to identify lessons learned to mitigate the risk of similar incidents in the future.

Decoupling incident 4 February 2020

LESSONS LEARNED

- For this particular incident, EMCO deployed a fix that makes it impossible for this kind of a situation to occur again.
- Given the interlinkage of the different levels of procedures (MRC, 4M MC, PCR, regional and local) and the timings, consistency is necessary. For some processes, a certain degree flexibility to adapt to the specific situation at hand is desired. To secure this consistency and to facilitate some flexibility, the parties
  - investigated whether the deadlines for calculation of market results and for declaration of decoupling can be slightly extended to allow more time for the standard processes. It has meanwhile been agreed to assign more time to the calculation and to move the full decoupling deadline
  - investigated whether the timings of procedures on the different levels have to be further harmonized
- To facilitate an efficient functioning of fallback measures in general and the shadow auctions in particular, it is recommended to:
  - offer market participants to participate in SDAC/MRC trainings with the TSOs and PXs, so all can get well familiar with shadow auction processes. This will facilitate all parties including the market participants to be prepared for handling a decoupling incident.
  - evaluate in the longer term if the growing maturity of SIDC and forthcoming Intraday Auctions (IDAs) can represent a solution which fits better in the day-to-day process, as this would be replacing a fallback option with an ordinary process.

INVESTIGATION REPORT

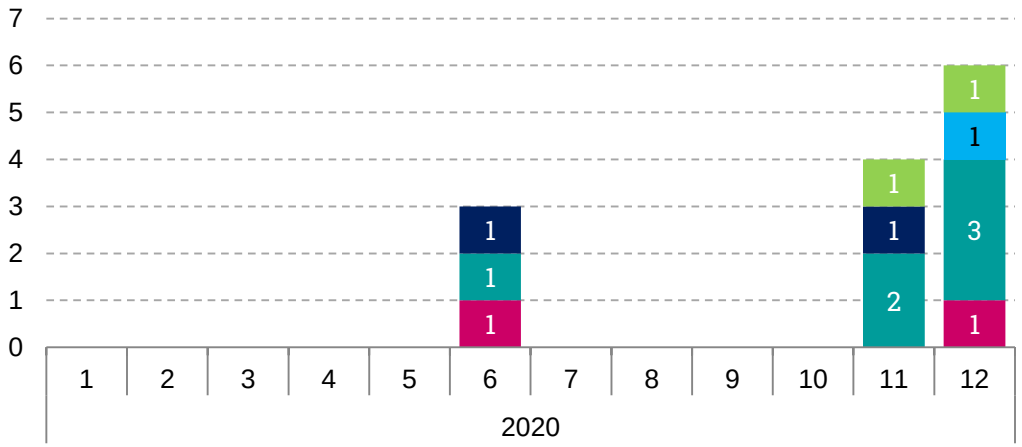
The full investigation report was published on 19 March 2020:

http://www.nemo-committee.eu/assets/files/sdac-report-on-decoupling-4th-feb-2020.pdf

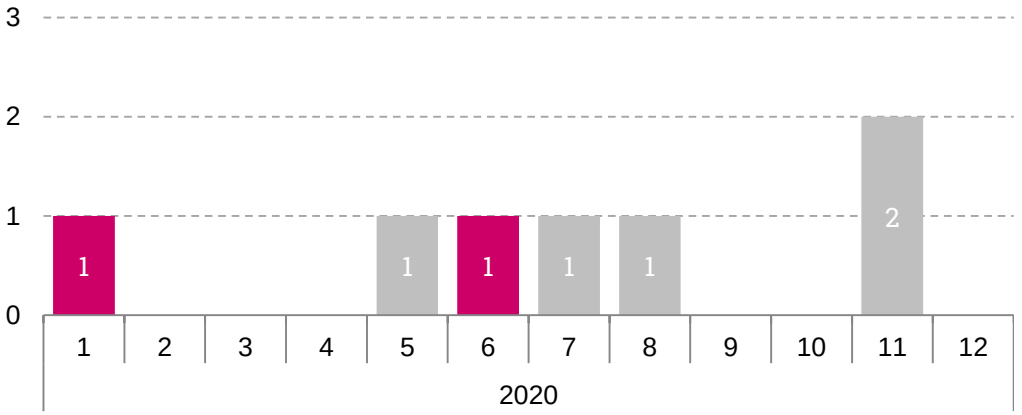
Operations Report: Request for change (RfCs) [2)]

Monthly

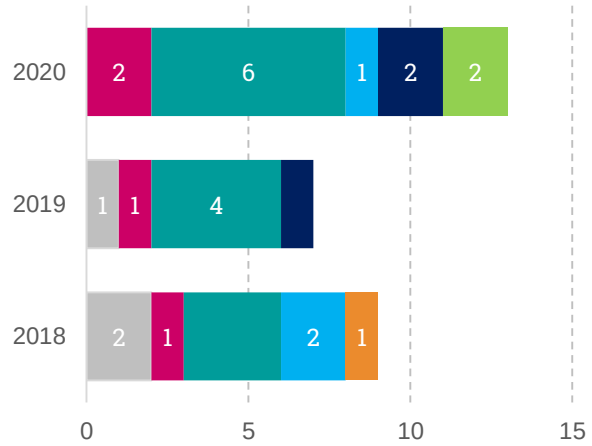
MRC

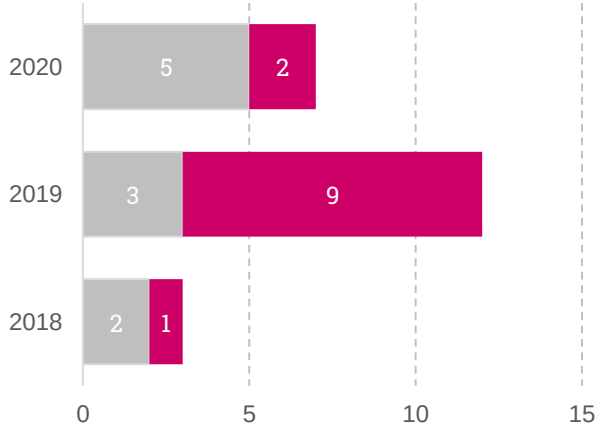


4MMC



Annual





Other

System Release

Network topology

Geographical extension

Products extension

MNA implementation

Flow based

Operations Report: Request for change (RfCs) 2)

MRC

Requirement	Name	Go-live Date*	Reason	Initiator/Owner	Details
MNA extension	Nordic MNA	03/06/2020	CACM	NEMOs/TSOs	
System release	PMB and Euphemia 10.4	17/06/2020	Other	NEMOs	Network constraints and parallel lines feature
Network topology	Parallel lines GB-FR and external constraint Alegro cable	17/06/2020 03/11/2020	Other Other	TSOs TSOs	
Flow based	Flow based plain in CWE	03/11/2020	Other	TSOs	Used instead of flow based intuitiveness
Network topology	NordLink cable (DE-NO)	17/11/2020	Other	TSOs	
MNA extension	NordNed MNA (NO2-NL)	17/11/2020	CACM	NEMOs/TSOs	
System release	PMB and Euphemia 10.5	01/12/2020	Other	NEMOs	LTA inclusion
Network topology	Removal LBI bidding zone	15/12/2020	Other	TSOs	
Geographical extension	Incorporation of Greek Bidding zone in SDAC	15/12/2020	Other	NEMOs/TSOs	
Flow based	Activation of LTA in CWE	15/12/2020	Other	TSOs	
Network topology	Hard Brexit Change in EIC code for Calabria	31/12/2020 31/12/2020	Other Other	NEMOs/TSOs TSOs	

4MMC

Requirement	Name	Go-live Date*	Reason	Initiator/Owner	Details
System release	Minimum bid volume change in LTS	01/01/2020	Other	NEMO	
Other	Annual certificate change	29/05/2020	Other	NEMO	
System release	Implementation of E 10.4 and PMB 11	23/06/2020	Other	NEMOs	
Other	Annual certificate change	01/07/2020	Other	NEMO	
Procedure update	Update of BUP 06	21/08/2020	Other	4MMC PWG	
System release	ETS patch installation	30/09/2020	Other	NEMO	
Other	Change of Service Provider	19/11/2020	Other	NEMOs	
Procedure update	Update of procedures due to change of SP	19/11/2020	Other	4MMC PWG	

*Go-live Dates are reported as trading dates. Their corresponding delivery date is trading date plus 1 day

Performance monitoring report

During 2020 the performance of the SDAC algorithm continued to be highly positive.

- The usage of products continued to show moderate growth, with respect to 2019 (+9%), in line with the previous year trend.
- The Time To First Solution (TTFS) – despite the implementation of a growing number of increasingly complex RfCs – remains well below the 12 minutes allowed for algorithm running. The average annual TTFS is 3.2 minutes, showing a significant improvement in performance when compared with 2019 (-6%). This result was made possible thanks to R&D, which allowed the algorithm to tackle and solve more complex problems in less time.
- Optimality and Repeatability continued to show good performances, as shown in previous years.

"The performance of the SDAC algorithm continued to be highly reliable, ensuring yearly average TTFS of 3.2 mins, well below the maximum the 12 mins allowed."

For performance monitoring, the indicators considered are listed in the draft annex 3 of the AM approved by ACER with decision 4/2020. The chapter addresses the past four years spanning from 2017 to 2020 in order to allow for a better appreciation of trends and seasonality.

The daily values for these indicators were considered as well as the maximum, minimum and average values observed throughout the year 2020. These are reported in tables in the following slides and compared with the average values of the past three years. When relevant, monthly values are also reported in separate graphs, with evidence of the main events which took place within the timeline of the graphs.

Following the approach from the previous years reports, usage of inputs to the algorithm and output of the algorithm are computed separately for MRC and 4MMC Regions, while the algorithm performance indicators are calculated only on the MRC perimeter, due to its greater scope and complexity.

Notes on the calculation of these indicators are included at the end of the report as Annex 2 and further details are provided in the Monitoring Procedure published on the NC website.

USAGE INDICATORS

- The data on the table show the actual level of usage of inputs to the algorithm separately for MRC and 4MMC regions. The greater dimension and complexity of MRC with respect to number and type of both orders used and network constraints respect to 4MMC is reaffirmed. The following analysis then focuses on the trend observe in MRC region.
- In 2020, we see a general increase in the average values for **product usage** (slides 32-33) indicators with respect to 2019. The indicators growth in 2020 with respect to 2019 is on average 9%, with some usages exceptions: the “number of linked families”, after the huge increase in 2019 (+177%), decreases down to -59%. Similarly, the “total number of complex orders” shows a reduction (-10%) and traces back to the average level of 2018. Opposite behaviour for the “total number of PUN orders”, which shows a growth rate equal to 43%.
- Among the **geographical extension** usages (slide 38), the major variations can be traced back to the Nordic MNA (Jun 2020), NorNed MNA (Nov 2020) and Greece coupling to SDAC (Dec 2020), which are reflected in the number of NEMO trading hubs.
- All indicators related to **network constraints** usage (slide 38) show an increase, in particular the increase in FB-PTDF constraints, starting in Nov 2020, can be traced back to the implementation of the Alegro cable. Such variation has been compensated in Dec 2020 by the activation of LTA in CWE.
- The analysis of time series shows a seasonal effect in the usage of different kind of orders, with an increase during the winter period. This is particularly evident when observing the trend of the total number of blocks orders (slide 34).

>>>

PERFORMANCE DATA

- The analysis of TTFS shows an improvement, with a reduction of the average annual value in 2020 of 6% w.r.t. 2019. The performance of the SDAC algorithm continued to show high reliability, with a yearly average of 3.2 mins (in MRC perimeter), and monthly values decreasing in June 2020 and Dec 2020, following the entry in operation of Euphemia 10.4 and Euphemia 10.5 respectively. Such data shows that the algorithm was able to absorb the increase in TTFS observed in May and Nov after the Nordic MNA and NordNed MNA go-live respectively. The improvement in performance in 2020 with respect to the previous years can be observed by comparing the TTFS duration curves for these two years (slide 42). The improvements reduced the TTFS even for the most challenging sessions, which never exceeded 7 minutes (well below the almost 10 minutes reached in 2018 and 2019).
- The welfare indicators show good quality of solutions, with negligible changes in the overall welfare for either first to final solution found in the standard 12 mins and for final solution to the one after extended calculation time. Values of the indicators are very similar to the obtained in 2018 and 2019, despite the usage level has been increased for most indicators.
- The level of repeatability in 2020 increased measured by the frequency indicator per delivery day is always higher than 98%, and the impact of differences over the relevant values, whenever present, proved to be negligible (average annual value around 0.2%). The same value with the deterministic time, measured for the first time in 2020, is, as expected, equal to 100%.

OUTPUT INDICATORS

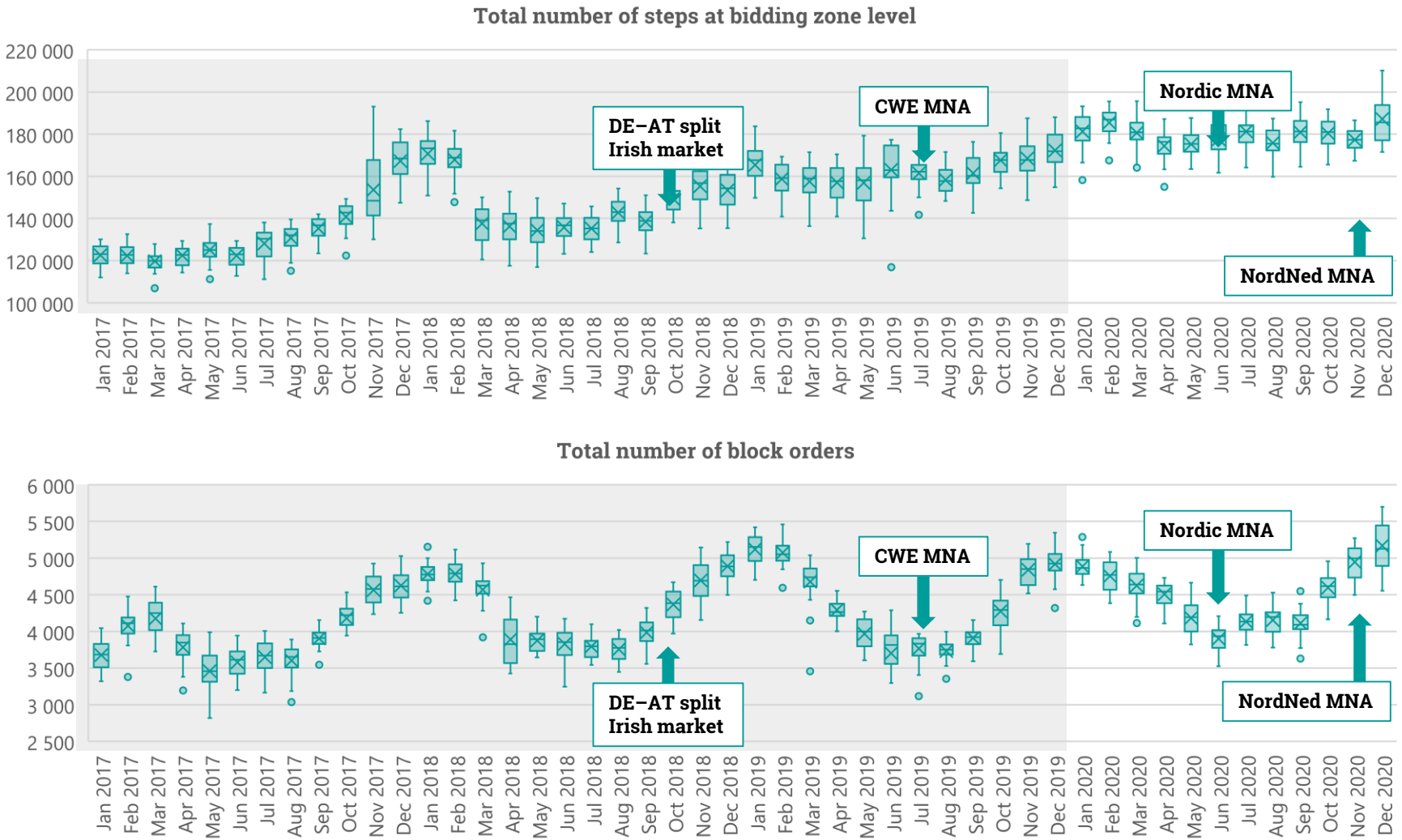
- Data shows that the daily welfare contribution of the MRC reached on average 8.9 B€, higher than level of 2019 (8.7 B€). The contribution of 4MMC, slightly decreasing, reached about 96 M€.
- Curve orders are responsible for the majority of the traded volumes, followed by merit orders, block orders and complex orders.
- While the TTFS show a reduction on the time needed from the algorithm to find the solution, the time spent on the different phases of the algorithm calculation process are increasing. In particular the time to solve root node for the master computer increased compared to 2019 average value, while decreasing w.r.t. 2017 and 2018.

Usage indicators Indicators to describe the Usage of SDAC products (Annex 3 of AM Article 10)	Year 2017	Year 2018	Year 2019	Year 2020		
	MRC	MRC	MRC	MRC		
	Avg	Avg	Avg	Avg	Min	Max
Total number of steps at bidding zone level*	132 609	146 278	162 366	179 776	154 979	210 199
Total number of block orders	3 938	4 265	4 351	4 498	3 524	5 698
Total number of block order exclusive groups	112	129	135	145	108	181
Total number of linked families	102	52	144	59	25	119
Total number of complex orders	83	91	105	95	77	111
Total number of demand merit orders	811	781	927	985	460	1445
Total number of supply merit orders	36 886	38 486	39 495	41 085	36 232	45 950
Total number of PUN orders	5 336	5 065	5 416	7 732	5 935	9 494

* This figure is the sum of number of points or steps of the aggregated bid curves or stepwise curves in all bidding zones in all 24 hours of the day respectively.

Usage indicators Indicators to describe the Usage of SDAC products (Annex 3 of AM Article 10)	Year 2017	Year 2018	Year 2019	Year 2020		
	4MMC	4MMC	4MMC	4MMC		
	Avg	Avg	Avg	Avg	Min	Max
Total number of steps at bidding zone level*	15 934	14 517	14 384	13 965	11080	16 330
Total number of block orders	156	172	141	103	34	177
Total number of block order exclusive groups	3.7	3.4	4.8	3,7	0	8
Total number of linked families	2.6	2.8	5.1	1,5	0	6
Total number of complex orders	–	–	–	–	–	–
Total number of demand merit orders	–	–	–	–	–	–
Total number of supply merit orders	–	–	–	–	–	–
Total number of PUN orders	–	–	–	–	–	–

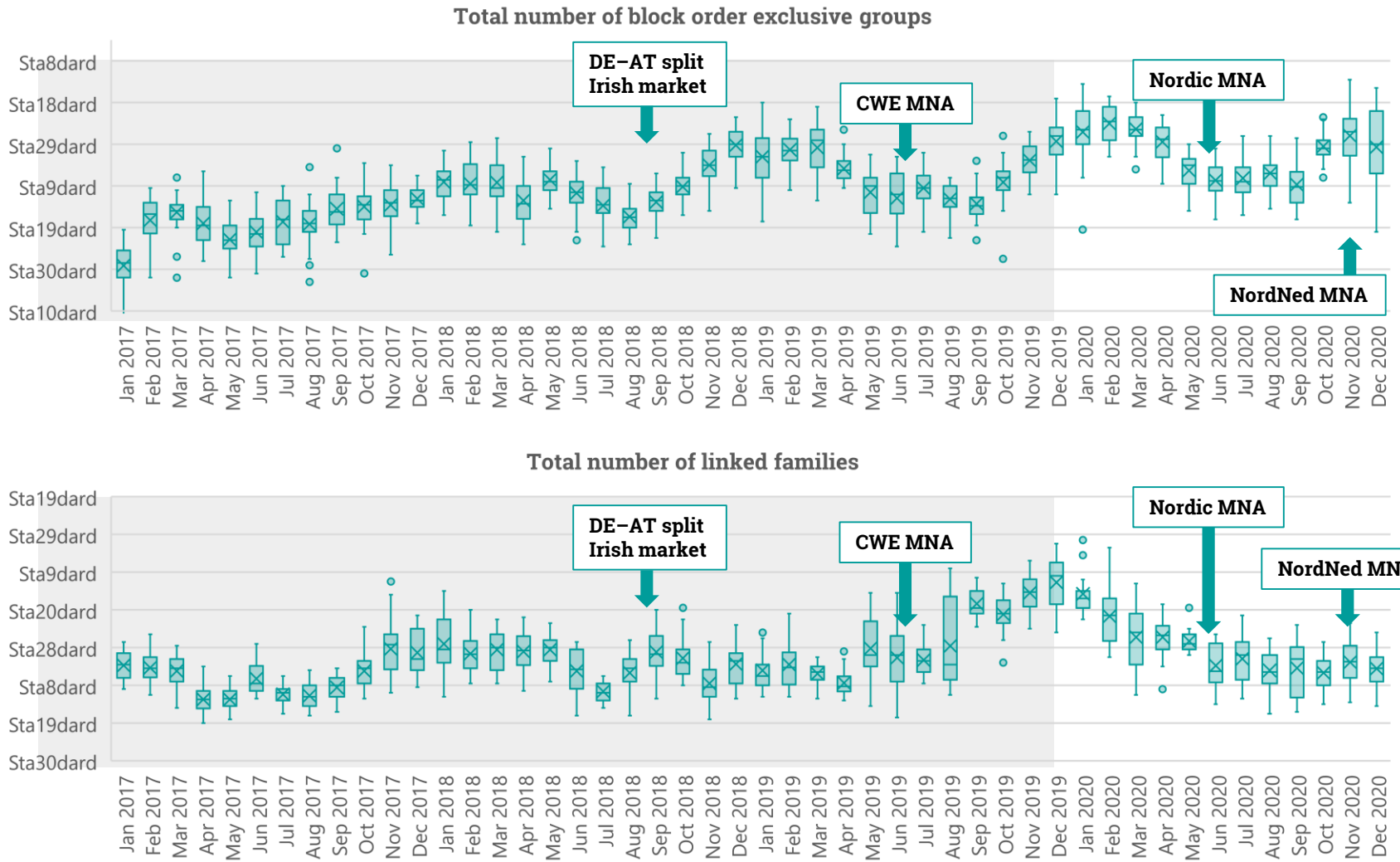
* This figure is the sum of number of points or steps of the aggregated bid curves or stepwise curves in all bidding zones in all 24 hours of the day respectively.



Weak seasonal variation, average increase w.r.t.2019 around 10%, in line with previous years trend.

Marked seasonal variation, after the increase in 2018, average annual level almost stable in 2020 w.r.t. 2019 (+2%).

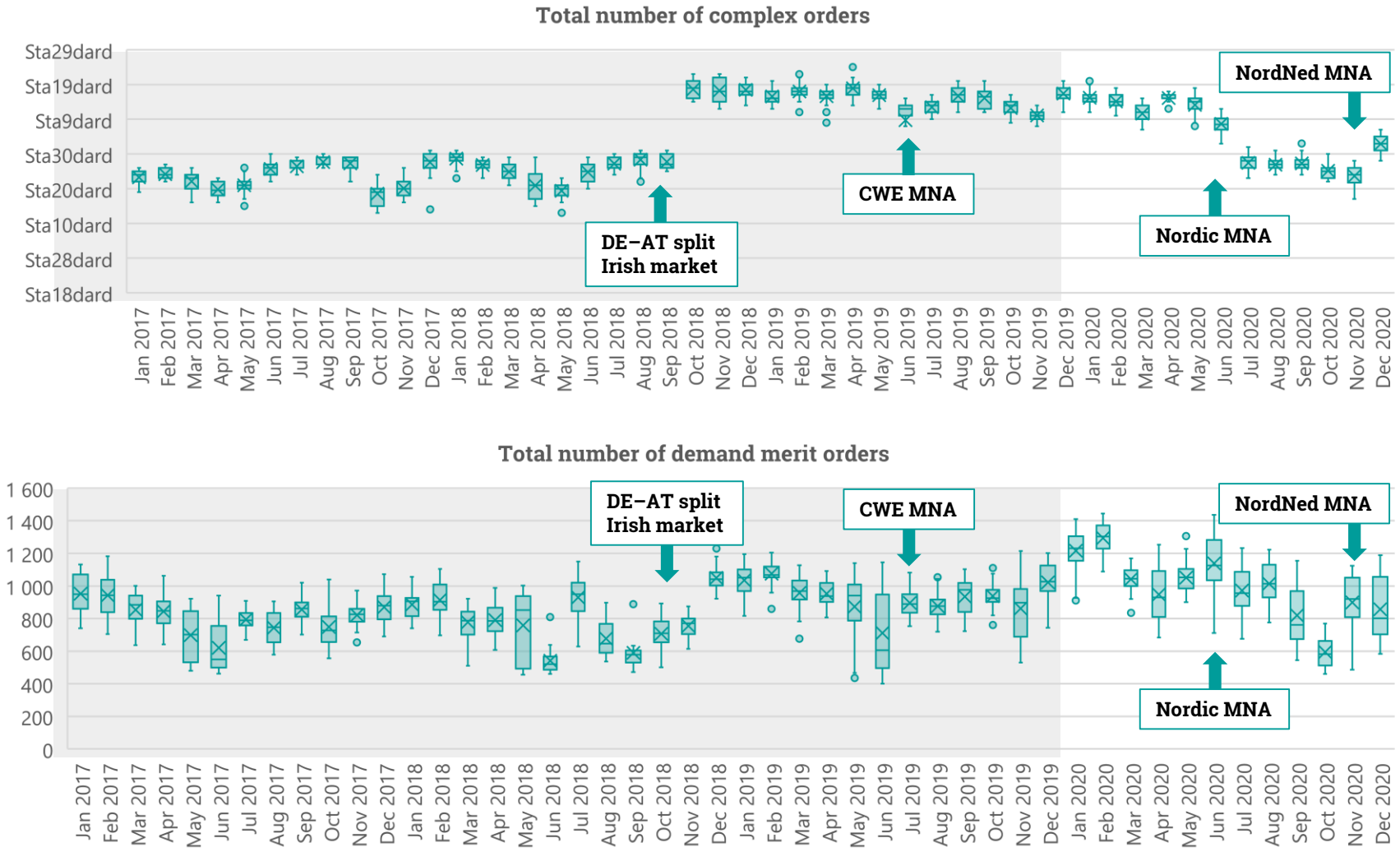
Performance monitoring report: Usage indicators – MRC [3)]



Average increase w.r.t.2019 around 7%, in line with previous years trend.

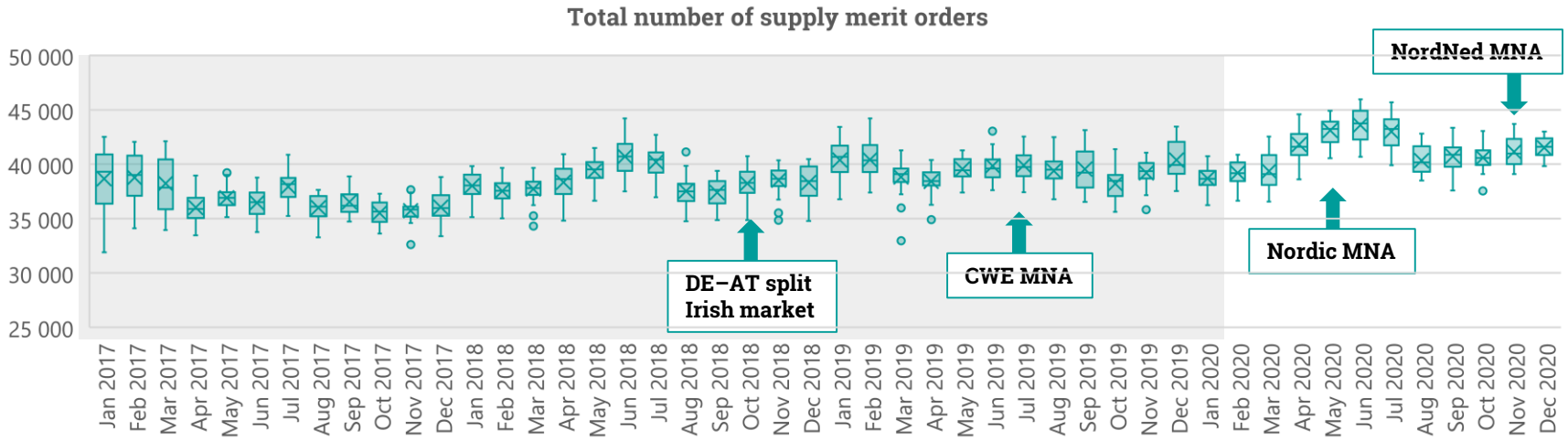
Reduction of the usage after the increase of 2019, stable value in the second half of the year.

Performance monitoring report: Usage indicators – MRC [3)]

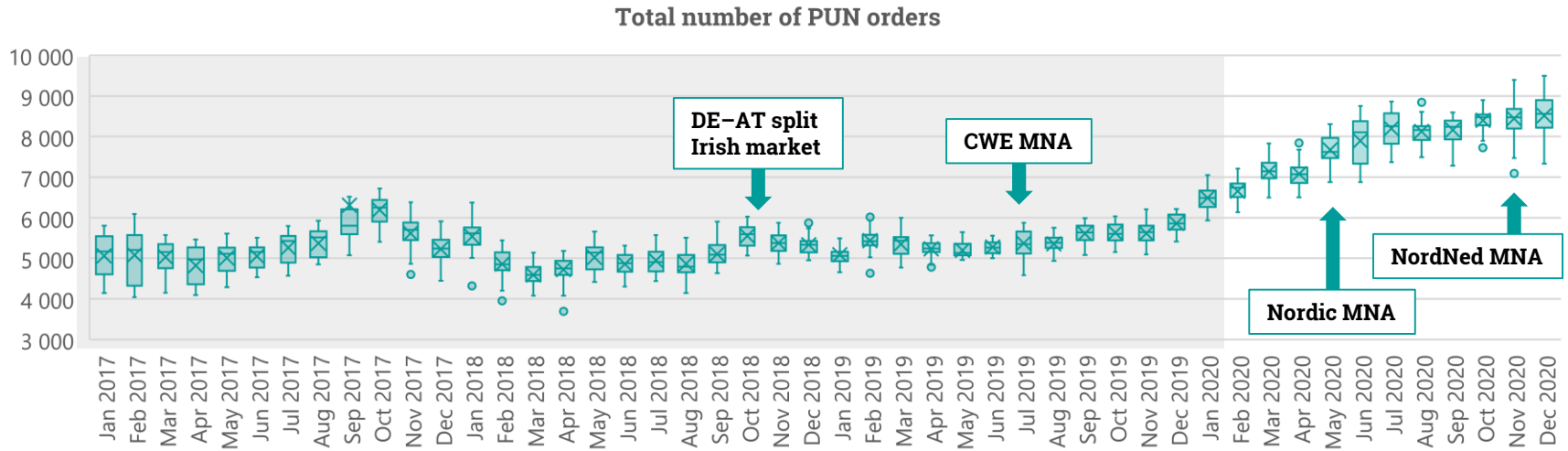


Reduction of the usage after the increase in 2018, stable value in the second half of the year, with an upward rebound in December 2020.

Moderate increase of the average usage w.r.t. 2019 (+6%).



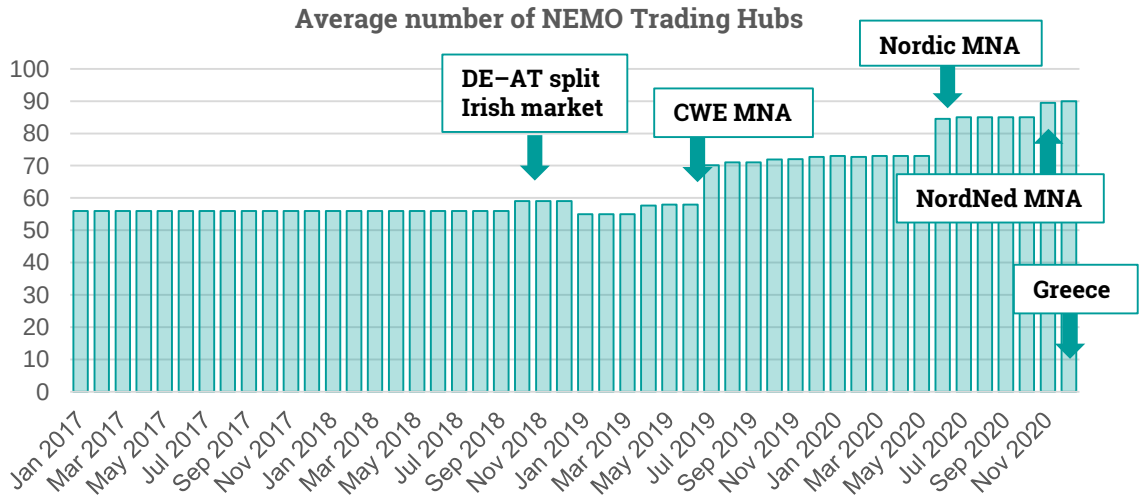
Moderate increase of the average usage w.r.t. 2019 (+7%).

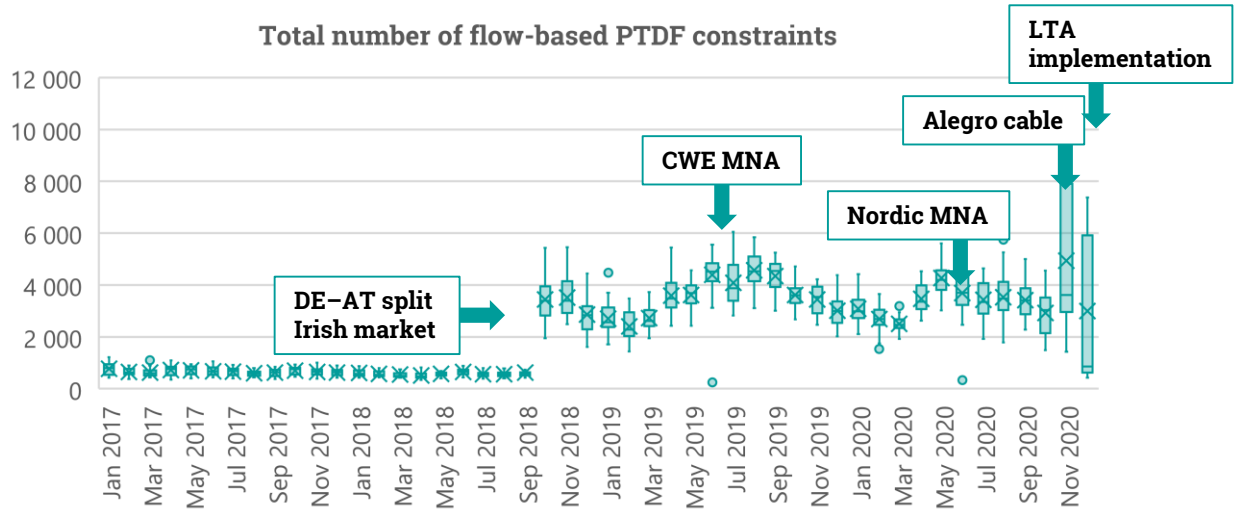


Steady increase of the usage since the beginning of 2020, due to the increase of the number of bids indicating price. Orders without price indication are submitted to the algorithm and aggregated into each hour and zone and counted as one.

Performance monitoring report: Usage indicators – MRC [3)]

Usage indicators		Year 2017	Year 2018	Year 2019	Year 2020		
		MRC	MRC	MRC	MRC		
		Avg	Avg	Avg	Avg	Min	Max
2) Indicators to describe geographical extension of the SDAC (Annex 3 of AM Article 11)	Number of bidding zones	56	57	55.3	56.2	55	57
	Total number of flow-based bidding zones	4	4.2	5	5.3	5	7
	Number of scheduling areas	56	57	57	59.2	58	60
	Number of NEMO Trading Hubs	56	57	64	80.7	65	90
3) Indicators to describe the network constraints (Annex 3 of AM Article 12)	Total number of bidding zone lines	72	74	75	78	77	81
	Total number of flow-based PTDF constraints	666	1 256	3 545	3 409	336	9 951
	Total number of scheduling area lines	72	74	82	88	87	91
	Total number of NEMO Trading Hub lines	72	74	108	161.5	106	190



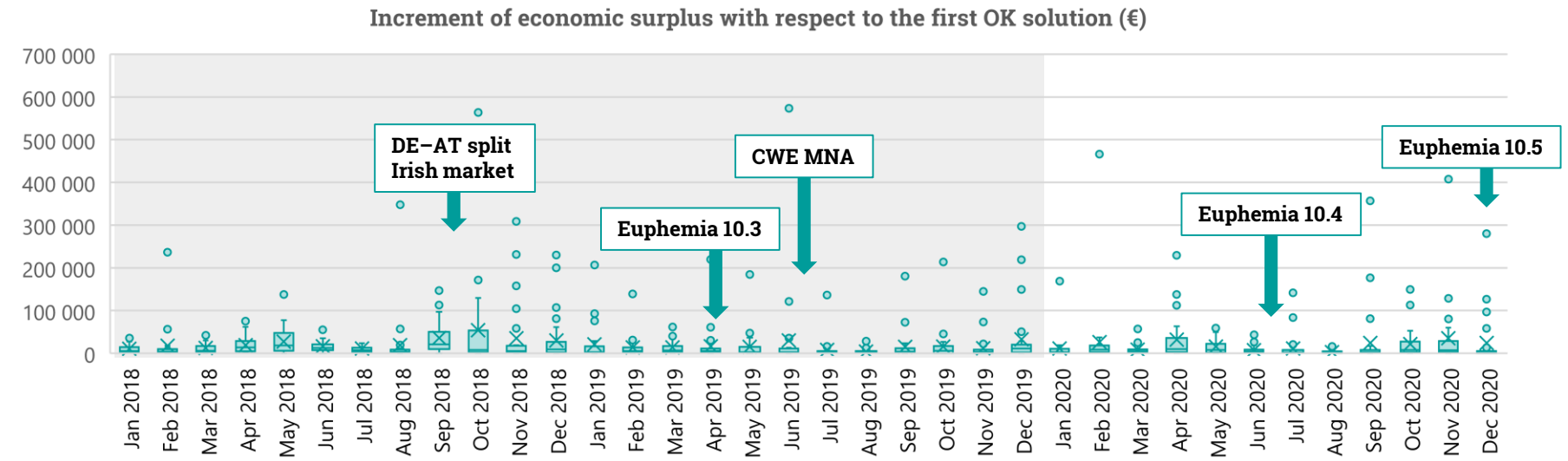


Usage indicators		Year 2017	Year 2018	Year 2019	Year 2020		
		4MMC	4MMC	4MMC	4MMC		
		Avg	Avg	Avg	Avg	Min	Max
2) Indicators to describe geographical extension of the SDAC (Annex 3 of AM Article 11)	Number of bidding zones	4	4	4	4	4	4
	Total number of flow-based bidding zones	–	–	–	–	–	–
	Number of scheduling areas	4	4	4	4	4	4
	Number of NEMO Trading Hubs	4	4	4	4	4	4
3) Indicators to describe the network constraints (Annex 3 of AM Article 12)	Total number of bidding zone lines	3	3	3	3	3	3
	Total number of flow-based PTDF constraints	–	–	–	–	–	–
	Total number of scheduling area lines	3	3	3	3	3	3
	Total number of NEMO Trading Hub lines	3	3	3	3	3	3

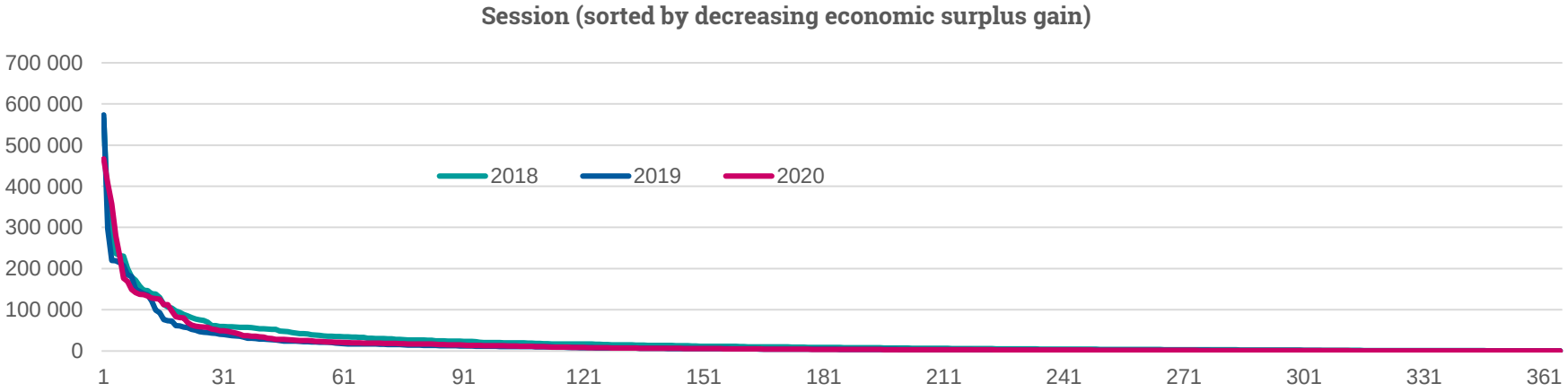
Performance monitoring report: Performance indicators [4)]

Performance		Year 2017	Year 2018	Year 2019	Year 2020		
		MRC	MRC	MRC	MRC		
		Avg	Avg	Avg	Avg	Min	Max
1) Ability to maximise economic surplus (Annex 3 of AM Art. 7)	(a) Increment of economic surplus with respect to the first OK solution (%)	0.000180%	0.000280%	0.000190%	0.000205%	0.000000%	0.004729%
	(b) Economic surplus gain after increasing allowed calculation time by 10 minutes (%)		0.000062%	-0.000020%	0.000063%	-0.002395%	0.002688%
2.a) Algorithm repeatability without deterministic time. Repeatability frequency indicator, measured as number of equal values over total values for the relevant results (%) [bigger is better]		Not available	99.70%	99.65%	99.83%	98.31%	100%
2.b) Algorithm repeatability without deterministic time. Repeatability impact of differences indicator, measured as average of the contributions of the sums of absolute values of differences over the sum of the absolute values, for all the relevant results (%) [lower is better]			0.54%	0.61%	0.24%	0%	4.63%
2.b) Algorithm repeatability with deterministic time. Repeatability frequency indicator, measured as number of equal values over total values for the relevant results (%) [bigger is better]			Not available		100%	100%	100%
2.b) Algorithm repeatability with deterministic time. Repeatability impact of differences indicator measured as average of the contributions of the sums of absolute values of differences over the sum of the absolute values, for all the relevant results (%) [lower is better]					0%	0%	0%
3) Algorithm scalability (Annex 3 of AM Art. 9) TTFS (min)		2.90	3.39	3.43	3.21	1.59	7.04

Ability to maximise the economic surplus

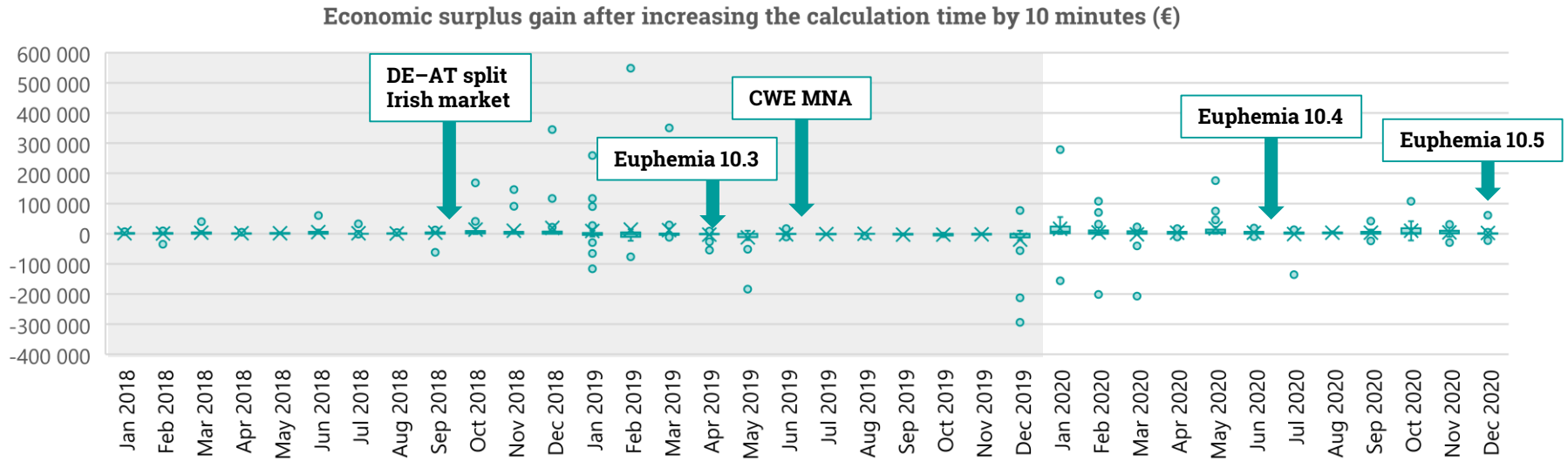


Increment of economic surplus with respect to the first OK solution: maximum increase around 500 k€ over 9 000 M€ average daily welfare. Negative axis is not shown due to the absence of negative values.

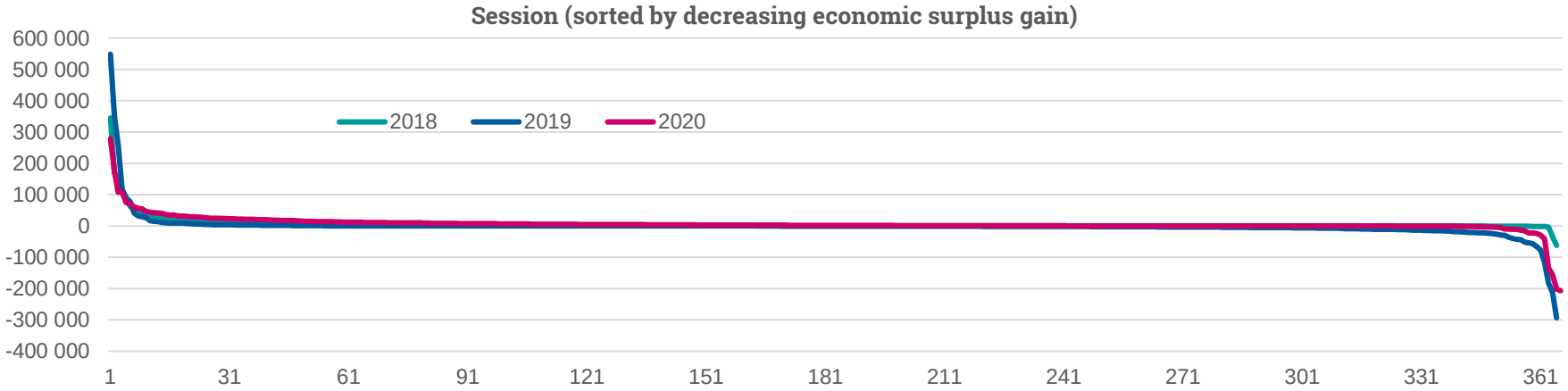


Duration curve shows the Increment of economic surplus with respect to the first OK ordered in descending order of magnitude, rather than chronologically. Values of the indicators are very similar to the obtained in 2018 and 2019, despite the increased level of many usages.

Ability to maximise the economic surplus

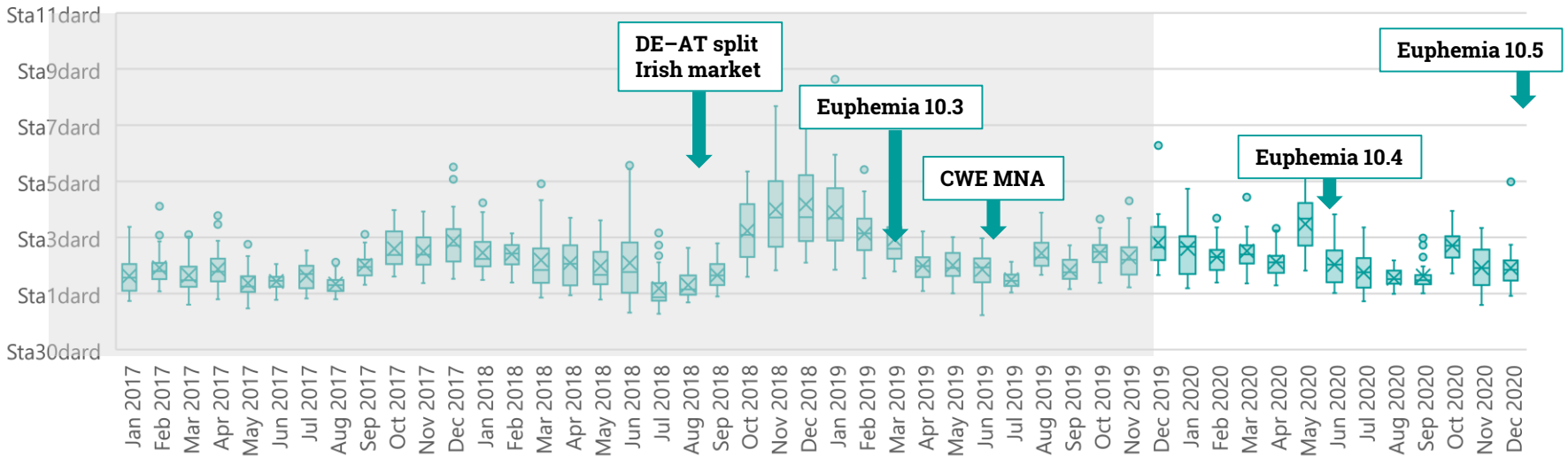


Economic surplus gain after increasing the calculation time by 10 minutes: maximum/minimum gain ranges among +300 k€ and –300 k€ over 9 000 M€ average daily welfare.

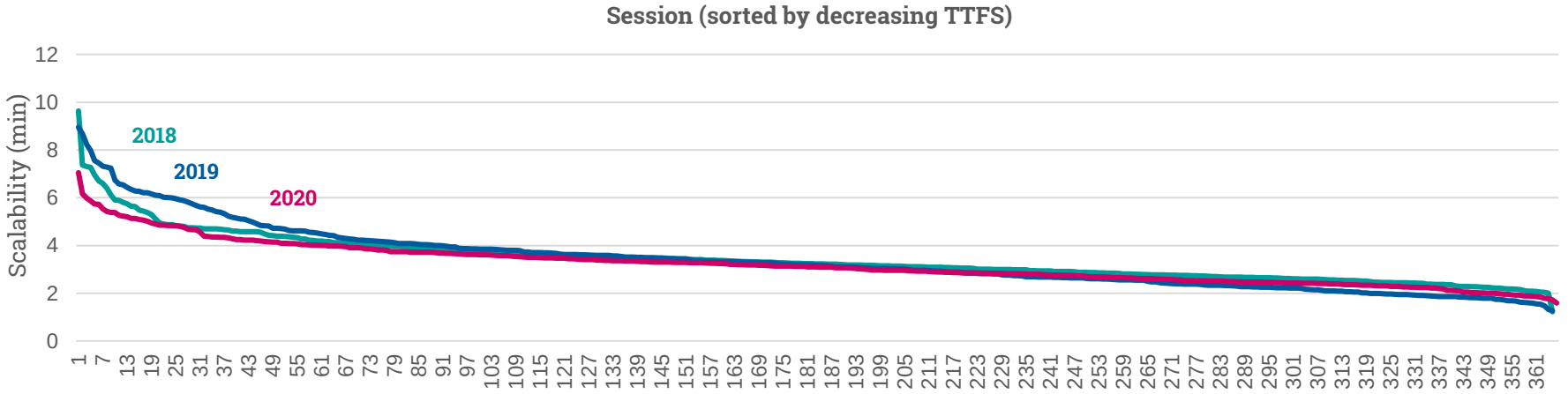


Duration curve shows the Economic surplus gain after increasing the calculation time by 10 minutes ordered in descending order of magnitude, rather than chronologically. Values of the indicators are very similar to the obtained in 2018 and 2019, despite the increased level of many usages.

Algorithm scalability (min)

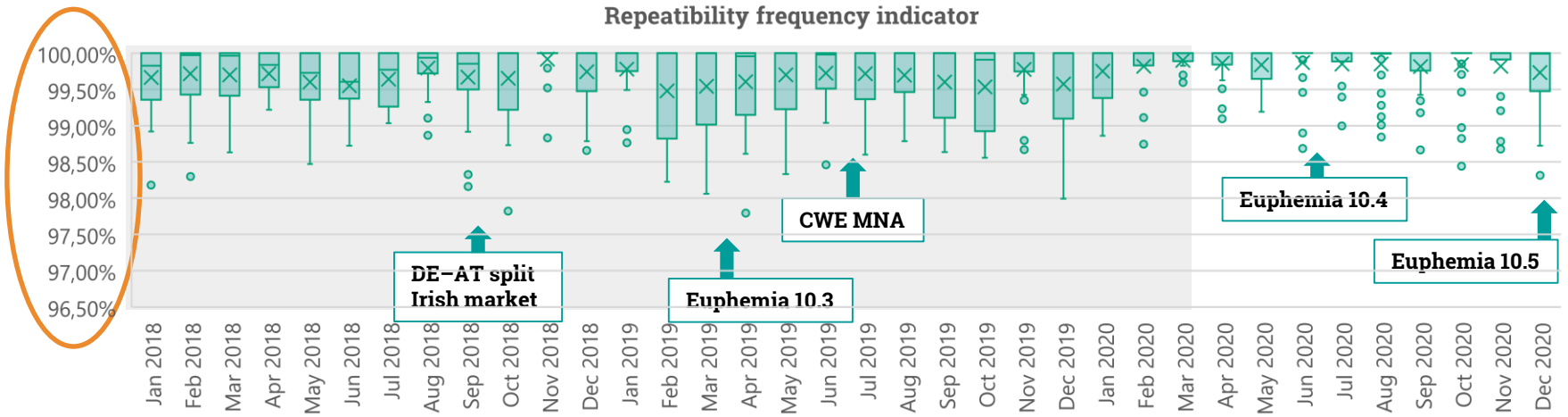


Improved performance obtained thanks to the go-live of updated Euphemia releases: Euphemia 10.4 takes into account network constraints and parallel lines features and Euphemia 10.5 with the LTA inclusion.

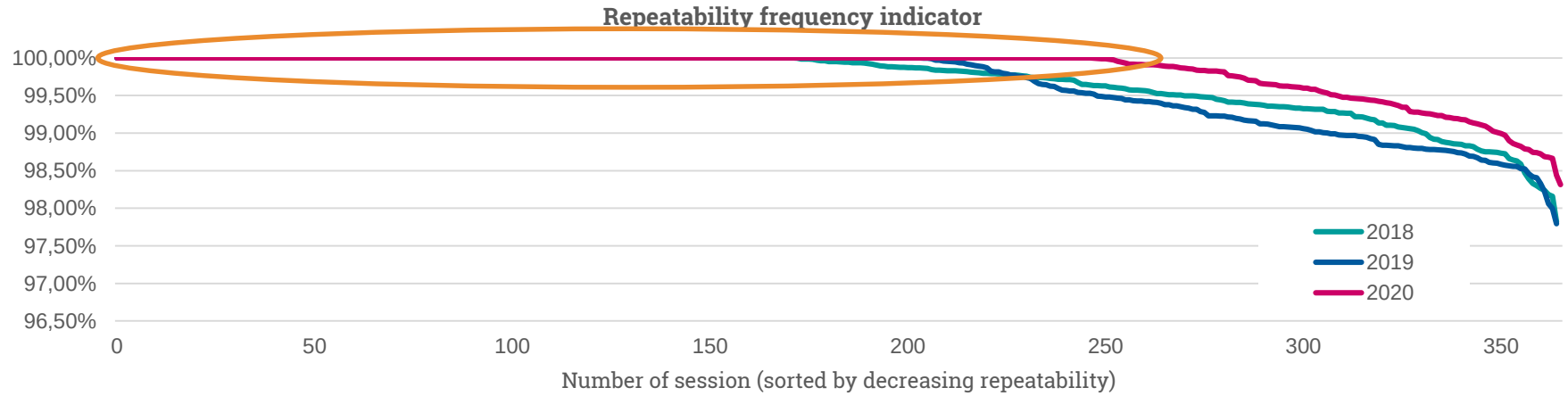


Duration curve shows the TTFS ordered in descending order of magnitude, rather than chronologically. Improved performance is demonstrated by fewer days with long resolution times when comparing 2020 curve with the previous-years ones.

Algorithm repeatability without deterministic time

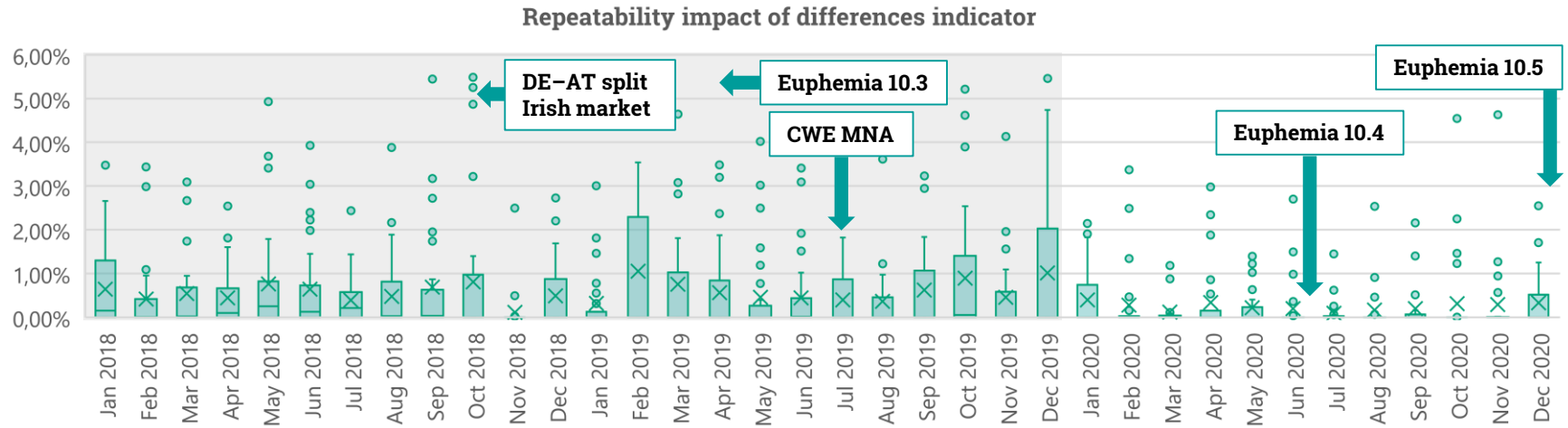


Repeatability frequency indicator: ellipses underlines the high level of repeatability, which, in 2020, is always higher than 98,50%.

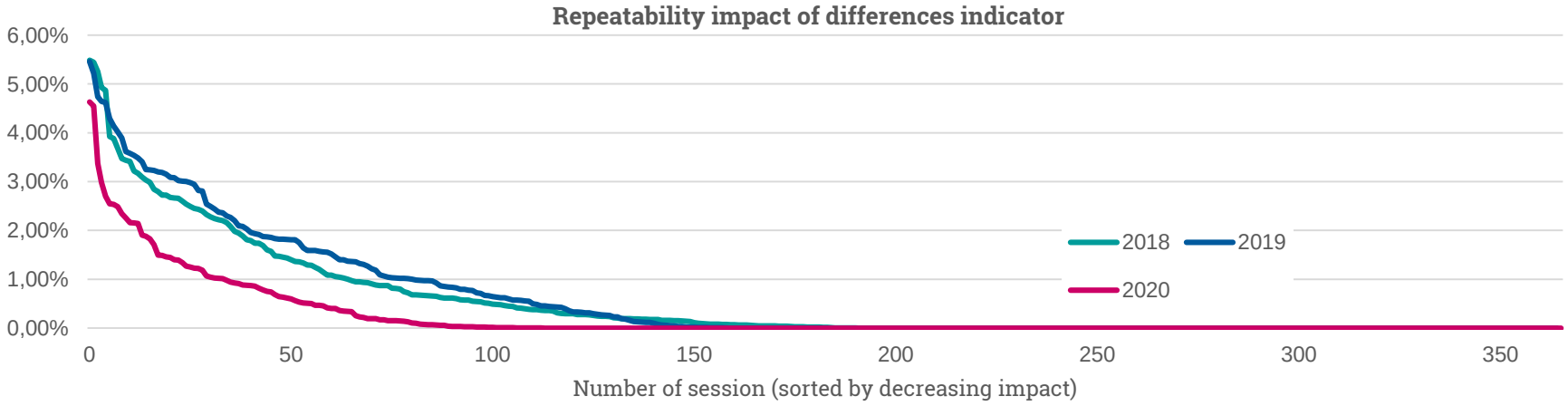


Duration curve shows the Repeatability frequency indicator ordered in descending order of magnitude, rather than chronologically. Ellipses underlines the predominant number of sessions, increased compared to 2018 and 2019, in which the repeatability reached 100%.

Algorithm repeatability without deterministic time



Repeatability impact of differences indicator: the impact of differences over the relevant values, whenever present, proved to be negligible.



Duration curve shows the Repeatability impact of differences indicator ordered in descending order of magnitude, rather than chronologically. Improved performance is demonstrated by fewer values of differences when comparing 2020 curve with the previous-years ones.

Output indicators			Year 2017	Year 2018	Year 2019	Year 2020		
			MRC	MRC	MRC	MRC		
			Avg	Avg	Avg	Avg	Min	Max
1) Indicators on the maximisation of economic surplus (Annex 3 of AM art 13)	Maximisation of the first economic surplus	Economic surplus of first OK solution (M€)	8 556.816	8 689.352	8 699.904	8 925.490	7 166.005	11251.672
		Economic surplus of the final solution (M€)	8 556.832	8 689.376	8 699.920	8 925.508	7 166.013	11 251.673
2)Indicators to describe the status of orders (Annex 3 of AM art 14)	Evolution of number of matched orders	Total number of matched blocks	614	661	734	692	360	1404
		Total number of matched complex orders	30	24	33	25	1	50
		Total number of matched non-PUN merit orders	28 758	30 505	31 589	31 272	25 938	35 776
		Total number of matched PUN orders	3 866	3 270	3 566	5 188	3 846	6 759
		Total matched volume from curves (MWh)	5 569 813	5 748 521	5 713 252	6 021 347	4 784 074	7 312 102
		Total matched volume from blocks (MWh)	374 146	321 327	353 316	383 584	196 081	626 891
		Total matched volume from complex orders (MWh)	213 814	150 012	184 038	128 166	1272	334 302
		Total matched volume from (non-PUN) merit orders (MWh)	751 674	753 386	763 679	732 837	486 513	937 842
		Total matched volume from PUN orders (MWh)	783 673	799 350	791 716	741 827	451 171	971 545
	Paradoxically rejected orders	Number of PRBs in the final solution	22	21	17	16	1	61
		Number of PRMICs in the final solution	1	1	1	1	0	6
		Maximum Delta P in the final solution	4	5	4	3.3	0	105
		Maximum Delta MIC in the final solution	0	1	2	1	0	25
		PRB utility loss in the final solution (k€)	24.524	30.077	20.266	18.339	0	169
		PRMIC utility loss in the final solution (k€)	2.374	4.690	11.669	5.686	0	152
		Volume of PRBs in the final solution (MWh)	27 444	26 488	22 645	21 905	119	102 238
		Volume of PRMICs in the final solution (MWh)	5123	4 343	7 557	4 615	0	31 540
	Indicators on the evolution of the use of network constraints along the time	Number of periods for ATC/DC lines with flows at full capacity	756	726	792	868	661	1 068

Output indicators			Year 2017	Year 2018	Year 2019	Year 2020		
			4MMC	4MMC	4MMC	4MMC		
			Avg	Avg	Avg	Avg	Min	Max
1) Indicators on the maximisation of economic surplus (Annex 3 of AM art 13)	Maximisation of the first economic surplus	Economic surplus of first OK solution (M€)	74.756	92.485	99.868	96.479	51.547	168.287
		Economic surplus of the final solution (M€)	74.756	92.485	99.868	96.479	51.547	168.287
2)Indicators to describe the status of orders (Annex 3 of AM art 14)	Evolution of number of matched orders	Total number of matched blocks	104	115	78	47	13	102
		Total number of matched complex orders	–	–	–	–	–	–
		Total number of matched non-PUN merit orders	–	–	–	–	–	–
		Total number of matched PUN orders	–	–	–	–	–	–
		Total matched volume from curves (MWh)	331 388	324 737	332 302	351 065	282 774	443 496
		Total matched volume from blocks (MWh)	27 863	35 289	30 856	33 862	13 113	68 423
		Total matched volume from complex orders (MWh)	–	–	–	–	–	–
		Total matched volume from (non-PUN) merit orders (MWh)	–	–	–	–	–	–
		Total matched volume from PUN orders (MWh)	–	–	–	–	–	–
	Paradoxically rejected orders	Number of PRBs in the final solution	1	1	1	1	0	9
		Number of PRMICs in the final solution	0	0	0	0	0	0
		Maximum Delta P in the final solution	1	1	1	0.3	0	7
		Maximum Delta MIC in the final solution	0	0	0	0	0	0
		PRB utility loss in the final solution (k€)	2.460	4.531	2.722	0.939	0	44.048
		PRMIC utility loss in the final solution (k€)	0	0	0	0	0	0
		Volume of PRBs in the final solution (MWh)	1 250	1 793	1 551	920	0	13 073
		Volume of PRMICs in the final solution (MWh)	0	0	0	0	0	0
	Indicators on the evolution of the use of network constraints along the time	Number of periods for ATC/DC lines with flows at full capacity	25	20	22	18	0	42

Output indicators			Year 2017	Year 2018	Year 2019	Year 2020		
			MRC	MRC	MRC	MRC		
			Avg	Avg	Avg	Avg	Min	Max
3) IT calculation process (Annex 3 of AM Article 15)	Time spent in every phase of the algorithm calculation process	TTFS (s)	174.0	203.7	205.6	192.7	95.6	422.7
		Input data reading time (s)*	21.2	12.9	9.4	10.5	3	39
		Input data delivery day creation (s)*	Not available		10.7	12.5	0	39
		Time to solve the root node for the master computer (s)*	36.3	22.3	9.6	19.5	9	51
		Time to solve the root node for the job that found first solution (s)*	36.3	27.5	14.8	17.2	1	73
		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 SDAC algorithm ****	3.3	3.9	3.2	3.4	1	9
		Total number of nodes in the master branch and bound tree	1 045	1 557	873	910	46	3 025

* Some time measurements in the calculation are overlapping (parallel processes).
** Zero nodes in the master branch can happen when the root node directly resolves to an optimal solution.
*** This number includes the first solution

Output indicators			Year 2017	Year 2018	Year 2019	Year 2020		
			4MMC	4MMC	4MMC	4MMC		
			Avg	Avg	Avg	Avg	Min	Max
3) IT calculation process (Annex 3 of AM Article 15)	Time spent in every phase of the algorithm calculation process	TTFS (s)	4.3	2.6	3.0	3.7	2.7	14.9
		Input data reading time (s)*	2.5	0.8	0.2	0.3	0	2
		Input data delivery day creation (s)*	Not available		0.7	0.9	0	11
		Time to solve the root node for the master computer (s)*	0.8	0.5	0.2	0.2	0	1
		Time to solve the root node for the job that found first solution (s)*	0.8	0.4	0.0	0	0	0
		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 SDAC algorithm ****	1.3	1.3	1.5	1.4	1	8
		Total number of nodes in the master branch and bound tree	23.6	15	104	27.8	0	3 894

* Some time measurements in the calculation are overlapping (parallel processes).
** Zero nodes in the master branch can happen when the root node directly resolves to an optimal solution.
*** This number includes the first solution

Performance monitoring report: analysis on the usage of each product and its impact on algorithm performance

In this section, the individual impact on performance of each product is assessed, as stated in article 8.3.a) of the Algorithm methodology approved by ACER on January 2020.

METHODOLOGY

The analysis is performed for the all the products included in the DA product methodology, apart from Stepwise Curves and Simple Blocks (which are deemed being the least impacting way to implement requirement explicitly mentioned in CACM) and merit orders (which are considered basically equivalent to stepwise curves in terms of performance impact). The analysis is performed against a historical dataset from Q4 2020.

CONVERSION OF PRODUCTS

In order to assess the individual impact on performance, the remaining products have been replaced by the most similar alternative product, following specific conversion rules.

- Piecewise curves: converted into stepwise curves. For each non-vertical piecewise curve segment, one stepwise curve segment is created with price at the middle of min and max price of the given source piecewise segment. In case of source segment is stepwise (e.g. having STEPWISE or HYBRID source curve) it is kept as it is. Vertical segments needed for the construction of the stepwise curve may be added or amended.
- Smart Blocks: converted into simple blocks.
  - Linked families where all members have same sign (all buy or sell) are converted into a single block that aggregates all their energy at the price of the family parent block. Linked families with mixed members (buy and sell) are discarded.
  - Exclusive groups are converted by randomly picking one of the blocks form the exclusive group, maintaining its MAR and price.
- Complex orders (BO + curves): converted into Simple Blocks plus Stepwise curves.
  - All suborders steps below the variable term are converted into profiled block orders with minimum acceptance ratio equal to 1 and whose price will be the variable term plus the contribution of the fixed term over the sum of all offered volume.
  - Remaining steps shall be integrated into the single curve.
- Complex orders (SCOs): converted into Scalable Complex Orders. The variable term from the complex order and their impact on the acceptance of the order is incorporated to the fixed term of the Scalable Complex Order.
- PUN orders: converted into Demand Merit Orders by changing their type.
- PUN and merit orders: converted into stepwise curves. All PUN and merit orders offered at the same price are merged in a single step in the stepwise curve.

Performance monitoring report: analysis on the usage of each product and its impact on algorithm performance

CONVERSION OF PRODUCTS DRAWBACKS

Due to the nature of the requirements these conversion rules are not able to convert all the requirements from the original product into requirements from remaining products.

The conversions done in this study may not reflect a realistic behaviour of market participants in case one product is replaced by another one. For instance, one stepwise order may be split in several stepwise orders by a market participants in order to reflect their needs.

It should be noted that such approach is overestimating the impact on performance, as the conversion eliminates not only the individual impact of each product but also the combined effect linked to the interaction with the remaining products. For such a reason, it should also be noted that the estimated impact of the different scenarios cannot be accumulated.

Performance monitoring report: analysis on the usage of each product and its impact on algorithm performance

RESULTS

First, the gains when we replace a product measured in seconds are in the order of few tens of seconds. Furthermore, repeated runs of the same input data may return small differences values for the time to first solution (TTFS), in the order of few seconds, even when the same machine and configuration is used.

Second, the impact on individual sessions is not evenly distributed. It has been observed that despite the average behaviour may be negative, there may exists sessions that are not single outliers and its value has a different sign, sometimes even with a distinct order of magnitude.

Third, it has been observed that the impact on TTFS may depend on the internal parameters of the simulation. The selection of values for internal parameters of CPLEX and heuristics in Euphemia is done pursuing a good behaviour in a wide variety of cases, covering adequate performance in average and being able to deal with problematic cases too. If one kind of product is removed, then the values of parameters should be reassessed against the full set of data scenarios used for the acceptance of new Euphemia releases.

Fourth, we have selected the Q4 of 2020, which contain the most challenging sessions of the year. We observed opposite counter intuitive behaviours such as in piecewise conversion into stepwise, for which a big outlier was obtained. Despite the size of the sample used for input data has been extended from 1 month in 2019 study to 3 months in 2020 study, data still show counter intuitive behaviours in some scenarios. This may be indicating that the size of the sample of sessions used as input data in this study might be not be big enough to extract clear statements regarding the individual impact of products.

Fifth, the comparison of impact from this study with the outcome from R&D activities may be indicating that the size of the input data for the sessions used in an impact of products on algorithm performance study is more relevant than the size of the sample (in number of sessions) used for the study.

Sixth, the combination of replacement of products may produce counterintuitive results. Comparison of “No PUN” and “PUN and merit orders” scenarios result in that usage of stepwise curves delivers worse performance than usage of merit orders in the Italian bidding zones, when the PUN orders have already been converted into either stepwise curves or merit orders.

Seventh, it should be reminded also the drawbacks due to the conversions of products applied that have been already explained in a previous slide.

In conclusion, the main findings of the study seems being:

- The outcome is heavily depending on the methodology used [replacement of products, length in number of sessions of the batch, selection of internal parameters of the algorithm, size of the input data for each one of the sessions contained in the batch, …]
- Given the chosen methodology, no product seems having a standalone key impact on performance.

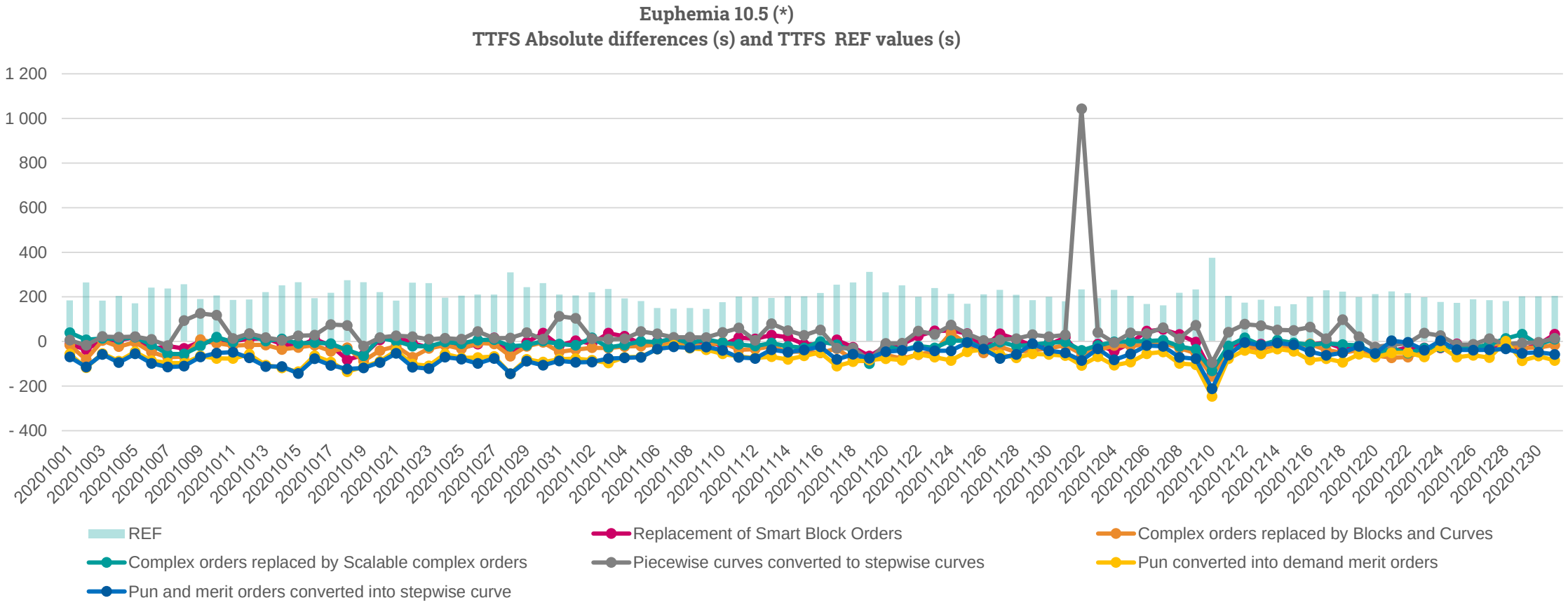
As a final remark, all these observations suggest to reconsider the approach to be followed to assess the impact of each product on algorithm performance. It should be noted than in the scope of this study only products were taken into account, while other requirements, such as flow based has also a significant impact, as shall be reflected in scalability report. NEMOs defend that in case corrective measures need to be applied, the decision should be accompanied with a study analysing the impact on prices.

Performance monitoring report: analysis on the usage of each product and its impact on algorithm performance

		Reference Scenario											
		Actual values		Impact on performance*			Assumptions for the simulation						
	Products	Orders submitted (#)	Traded volumes (GWh)	AVG TTFS (s) E10.5	ΔTTFS (s) E10.5	ΔTTFS (%) E10.5	# of steps at BZ level	# of block orders	# of Smart block orders	# of complex orders	# of scalable complex orders	# of merit orders (including PUN)	# of PUN orders
Reference	Reference scenario			211.9	-	-	181 677	4 904	2 671	87	0	50 315	8 449
Scenarios in which products are replaced	Stepwise Curves	181 677	6 374	Not estimated			-	-	-	-		-	-
	Piecewise Curves			248.6	+36.6	+17.3%	170 796	4 904	2 671	87	0	50 315	8 449
	Merit orders	41 866	721	Not estimated			-	-	-	-	-	-	-
	Block Orders	4 904	449	Not estimated			-	-	-	-	-	-	-
	Smart Block Orders (exclusive groups + linked blocks)	2 671		203.1	-8.9	-4.2%	181 677	2 386	0	87	0	50 315	8 449
	Complex Orders (BO and curves)	87	103	178.1	-33.8	-16.0%	183 961	4 984	2 671	0	0	50 315	8 449
	Complex Orders (SCO)			199.0	-13.0	-6.1%	181 677	4 904	2 671	0	87	50 315	8 449
	PUN Orders	8 449	757	136.9	-75.0	-35.4%	181 677	4 904	2 627	87	0	50 075	0
	PUN and Merit Orders	50 315	1 478	149.3	-62.6	-29.5%	195 851	4 904	2 671	87	0	0	0

* Calculated with respect the reference scenario. The values of the impact (ΔTTFS) report AVG(TTFS from scenario replacing the product X) compared against AVG(TTFS from REF scenario).
A negative value means that when the product is replaced, the TTFS is shorter than in the reference scenario. The reference scenario is calculated using default configuration (the one used in production).
For the other scenarios in which one product is replaced by other product(s), different internal parameters have been used, as suggested by the algorithm provider (these are different than the default configuration)

Performance monitoring report: analysis on the usage of each product and its impact on algorithm performance



* Calculated with respect the reference scenario. The values of the impact (ΔTTFS) report AVG(TTFS from scenario replacing the product X) compared against AVG(TTFS from REF scenario). A negative value means that when the product is replaced, the TTFS is shorter than in the reference scenario. The reference scenario is calculated using default configuration (the one used in production). For the other scenarios in which one product is replaced by other product(s), different internal parameters have been used, as suggested by the algorithm provider (these are different than the default configuration)

Scalability report

For the years 2022-2024, the demand for scalability is expected to increase significantly, due to many Requests for Change planned to go-live during this period, already included in the Roadmap (the main RfCs being the merger of MRC and 4MMC, the extension of MNA to the Nordics and the Baltics, the extension of the Flow Based approach to the Nordic and CORE Regions), as well as to an exogenous growth trend in the usage of products.

This year's scalability indicator unveiled more performance challenges compared to last year, even when accounting for the increase in calculation time to 17 minutes. In part this can be attributed to higher levels of growth in this 2020 report (following NRA guidance to add 1 more year of growth compared to the 2019 report, and following the actual growth between 2019 and 2020 that was uncharacteristically large for some product usages).

Work on improving Euphemia performances to better cope with 15 min MTU sessions is in scope of the R&D activities (also see next section). Promising results were obtained through some of the prototypes developed in 2020. This work will continue up until the 15 MTU implementation.

"Beyond 2022 performance degrades widely due to overestimation of growth. R&D outcomes show promising improvements"

>>>

In this section, the scalability of the SDAC is assessed, simulating the performance of the scalability indicator in relation to the expected evolution of foreseen requests for change (included in the roadmap), as well as to the exogenous usage of requirements. This exercise is carried out for the 2022-24 period, as understood at the end of 2020, and using the latest available version of the SDAC Algorithm (Euphemia 10.6).[6)]

ROADMAP

The Roadmap anticipates the impact of RfCs expected to go-live in the next three years. Based on this three scenarios have been tested.

- **Scenario 1:** including the anticipated usage of existing products and requirements in 2022. This includes the FB extension to CORE and Nordic Regions (where Nordic FB could only be crudely represented as only 1 day of relevant network data was available). For this scenario the introduction of scalable complex orders was not yet foreseen.
- **Scenario 2:** including the anticipated usage of existing products and requirements in 2024. Here the introduction of scalable complex orders has been foreseen. Historical classical complex orders were converted into scalable complex orders making assumptions not explicitly validated by users of these order types.
- **Scenario 3 (c.d. Full CACM Requirements):** including Scenario 2 assumptions, plus go-live of 15 mins MTU throughout EU (c.d. Big Bang approach, simulated on a 90 days batch exploded by 4).

ANTICIPATED USAGE

The expected usage of products and requirements reflects the actual usage recorded between 2019 and 2020 and projected to 2022–24 usage by applying the historical growth of each product/requirement usage projected into the future (for full details see slide on anticipated usage). Mind that GB orders were considered in the 2020 actuals, but the simulated scenarios reflect the post Brexit situation where GB has been removed from SDAC.

In general, the large increase of the usage values in 2024 reflects not only the multi-year growth rate but also the fourfold increase in the size of the problem due to the shift to 15 minutes. The assumption of quadrupling the input was made only for hourly granularity orders (curves, merit orders, PUN, complex orders), while for multi-hourly products (block orders) a conservative assumption was made and only the multi-year growth rate was applied, with a consequent potential underestimation of the impact on performance.

SCALABILITY INDICATOR

This year's scalability indicator unveiled more performance challenges compared to last year, even when accounting for the increase in calculation time to 17 minutes.

Scenario 1 requires on average 9 minutes and 41 seconds to find a solution, albeit 5% of sessions required > 17 minutes;

Scenario 2 requires on average 17 minutes and 33 seconds to find a solution, and 42% of sessions required > 17 minutes;

Scenario 3 requires on average ~2 hours to find a solution, on those sessions where solutions could be found. For 7% of sessions no solution was found. All solutions were found after 17 minutes.

Some of the increases in complexity stem from the method used to estimate organic market growth:

- This year's scalability study implemented NRA's guidance to create scenarios 1 and 2 by projecting +2y respectively +4y rather than +1y and +3y as in the 2019 report, adding more orders than for last year's scenarios;
- The growth factors for the different product types themselves are estimated using only historical usage, not trying to find fundamentals driving growth. An example would be the usage of PUN orders:
  - In the 2019 report we considered actuals for 2018 (5065) and 2019 (5416) suggesting a 7% annual increase, we then used for subsequent growth scenarios. In our estimated 2020 scenario we generated 5901 PUN orders (using the 7% we should have created ~5790, but due to indivisibility constraints we created slightly too many). Compared to the 7732 PUN orders in 2020 this was too optimistic;
  - For this year's study we considered actuals for 2019 (5416) and 2020 (7732) suggesting a 43% increase. Since we now create a +2Y scenario this implies an 86% increase and 14344 PUN orders. Again due to indivisibility constraints we created slightly too many for our scenario 1 (15 609).
  - It should be noted that preliminary data show an increment of PUN order in 2021 with respect to 2020 of around +12%, once accounted for the effect of the go-live of the new Calabria Bidding Zone, well below the +43% annual increase considered in the simulations.

Scenario 3 which proved most challenging is the scenario implementing 15 minute MTU. Bear in mind the scalability scenarios were computed on Euphemia 10.6 using current production hardware, both of which are optimised for today's (60 min MTU) production configuration.

Work on improving Euphemia performances to better cope with 15 min MTU sessions is in scope of the R&D activities (also see next section). Promising results were obtained through some of the prototypes developed in 2020. This work will continue up until the 15 MTU implementation.

Roadmap of RfCs

The following tables list the different requests for change as captured by the roadmap. The changes are organized by:

- Operational changes: those changes where the Euphemia configuration changes: i.e. either topological changes (e.g. inclusion or removal of lines, adding or removing bidding zones, new NEMO hubs, etc.), or changes in usage (e.g. introduction of new products in bidding zones not yet using them, or not using them to as high an extent where expected usage increase / introduction of new network features not previously in use for specific lines or regions);
- Functional changes: those changes requiring changes to the algorithm. Once those changes become available an operational change is required before using them.

Roadmap of RfCs (operational)

Requirement	Name	Go-live Date	Reason	Initiator/Owner	Details	2022	2024	2024 (incl. 15' MTU)
Multi-NEMO	Baltic MNA	2020 (no precise date)	CACM	NEMOs/TSOs	Introduction of multi-NEMO framework in the Baltic region	☐	☐	☐
Multi-NEMO	Polish MNA	Q3 2020	CACM	NEMOs/TSOs	Introduction of multi-NEMO framework in Poland	☑	☑	☑
Multi-NEMO	NASDAQ in Nordic	2021	CACM	NEMOs	Entrance of NASDAQ in the Nordic region	☑	☑	☑
Multi-NEMO	NASDAQ in CWE	2023	CACM	NEMOs	Entrance of NASDAQ in CWE region	☐	☐	☐
Network requirement	Bounded net positions in Belgium	2020-06-16	TSO	TSOs	Possibility to limit in import or export the net position of the Belgian bidding zone (BZ), per period	☑	☑	☑
Brexit	Hard Brexit Enduring Solution	2020-12-31 STANDBY	Other	NEMOs/TSOs	Removal of Great Britain bidding zones & interconnections from MRC coupling in case of hard Brexit. Will only be implemented in case of no deal situation between UK and EU (discarded otherwise)	☑	☑	☑
Network topology	DE–AT–PL–4M Coupling	June 2021	TSO	TSOs	Implementation of DE–AT–PL–4M with NTC coupling	☐*	☐*	☐*
Network topology	ALEGrO cable introduction	Nov 2020	TSO	TSOs	Implementation of an HVDC line between Belgium (BE) and Germany (Amprion scheduling area) using a 'evolved hybrid flow-based' modelling	☑	☑	☑
Network topology	CORE FB	Q4/2020	CACM/ Core CCR	NEMOs/TSOs	Implementation of FB Capacity Calculation in the CORE region	☑	☑	☑
Network topology	Nordic FB	Q2/2021	CACM/Nordic CCR	TSOs	Implementation of (plain) FB coupling for the Nordic region	☑**	☑**	☑**

* All scenarios consider Core FB, hence the NTC ICP coupling is not reflected in any scenario
** Nordic FB capacity calculation systems were not sufficiently stable to deliver a full 1 year dataset.
Instead Nordic FB is reflected using 1 day of capacity day, repeated throughout all simulated sessions.

Roadmap of RfCs (operational)

Requirement	Name	Go-live Date	Reason	Initiator/Owner	Details	2022	2024	2024 (incl. 15' MTU)
System release	Implementation of 15-min MTU for MRC areas	Unknown	CACM	NEMOs/TSOs	According to ACER's decision of 24.04.2018, by 01.01.2021, MTU shall be implemented on each border as equal to the shortest common ISP of the corresponding bidding zones	☐	☐	☑
Network topology	Coupling of Bulgaria with the Greek market	Q2/2021	TSO	TSOs	Addition of a new interconnection between Greece and Bulgaria, effectively coupling Bulgaria (for now operated in MRC but isolated)	☑	☑	☑
Network topology	Losses on Skagerrak cable	2020	TSO	TSOs	Implementation of loss-factor on DK1(A)-NO2 area connection. Cable between Norway and Jutland/Denmark.	☑	☑	☑
Network topology	New interconnection between Slovenia and Hungary	Q4/2022	TSO	TSOs	New AC cable between SI and HU	☑	☑	☑
Network topology	New cable between Poland and Lithuania (Harmony Link)	by 2025	TSO	TSOs	New (undersea) HVDC line between PL and LT areas	☐	☐	☐
Network topology	New cable HansaPowerBridge	by 2025	TSO	TSOs	New (undersea) HVDC line between DE (50Hertz) and SE4 (SVK)	☐	☐	☐
Network topology	New interconnection between SK and HU	end of 2020	TSO	TSOs	New interconnection between SK and HU. MAVIR: For now, this is to our knowledge not considered as part of CORE FB data	☐	☐	☐
Network topology	Flow-based in region IT-North	not before 2024	CACM	TSOs	Flow-based approach to be applied on IT-North according to art 20.3 of CACM	☐	☐	☐
Network topology	ES–FR capacity increase	by 2026-27	TSO	TSOs	Increase in ATC capacity between Spain and France (both senses), from 2 800 MW to 5 000 MW (+2 200MW increase)	☐	☐	☐
Network topology	FR-IT capacity increase	Unknown	TSO	TSOs	Increase in ATC capacity with +1200MW between France and Italy	☑	☑	☑

Roadmap of RfCs (operational)

Requirement	Name	Go-live Date	Reason	Initiator/Owner	Details	2022	2024	2024 (incl. 15' MTU)
Network topology	Celtic Interconnector	by 2026	TSO	TSOs	New interconnection between France-Ireland	☐	☐	☐
System release	Changes in algorithm timings	2020-07-08	NEMO	NEMOs	Algorithm calculation time to be increased from 12 to 17 minutes	☑	☑	☑
Network topology	Bulgaria-Romania Coupling	Dec. 2020	TSO	TSOs	Coupling of the Bulgarian bidding area with the Romanian one	☑	☑	☑
Network topology	Allocation and Ramping constraints on the Italian Northern borders	Dec. 2020	TSO	TSOs	Addition of allocation and ramping constraints on IT NORD bidding zone cross-border exchanges (=capacity and ramping lineset constraints)	☑	☑	☑
Product activation	Introduction of Scalable Complex Orders on Iberian markets	Q4 2022	NEMO	NEMOs	Improve performance and offer new trading capabilities	☐	☑	☑
Product activation	Introduction of Scalable Complex Orders on Irish markets	Q4 2022	NEMO	NEMOs	Improve performance and offer new trading capabilities	☐	☑	☑
Product activation	Introduction of profile blocks and linked blocks for IBEX in the BG bidding area	Feb-21	NEMO	NEMOs	offer new trading capabilities	☑	☑	☑

Scope of scalability scenario 2022

Requirement	Name	Details
Multi-NEMO	Polish MNA	Introduction of multi-NEMO framework in Poland
Multi-NEMO	NASDAQ in Nordic	Entrance of NASDAQ in the Nordic region
Network requirement	Bounded net positions in Belgium	Possibility to limit in import or export the net position of the Belgian bidding zone (BZ), per period
Brexit	Hard Brexit Enduring Solution	Removal of Great Britain bidding zones & interconnections from MRC coupling in case of hard Brexit. Will only be implemented in case of no deal situation between UK and EU (discarded otherwise)
Network topology	ALEGrO cable introduction	Implementation of an HVDC line between Belgium (BE) and Germany (Amprion scheduling area) using a 'evolved hybrid flow-based' modelling
Network topology	CORE FB	Implementation of FB Capacity Calculation in the CORE region
Network topology	Nordic FB	Implementation of (plain) FB coupling for the Nordic region
Network topology	Coupling of Bulgaria with the Greek market	Addition of a new interconnection between Greece and Bulgaria, effectively coupling Bulgaria (for now operated in MRC but isolated)
Network topology	Losses on Skagerrak cable	Implementation of loss-factor on DK1(A)-NO2 area connection. Cable between Norway and Jutland/Denmark.
Network topology	New interconnection between Slovenia and Hungary	New AC cable between SI and HU
Network topology	FR-IT capacity increase	Increase in ATC capacity with +1200MW between France and Italy
System release	Changes in algorithm timings	Algorithm calculation time to be increased from 12 to 17 minutes
Network topology	Bulgaria-Romania Coupling	Coupling of the Bulgarian bidding area with the Romanian one
Network topology	Allocation and Ramping constraints on the Italian Northern borders	Addition of allocation and ramping constraints on IT NORD bidding zone cross-border exchanges (=capacity and ramping lineset constraints)
Product activation	Introduction of profile blocks and linked blocks for IBEX in the BG bidding area	offer new trading capabilities

Scope of scalability scenario 2024

Requirement	Name	Details
Multi-NEMO	Polish MNA	Introduction of multi-NEMO framework in Poland
Multi-NEMO	NASDAQ in Nordic	Entrance of NASDAQ in the Nordic region
Network requirement	Bounded net positions in Belgium	Possibility to limit in import or export the net position of the Belgian bidding zone (BZ), per period
Brexit	Hard Brexit Enduring Solution	Removal of Great Britain bidding zones & interconnections from MRC coupling in case of hard Brexit. Will only be implemented in case of no deal situation between UK and EU (discarded otherwise)
Network topology	ALEGrO cable introduction	Implementation of an HVDC line between Belgium (BE) and Germany (Amprion scheduling area) using a 'evolved hybrid flow-based' modelling
Network topology	CORE FB	Implementation of FB Capacity Calculation in the CORE region
Network topology	Nordic FB	Implementation of (plain) FB coupling for the Nordic region
Network topology	Coupling of Bulgaria with the Greek market	Addition of a new interconnection between Greece and Bulgaria, effectively coupling Bulgaria (for now operated in MRC but isolated)
Network topology	Losses on Skagerrak cable	Implementation of loss-factor on DK1(A)-NO2 area connection. Cable between Norway and Jutland/Denmark.
Network topology	New interconnection between Slovenia and Hungary	New AC cable between SI and HU
Network topology	FR-IT capacity increase	Increase in ATC capacity with +1200MW between France and Italy
System release	Changes in algorithm timings	Algorithm calculation time to be increased from 12 to 17 minutes
Network topology	Bulgaria-Romania Coupling	Coupling of the Bulgarian bidding area with the Romanian one
Network topology	Allocation and Ramping constraints on the Italian Northern borders	Addition of allocation and ramping constraints on IT NORD bidding zone cross-border exchanges (=capacity and ramping lineset constraints)
Product activation	Introduction of Scalable Complex Orders on Iberian markets	Improve performance and offer new trading capabilities
Product activation	Introduction of Scalable Complex Orders on Irish markets	Improve performance and offer new trading capabilities
Product activation	Introduction of profile blocks and linked blocks for IBEX in the BG bidding area	offer new trading capabilities

Scope of scalability scenario 2024 (incl. 15' MTU)

Requirement	Name	Details
Multi-NEMO	Polish MNA	Introduction of multi-NEMO framework in Poland
Multi-NEMO	NASDAQ in Nordic	Entrance of NASDAQ in the Nordic region
Network requirement	Bounded net positions in Belgium	Possibility to limit in import or export the net position of the Belgian bidding zone (BZ), per period
Brexit	Hard Brexit Enduring Solution	Removal of Great Britain bidding zones & interconnections from MRC coupling in case of hard Brexit. Will only be implemented in case of no deal situation between UK and EU (discarded otherwise)
Network topology	ALEGrO cable introduction	Implementation of an HVDC line between Belgium (BE) and Germany (Amprion scheduling area) using a 'evolved hybrid flow-based' modelling
Network topology	CORE FB	Implementation of FB Capacity Calculation in the CORE region
Network topology	Nordic FB	Implementation of (plain) FB coupling for the Nordic region
System release	Implementation of 15-min MTU for MRC areas	According to ACER's decision of 24.04.2018, by 01.01.2021, MTU shall be implemented on each border as equal to the shortest common ISP of the corresponding bidding zones
Network topology	Coupling of Bulgaria with the Greek market	Addition of a new interconnection between Greece and Bulgaria, effectively coupling Bulgaria (for now operated in MRC but isolated)
Network topology	Losses on Skagerrak cable	Implementation of loss-factor on DK1(A)-NO2 area connection. Cable between Norway and Jutland/Denmark.
Network topology	New interconnection between Slovenia and Hungary	New AC cable between SI and HU
Network topology	FR-IT capacity increase	Increase in ATC capacity with +1200MW between France and Italy
System release	Changes in algorithm timings	Algorithm calculation time to be increased from 12 to 17 minutes
Network topology	Bulgaria-Romania Coupling	Coupling of the Bulgarian bidding area with the Romanian one
Network topology	Allocation and Ramping constraints on the Italian Northern borders	Addition of allocation and ramping constraints on IT NORD bidding zone cross-border exchanges (=capacity and ramping lineset constraints)
Product activation	Introduction of Scalable Complex Orders on Iberian markets	Improve performance and offer new trading capabilities
Product activation	Introduction of Scalable Complex Orders on Irish markets	Improve performance and offer new trading capabilities
Product activation	Introduction of profile blocks and linked blocks for IBEX in the BG bidding area	offer new trading capabilities

Roadmap of RfCs (functional)

Requirement	Name	Go-live info	Reason	Initiator/Owner	Details
Network requirement	Interconnector ramping	Unknown (not part of CACM future requirements)	TSO	TSOs	Implementation of "minute by minute" ramping
Network requirement	Limitation of BZ net positions	E10.4	TSO	TSOs	Possibility to limit in import or export the net position of the Belgian bidding zone (BZ), per period
Network requirement	Support of parallel ATCs	E10.4	TSO	TSOs	Capability of the algorithm to support the definitions of multiple line between the same pair of bidding zones
Network requirement	Evolved Flow-Based	Already available but not in operation yet	TSO	TSOs	Implementation of 'evolved flow-based' capability via the implementation of virtual areas
Order requirements	Order cross-match under heterogeneous MTUs	Already available but not in operation yet	CACM	NEMOs	Allow for the definition of orders under heterogeneous Market Time Units (“MTUs”), such as 15 minutes, 30 minutes and hourly. The algorithm shall be able to cross-match these products. MTUs shall be configurable per bidding zone.
Network requirement	Network allocation under heterogeneous MTUs	E10.6/?	CACM	NEMOs/TSOs	Allow for the definition of heterogeneous MTU network allocations. The MTU shall be defined per interconnection (i.e. inter-BZ line). The corresponding BZs shall have their markets designed for the support of such property
Network requirement	Advanced hybrid coupling	Unknown	TSO	TSOs	The Algorithm shall be able for each MTU to facilitate the Advanced hybrid coupling, where realised cross-zonal capacity transactions are taken into account in the margin of the Flow-based critical branches (using virtual bidding areas).
Algorithm requirement	Full algorithm reproducibility	Available in E10.4 but not foreseen in operation yet	CACM	NEMOs	The algorithm shall be fully reproducible, i.e. allow obtaining identical solutions in case of rerun
Algorithm requirement	Scalability	Continuous improvement	CACM	NEMOs	The algorithm shall be able to cope with the complexity of MRC coupling whatever the geographical extension / network change / competition aspects
Order requirements	Scalable Complex Orders	E10.5	NEMO	NEMOs	Improved modelling of complex orders, where the variable term is removed and replaced with a Minimum Acceptance Ratio per period

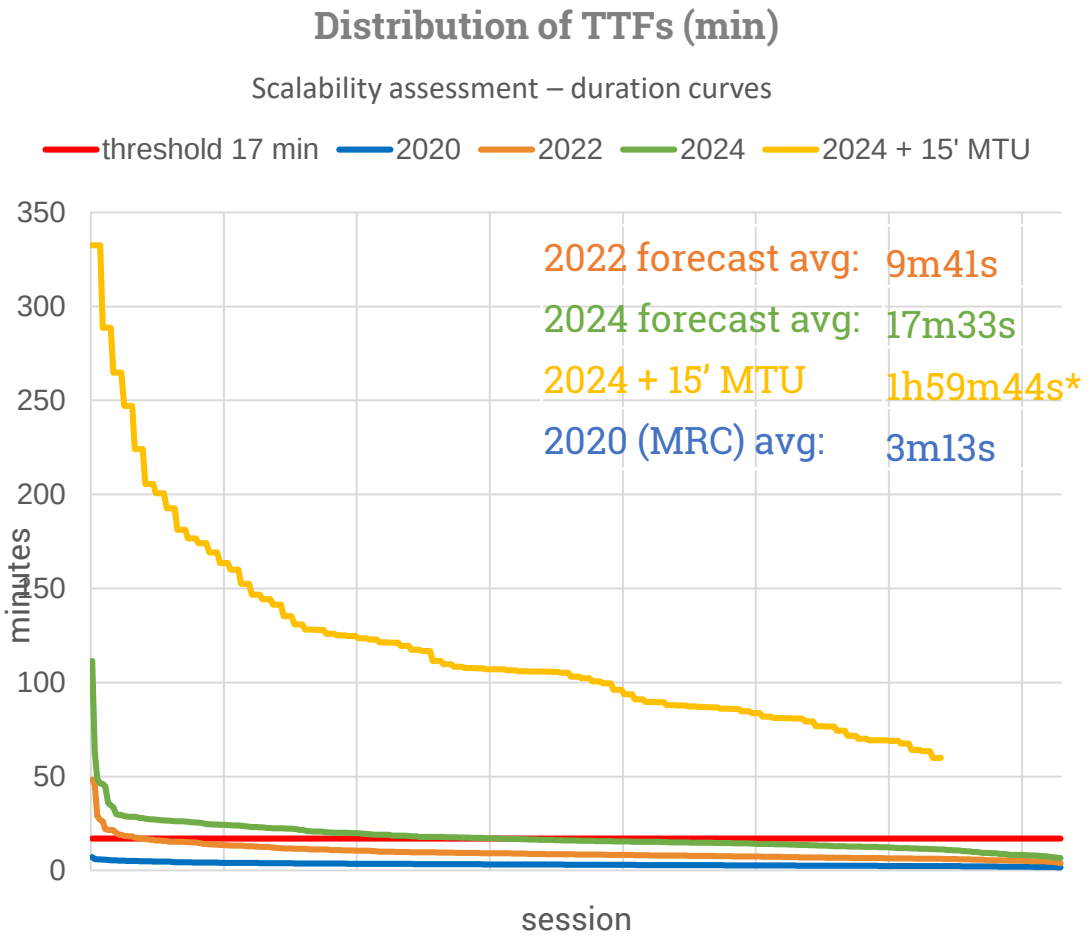
Roadmap of RfCs (functional)

Requirement	Name	Go-live info	Reason	Initiator/Owner	Details
Network requirement	"zero balanced" FB domain		TSO	TSOs	Process “zero balanced“: the available margin on critical network elements applies from zero exchanges and pre-existing exchanges are transmitted aside;
Network requirement	ramping and pre-existing nominations	E10.4: supported for single lines; Support for linesets to be defined	TSO	TSOs	Constrain the increase/decrease of scheduled exchanges over one DC interconnector and/or a combination of DC 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;
Algorithm requirement	FB shadow prices		CACM	NEMOs	Shadow prices of critical network elements as needed for flow-based capacity allocation;
Network requirement	Updated RAM		TSO	TSOs	Available margin on critical network elements or the remaining allowable scheduled exchange on the network element in case of flow-based approach.
Network requirement	Extended LTA inclusion	E10.5	TSO	TSOs	Allow for a separate treatment of LTA constraints, aside the "virgin" flow-based domain, in order to decrease the total amount of constraints and to only consider LTA in case violations are observed. Aims to improve the algorithm performance.
Algorithm requirement	Delivery of Shadow Prices for bidding zone net position constraints	E10.6	TSO	TSOs	Expose the shadow prices relative to the enforcement of bidding zone net position limits through the interfaces

Usage indicators		Years			
		historical	scenario 1	scenario 2	Scenario 3
		2020	2022 (Y+1)	2024 (Y+3)	2024 + 15' MTU (Y+3)
1) Indicators to describe the Usage of SDAC products (Annex 3 of AM Article 10)	Total number of steps at bidding zone level	193 742	183 489[6.2]	183 489[6.2]	734 269
	Tot. number of block orders	4 600	4 365	4 604	4 601
	Total number of block order exclusive groups	149	126	136	136
	Total number of linked families	61	73	73	73
	Total number of complex orders	95	100	0	0
	Total number of scalable complex orders	0	0	102	103
	Total number of demand merit orders	986	1 105	1 200	4 828
	Total number of supply merit orders	41 085	44 374	47 680	190 767
	Total number of PUN orders	7 732	15 609	23 130	92 460
2) Indicators to describe geographical extension of the SDAC (Annex 3 of AM Article 11)	Number of bidding zones	60	74	74	74
	Total number of flow-based bidding zones	5	43	43	43
	Number of scheduling areas	63	77	77	77
	Number of NEMO Trading Hubs	85	153	153	153
	Number of NEMOs	12	14	14	14
3) Indicators to describe the network constraints (Annex 3 of AM Article 12)	Total number of bidding zone lines	81	101	101	101
	Total number of flow-based PTDF constraints	3 409	5 691	5 691	22 762
	Total number of scheduling area lines	91	111	111	111
	Total number of NEMO Trading Hub lines	165	349	349	349

Condition of the simulations

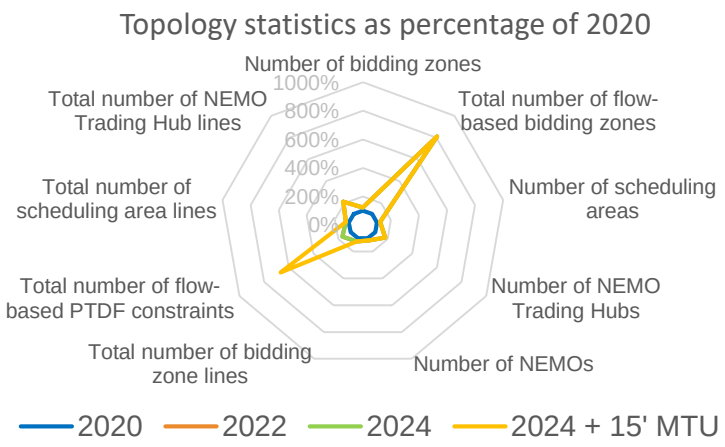
- 2022
  - For 27/366 sessions Euphemia was configured using a non-default (aka “alternate”) algorithm configuration to find a solution. These alternate solutions can be used operationally in case the algorithm provider needs to intervene;
- 2024
  - For 145/366 sessions Euphemia was configured using an “alternate” configuration;
  - For 4/366 sessions Euphemia was configured with a custom configuration compiled by the algorithm provider for the benefit of this analysis;
- 2024 + 15’ MTU
  - E10.6 cannot yet deal with NEMO volume problems for 15’ MTU sessions. These volume problems were hence deactivated;
  - Calculations were terminated after 5h30m. For 6/89 sessions no solution could be found.



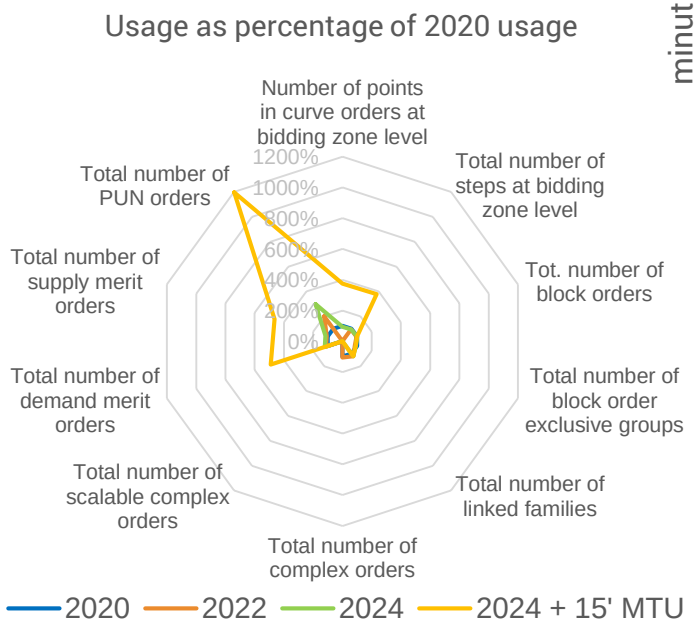
2022 + 15’ MTU: 6/89 sessions could not find a solution in < 5h30m. For the remaining 83 sessions the NEMO volume problems had to be deactivated as E10.6 can’t yet solve them for 15’ MTU sessions.

Scalability report: Performance indicators [6)]

Algorithm scalability

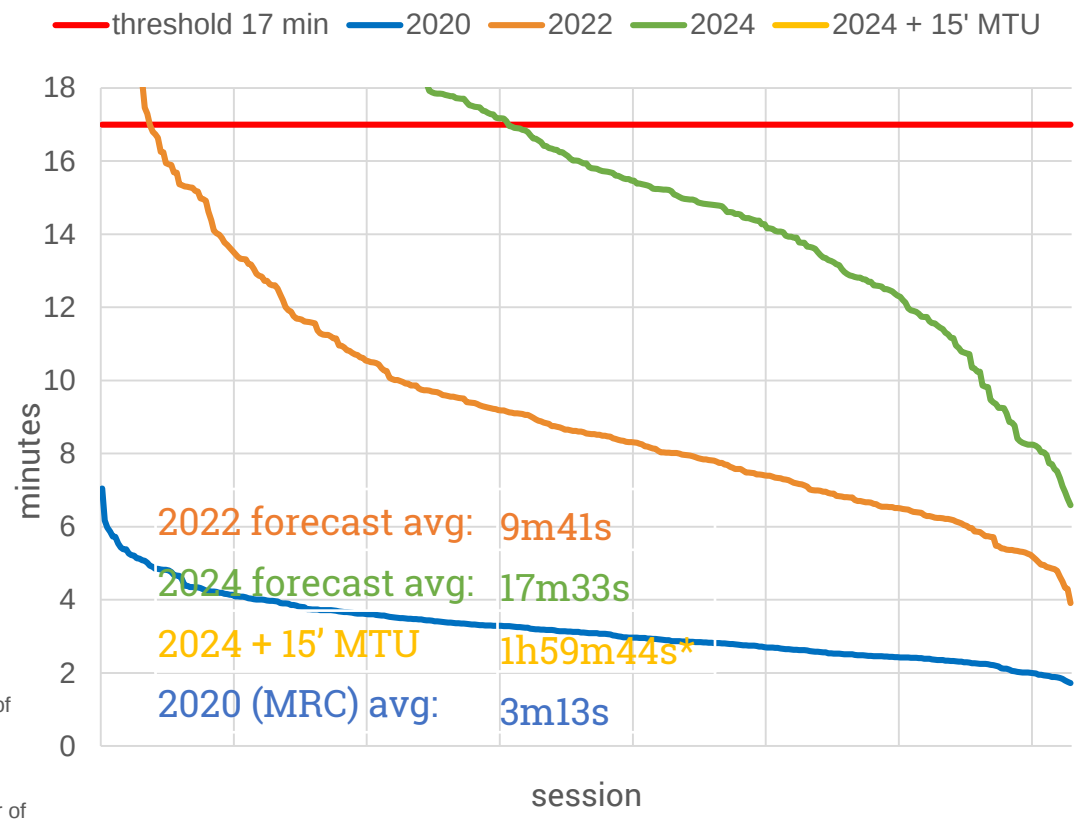


Increase of the usages related to topology foreseen in each simulated scenario.



Increase of the usages related to products foreseen in each simulated scenario.

Distribution of TTFs (min)



Same TTFS distribution graph as on the previous slide, however with a zoomed vertical axis

R&D report

In 2019, SDAC started an ambitious 3-year R&D program, in order to guarantee to Euphemia a constant development and timely adaptation to the regulatory requirements and market evolution, while improving design and performance. After 2 years, the program brought tangible results, with multiple features implemented in Euphemia releases.

In 2020, into Euphemia 10.4 and 10.5 were implemented features that improve scalability and considerably reduce the optimality gap: LTA inclusion, Complex order first, Scalable Complex orders.

In 2021 Distributed computing architecture shall be implemented into Euphemia, plus step based heuristics and key features in prevision of the 15 min MTU implementation: 15 min MTU interface changes and 15 min MTU prototype, including the "cross-matching functionality". The latter enables the stepwise implementation of 15 min MTU foreseen in 2024, though some further developments are still necessary.

According to simulations on 2019 production data, the time to first solution improved:

- In 2020, from E10.4 to E10.5: Average TTFS - 15%
- Expectation in 2021, from E10.5 to E11.0: Average TTFS - 9%

In order to make emerge new and challenging ideas, All NEMO Committee launched in July 2020 an open call for papers regarding the Euphemia algorithm (for more information, see the chapter on NEMO Committee Activities). The contributions were assessed with regards to the topics already in the scope of the current Euphemia Lab research; some of them were presented during a workshop in March 2021.

"R&D Programme launched by SDAC JSC in 2019 with a 3 years planning, continues delivering successful items"

THE R&D PLAN IN A NUTSHELL: HOW IT WORKS

With the approval of CACM and the related methodologies, further challenging requirements have been introduced in terms of dimension (a wider geographical scope, higher usage from market participants, more complex network topology), market design (MNA, new demanding network constraints, 15 mins MTU, …) and algorithm performance (optimality, scalability and repeatability).

To be ahead of the change and keep on ensuring the best level of performance even in the new demanding environments, NEMOs and TSOs launched in 2019 a forward-looking R&D program, aimed at increasing both the scalability of Euphemia and the quality of the solutions in terms of welfare.

- The overall programme spans 3 years time (2019–2021). A budget of 720 000 € is dedicated to the activities contained in iterations 3 and 4, covering most of the year 2020.
- Proposals address three areas of research: hardware, software and market design. They are grouped by estimated impact on the algorithm (non- disruptive, moderately disruptive, highly disruptive concepts) and lead time (short-medium-long term).
- Outcomes are assessed against the estimated impact on scalability (TTFS decrease), optimality (optimality gap measurement, number of PRB), repeatability.
- From the timeline perspective, from 6 to 12 months are needed between the end of the iteration and the implementation of a feature into a production version of the algorithm. This time is due to the finalization of developments and a comprehensive testing.

>>>

2020 OUTCOMES

During 2020, two research iterations of six months each have been carried out in order to address the R&D topics reported in the following table, and more extensively addressed below. The R&D focus remained the improvement of Euphemia´s scalability altogether with the adaptation of the algorithm to the forthcoming implementation of 15 min MTU.

- **Work on 15 min MTU implementation, with interface changes and the module including the necessary functionalities. About 40% of the workload of each of the 2 iterations was assigned to this key topic.** All core functionalities are now introduced in the prototype, including LTA inclusion and line set constraints. The implementation into production is foreseen in late 2021 or early 2022.
  - PTDF constraints in CCR and line capacities (ATCs)
  - Line set constraints (capacity, ramping)
  - LTA inclusion
  - Classic Complex Orders and Scalable Complex Orders
  - Merit orders and PUN orders
  - Interface (DB schema) and physical unit updates
  - Input check updates
- **Distributed architecture.** This is a Hardware improvement, aimed at increasing scalability and optimality by parallelising computation not on different cores of the same machines but on different machines, in order to overcome memory bandwidth constraints. The work was finalized in 2020. DC will be able to leverage future R&D results. The final improvement will depend on the number of machines – following a cost-benefit analysis - nonetheless within Euphemia Lab simulations with 6 machines improved the TTFS by at least 18% with classical complex orders, and by 47% with Scalable complex orders. The discussion on the appropriate hardware choice is ongoing in H1 2021.
- **Market product improvements: PUN.** Several ideas were investigated in both iterations. In the end, two features confirmed the promising results and their industrialization is recommended. They concern the field of parallelization of jobs and search improvement. For another studied item some further research is needed to validate the promising potential.

Several topics are being studied, with a potential to be implemented once the research is finalized:

- **Market products improvements: PUN orders**
- **Heuristics**
- **Scalability improvement research with academic experts**

Dismissed ideas: Further solutions have been dismissed after preliminary prototypes showed little benefits.

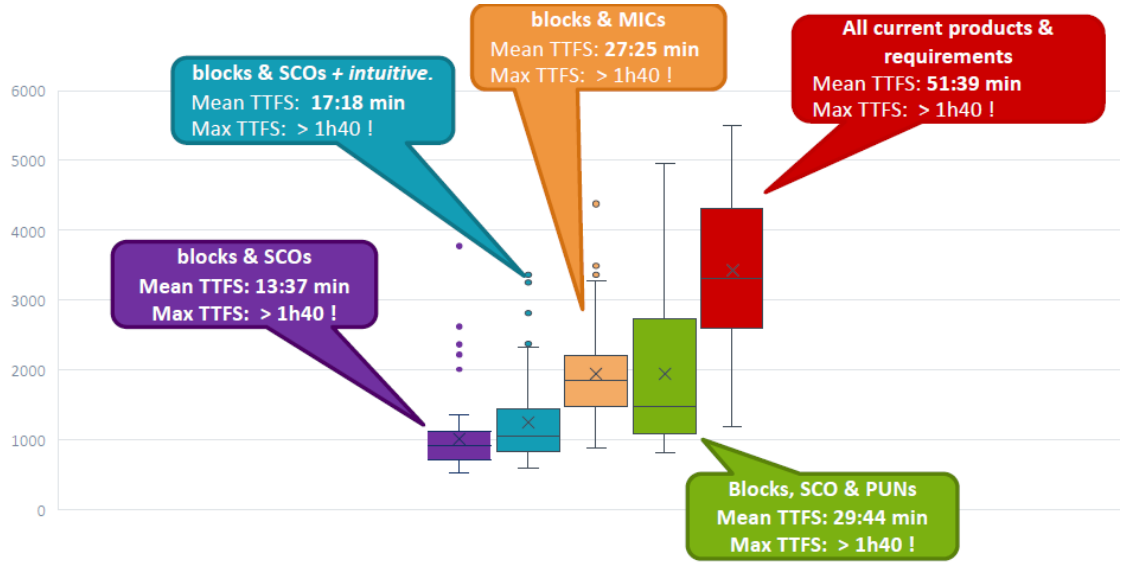
FOCUS: 15 min MTU implementation

Implementation of 15 min MTU requires to adapt Euphemia and presents an important challenge for the performance: with the increase of the market size (orders, periods), the computational complexity can be exponential.

Thanks to the achievements of Euphemia Lab:

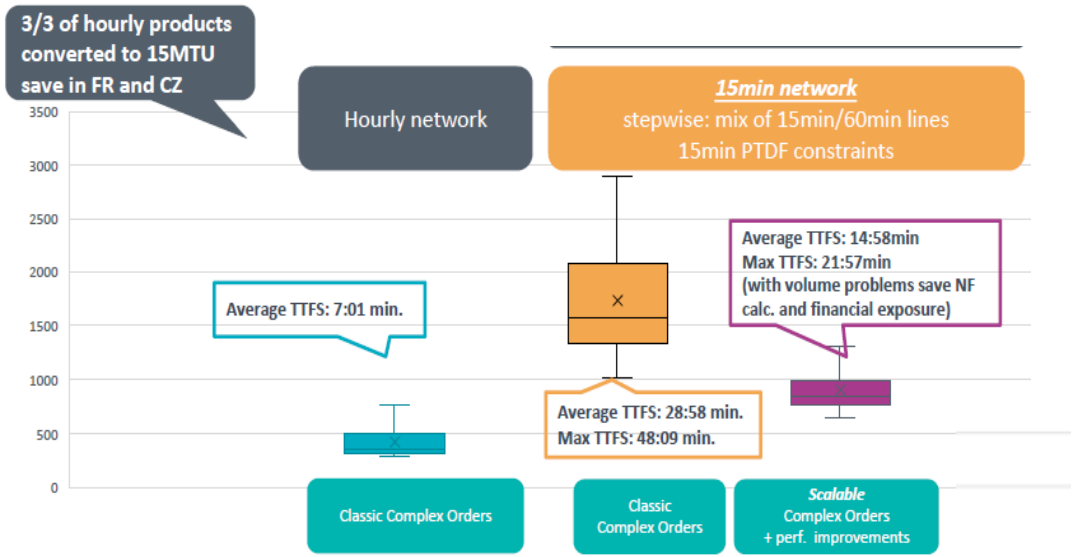
- All core functionalities are now introduced in the prototype, including LTA inclusion and line set constraints.
- Performance: while orders and network constraints were multiplied by 4, the current average TTFS presents a 2 – 2.5x increase; at this stage nonetheless some constraints were removed (see following page).
- Scalable complex orders contribute to reach these performances.

Feb. 2020: Simulation on Euphemia 10.5 prototype



Big bang approach: Batch simulating 15´MTU & 2 years of market growth

Feb. 2021: Simulation on 15 min MTU prototype (future Euphemia 11.1)



Stepwise approach: Batch with partial conversion to 15' in SDAC save in FR and CZ with 60' products

Please note that the above results do not assume all the conditions and constraints, e.g. the LTA inclusion and the NEMO flow/financial exposure calculation.

The simulations were performed on a single machine – the distributed computing features were not available for the version of the 15 min MTU prototype which was used for this simulation.

R&D PROGRAMME FOR THE PRICE COUPLING ALGORITHM – ITERATION 3 (1/2)

R&D topic	Description	Iteration #*	Share of Iteration workload and budget	Share of 12 months workload and budget	CACM compliance	Outcome and impact on CACM compliance	Implementation in production (forecast)
15 min MTU: RD prototype	R&D prototype implementing 15'MTU for network models, (Scalable) Complex Orders and merit orders	3	16.3%	8.2%	ACER decision 04/2020	Delivered in Q4/2020 Analysis of network constraints, interface (DC schema) and physical units update, input check updates, classical and scalable complex orders, merit orders, PUN orders	*NA: 15 min MTU support*
15 min MTU: Dedicated scalability improvements and impact assessment	Dedicated scalability improvements for the 15'MTU (step-based heuristics and first approach to solve very large root nodes). Assessment of the options Big bang implementation vs Stepwise implementation.	3	26.7%	13.3%	Scalability improvement	Step-based heuristics: continuous linear problem solved much faster than quadratic ones, PUN search much faster with step curves. Average TTFS - 30,95% for simulations including FB Core and Nordic.	Euphemia 10.6 in 2021
Scalability improvements research by academic experts	Scalability improvement suggestions in collaboration with leading academic experts with a strong industrial experience.	3	3.3%	1.7%	Scalability improvement	3 proposals to improve scalability: root node scalability, PUN search improvement, PUN problem analysis.	*To be further investigated*
Core Flow-Based: FB improvements - LTA inclusion in Core FB	Follow-up work on the new methodology for LTA inclusion performed within Euphemia.	3	2.3%	1.2%	Scalability improvement	LTA inclusion module was introduced in Euphemia 10.5. Need for additional outputs materialized, to better assess the validity of the solution and, as such, the quality of the LTA module. Tight LTA inclusion substantially improves grid security and reduces re-dispatch costs.	Euphemia 10.6 in 2021
Heuristic algorithms	Quickly build good feasible solutions and then improve them, to complement the current algorithm. Promising options are iteratively killing all fractional blocks, killing all PABs, and smart rounding.	3	16.7%	8.3%	Scalability improvement	Killing Paradoxically Accepted Orders: no substantial improvements. Killing fractional orders: improvements achieved for sessions with scalable complex orders. To be postponed until the transition to SCO is completed.	*Paused*

*Iteration 2: September 2019 – February 2020, presented in the 2019 CACM Annual report; Iteration 3: March – August 2020; Iteration 4 : September 2020 – February 2021

R&D PROGRAMME FOR THE PRICE COUPLING ALGORITHM – ITERATION 3 (2/2)

R&D topic	Description	Iteration #*	Share of Iteration workload and budget	Share of 12 months workload and budget	CACM compliance	Outcome and impact on CACM compliance	Implementation in production (forecast)
Market product improvements: PUN	Alternative MIP models: either full guarantee to find a PUN solution if one exists, or to certify that no solution exists. PUN imbalance condition over the whole day instead of 'per period': Keeps the spirit of the current PUN requirements.	3	12.0%	6.0%	Scalability improvement	Alternative MIP models: investigation stopped. PUN imbalance conditions over whole day: modest improvements achieved, a clear custom adaptation of the PUN search shall help to reach better performance.	*To be further investigated (see iteration 4 where 2 research tracks are recommended for implementation)*
Architecture: Distributed computing	Parallelization without hardware bottlenecks: several computers each with its own resources. (topic started to be explored in iteration 2)	3	6.7%	3.3%	Scalability improvement	DC enables Euphemia to distribute its computations on multiple computers. The DC architecture enables to coordinate different search strategies on multiple & separated machines. Decrease of TTFS, more robustness, enables to process more nodes and more candidate solutions. HW solution needs to be adapted (multiple machines required) in order to leverage the improvement (with 1 machine, status quo maintained).	Euphemia 11.0 in 2021 (though HW not yet adapted)
Euphemia training	Three online sessions (2 hours each) providing a high level view on concepts underlying Euphemia and providing background on how Euphemia works, in relation to Euphemia Lab R&D activities	3	3.3%	1.7%	NA	The training (3 sessions) was organized in 2020, with numerous participants from Market System Design Group and also other SDAC groups. To be assessed whether this training is to be provided on regular basis in order to facilitate the integration of newcomers.	NA
Prospective and preparation costs	Diagnosis, preparation of iteration, iteration wrap-up	3	12.7%	6.3%	NA	Recurrent cost: prepare a forthcoming iteration, prepare a wrap-up of the ending iteration, diagnosis to search further improvement areas	NA

*Iteration 2: September 2019 – February 2020, presented in the 2019 CACM Annual report; Iteration 3: March – August 2020; Iteration 4 : September 2020 – February 2021

R&D PROGRAMME FOR THE PRICE COUPLING ALGORITHM – ITERATION 4 (1/3)

R&D topic	Description	Iteration #*	Share of Iteration workload and budget	Share of 12 months workload and budget	CACM compliance	Outcome and impact on CACM compliance	Implementation in production (forecast)
15 min MTU: RD prototype	Finalization of the 15' Prototype, market design consulting (support for the design/adaptations of requirements) and later implementation updates based on the evolution of the requirements.	4	11.7%	5.8%	Scalability improvement	Prototype 3rd version: 15'MTU support for crossborder cross-matching (core functionalities).	*NA: 15 min MTU support*
15 min MTU: Dedicated scalability improvements and impact assessment	NEMO Flow calculations, liquidity with 15', decomposition methods for large root nodes, configurations fine tuning	4	26.7%	13.3%	Scalability improvement	Large root nodes: The decomposition methods while being promising for larger root nodes are for now not providing enough gains. To be paused and re-assessed after re-assessment of other sources of gains. Advanced configuration management + automatic selections based on predefined criteria: to be implemented	Successfully finalized
Market product improvements: PUN	Adaptation of the PUN search to better leverage additional degrees of freedom with a daily imbalance condition (instead of per period) (started in iteration 3) • Parallelization of the PUN search, possibly leveraging the alternative PUN search strategies	4	13.3%	6.7%	Scalability improvement	(1) Running multiple PUN jobs in parallel: - 15% computation time for a PUN Search (2a) Improved PUN Search + (2b) Deactivation of feasopt:- 50% computation time within a job No continuation: (3) Multithreading the PUN position probing for all periods: no improvements (4) Daily imbalance condition: ambiguous results (improvements on one side bring difficulties on other side)	(1) and (2a) successfully finalized. (2b) will depend on results of iteration 5

*Iteration 2: September 2019 – February 2020, presented in the 2019 CACM Annual report; Iteration 3: March – August 2020; Iteration 4 : September 2020 – February 2021

R&D PROGRAMME FOR THE PRICE COUPLING ALGORITHM – ITERATION 4 (2/3)

R&D topic	Description	Iteration #*	Share of Iteration workload and budget	Share of 12 months workload and budget	CACM compliance	Outcome and impact on CACM compliance	Implementation in production (forecast)
Heuristic algorithms	Testing new heuristic: at root node	4	13.3%	6.7%	Scalability improvement	On one hand, root node prices are good predictor of final market prices in bidding areas with blocks orders and SCOs (no classical CO). On the other hand, TTFS is not reduced and can even increase, due to difficulty to calibrate the Delta Price for SCOs linked to the reintegration of complex orders. No promising results obtained, neither on the production batch nor on the 15MTU batch	To drop: no promising results
Architecture: Distributed computing	Hardware study to identify best suitable hardware to reach best performances with DC and provide a cost/benefit analysis of the different hardware options	4	3.3%	1.7%	NA	Recommendation provided with respect to the cost-benefit (performance) analysis	Linked to the DC HW implementation
Flow-based improvements	Dedicated follow-up work on CORE FB (go-live Q4 2020) , ELIC (LTA inclusion in CORE), Nordic FB (go-live Q2 2021), and Interim Coupling (DE-AT-PL-4M MC Project). Other flow-based management improvements based on TSOs needs. Analysis of other upcoming TSO requirements.	4	1.7%	0.8%	NA	KPIs mainly seek to quantify the improved operational security brought by ELI (Extended LTA Inclusion), and identify any performance impact. KPIs computations required solving "small" ad hoc optimization models aside Euphemia. KPIs illustrated the added value of ELI in CORE flow-based: improved operational security comes from Market Clearing Points (MCP) outputted by Euphemia closer to the original "physical flow-based domains". Improved operational security.	CORE FB Experts decided to continue with ELI in CORE

*Iteration 2: September 2019 – February 2020, presented in the 2019 CACM Annual report; Iteration 3: March – August 2020; Iteration 4 : September 2020 – February 2021

R&D PROGRAMME FOR THE PRICE COUPLING ALGORITHM – ITERATION 4 (3/3)

R&D topic	Description	Iteration #*	Share of Iteration workload and budget	Share of 12 months workload and budget	CACM compliance	Outcome and impact on CACM compliance	Implementation in production (forecast)
Market design: Non-uniform pricing	Study II	4	16.7%	8.3%		Delivery of a prototype Further analyses: adjusted executed prices, size of side-payments, transfers across NEMOs/NEMO hubs/BZ when allowed	*To be further investigated*
Prospective and preparation costs	Diagnosis: Detailed performance analysis with focus on 15'MTU batches in view of the latest R&D outcomes and latest available data. Delivery of an updated executive report on scalability. Iteration wrap-up	4	13.3%	6.7%	NA	Recurrent cost: diagnosis, wrap-up of the ending iteration	NA
Market design: Non-uniform pricing	Study II	4	16.7%	8.3%		Delivery of a prototype Further analyses: adjusted executed prices, size of side-payments, transfers across NEMOs/NEMO hubs/BZ when allowed	*To be further investigated*

Total budget for iterations of 3 and 4 is 720 000 €.

The budget is shared equally between the two iterations.

*Iteration 2: September 2019 – February 2020, presented in the 2019 CACM Annual report; Iteration 3: March – August 2020; Iteration 4 : September 2020 – February 2021

FUTURE R&D

The delivered R&D improve Euphemia performance and makes it more robust, able to support operations in the years to come. Nevertheless, despite the important progress achieved within the adaptation to the 15 min MTU implementation, further R&D will be needed to finalize the functionalities and improve the performance.

This shall include a) changes to existing heuristics; b) changes to product design; d) alternative pricing rules.

- The short term target consists in finalizing the functionalities of the 15 min MTU module. Industrialization (merging into release) is foreseen in Q4 2021 with potential follow-up for certain functionalities, and further focus on improving performances.
- The open call for papers , organised in 2020, allowed to gather several interesting ideas. They shall be further analysed within the R&D, to assess whether they shall be implemented into Euphemia.
- Besides it, the corrective measures need to be explored, in case that the required scalability would not assured for the 15 min MTU implementation.
- The potential of the non-uniform pricing (NUP) shall be also further explored: it could highly increase Euphemia´s performance and in this way guarantee the sufficient performance for long time ahead.
- In addition, for the implementation of the co-optimization (analysis currently ongoing within SDAC), an R&D action will be very likely required before industrialization.
- In long-term perspective, other requirements, market growth and increasing complexity are to be expected. The algorithm needs to be able to satisfy them. Further research including disruptive approaches, like non-uniform pricing, is thus needed.

Single Intraday Coupling

SIDC main features

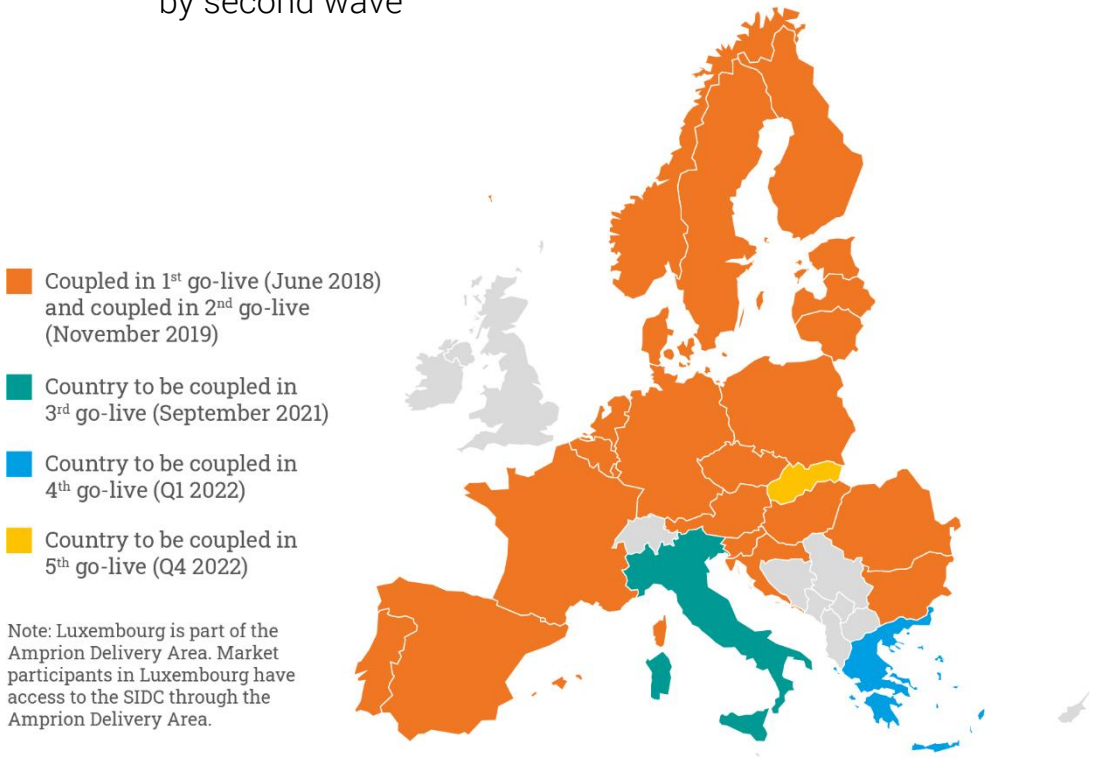
NEMO requirements
- MTU: 15, 30, 60 mins without cross-matching
- Regular orders
- Linked orders
- Iceberg Orders

TSO requirements
- ATC (including possibility to set a global constrain for set of cross-zonal interconnectors)
- Ramping constraints
- Explicit capacity requests

CACM requirements
- Adequate scalability
- MNA
- MTU: 15-60 mins

Systems release(s)
- 2.0.25.5 until 15/06/2020
- 2.0.36.3 (Agile pilot) until 07/07/2020
- 2.0.36.5 (R3.0.1 OCC) as the last release in 2020

Geographical scope
- First wave (PT, ES, FR, DE, BE, NL, AT, LT, LV, EE, FI, SE, DK, NO) and second wave (BG, HR, CZ, HU, PL, RO, SI)
- Since 19 November 2019 SIDC operations is extended by second wave



ALL NEMO COMMITTEE

High level market data

In 2020 the continuous market 2019 has continued to mature, witnessing a constant increase in executed orders and trades, this follows the second wave go live at the end of 2019.

– The 'topology' of the intra-day coupling market encompassed at 21 countries, 31 bidding zones, 32 TSOs and 10 NEMOs.

– The size of the coupled market grew to 82.3 TWh, from 57 TWh in 2019, representing over 40 million trades.

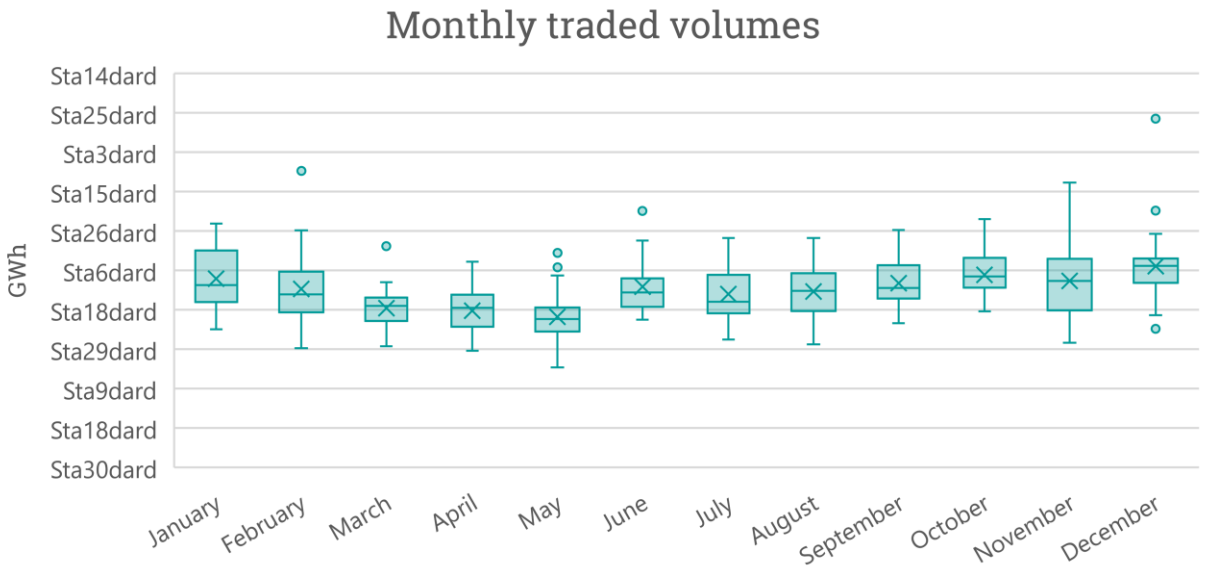
– The annual average clearing price was around 30 €/MWh and 32€/MWh for the last trading hour. Annual mean price per bidding-zone ranged from 9.09 €/MWh to 46.89 €/MWh. The volume weighted prices per contract ranged from -250 €/MWh to +795 €/MWh, significantly less than the absolute minimum and maximum prices set in the related methodology.

"Volume of continuous trading in 2020 grew to 82.3 TWh, representing over 40 million trades"

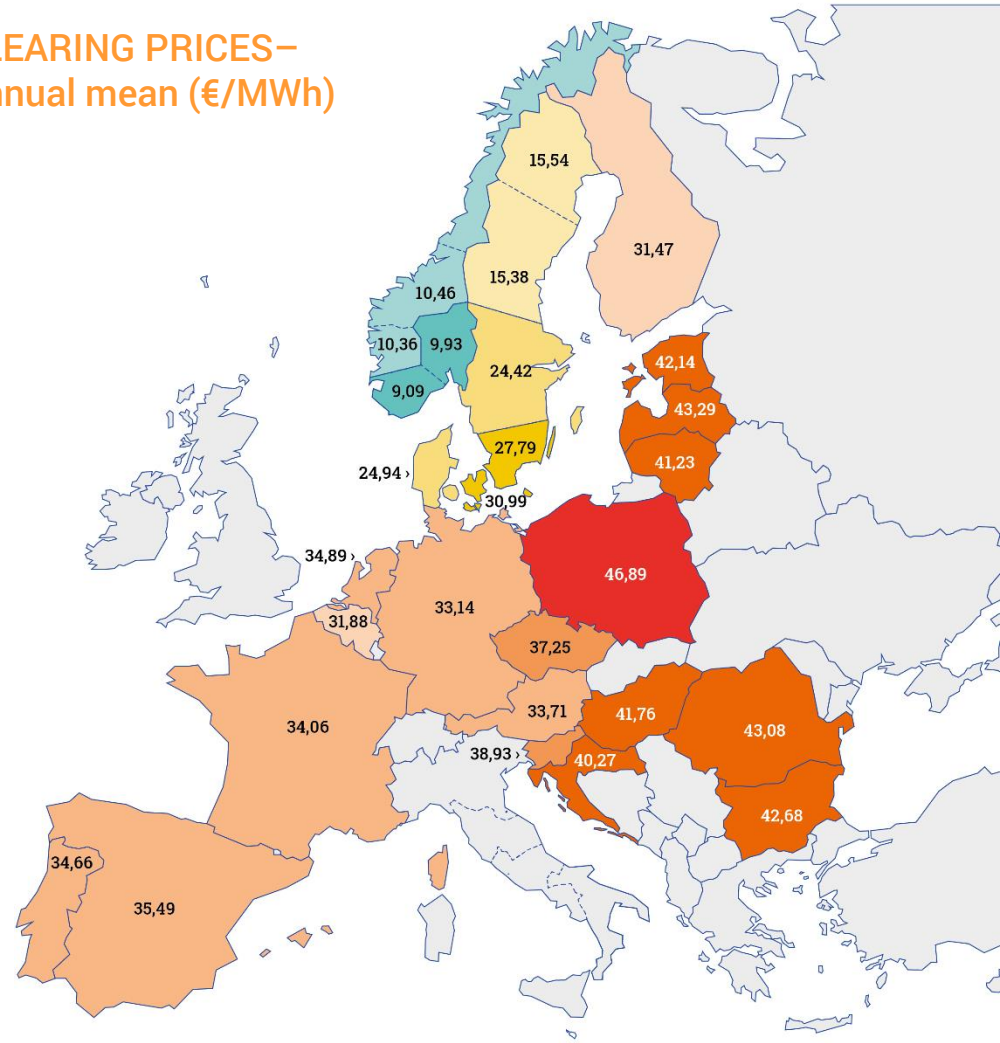
Yearly prices are computed as volume-weighted average prices of all trades per contract per bidding zone.

TRADED VOLUMES (GWh)

Annual	Daily average	Daily minimum	Daily maximum
82 333	224.956	126.77	442.761



CLEARING PRICES– Annual mean (€/MWh)



Operations report

This section reports on operational events occurred in SIDC during 2020, including: the incidents, requests for changes decided upon and corrective measures applied.

INCIDENTS

They are classified according to two criteria (severity and causes), with a classification in SIDC which is similar but not identical to that applied in SDAC due to the specificities of the two technical solutions.

- In 2020 there were 24 incidents, slightly fewer compared to 2019. Incidents caused by interface issues and system bugs increased but fewer incidents were caused by unusual processes (maintenance at the data center and hardware failures).
- The most critical incidents in SIDC (those that lead to a halt in trading) decreased from 9 in 2019 to 4 incidents in 2020. The four occurrences were in April, June, October and November for a total aggregated duration of 6 hours and 59 minutes.
- The most frequent cause of incidents in 2020 was related to interface issues and system bugs.

"The operation of SIDC in 2020 was stable with slightly fewer incidents and significantly fewer leading to halt in trading."

Date	Real duration	Comments and observations
06/04/2020	00 h 38 min	CMM was down
22/06/2020	00 h 39 min	Market Halt caused because of XBID CORE Failover
15/10/2020	02 h 37 min	XBID core failover caused by an integer overflow when declaring a value to write to database.
07/11/2020	03 h 05 min	Issue related with an internet connection problem of DBAG

REQUESTS FOR CHANGE (RfC)

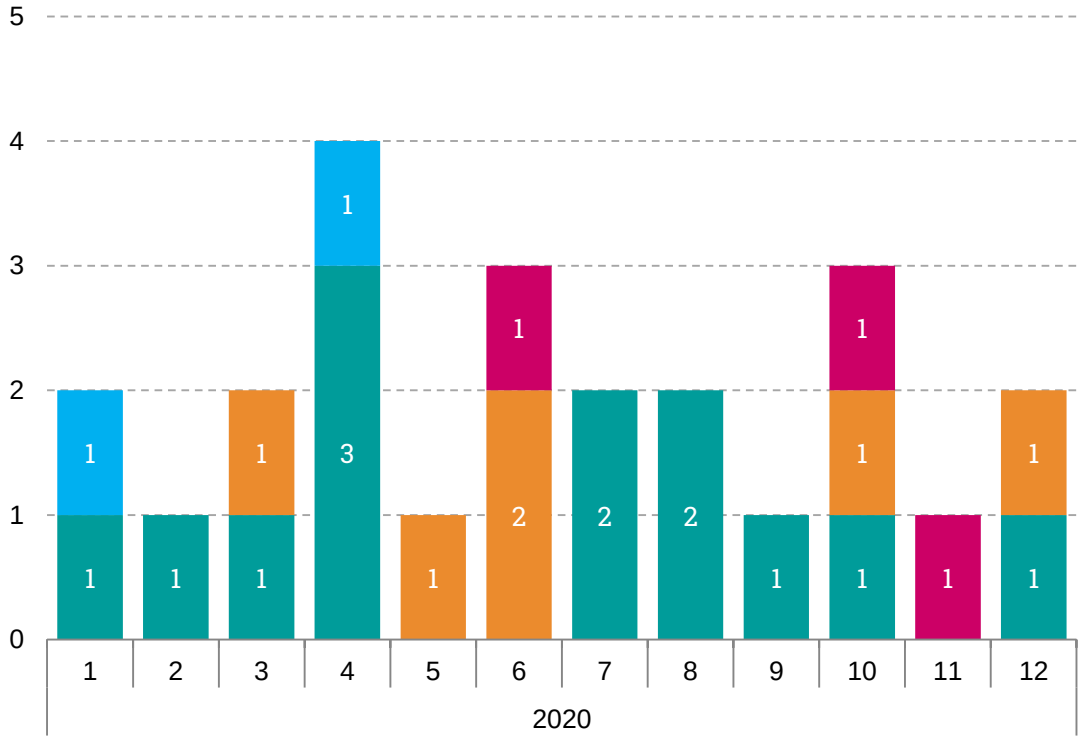
RfCs are classified per type of requirement, with the same classification being applied in SDAC and SIDC despite the specificities of the two technical solutions.

- Among the 22 RfCs that were implemented in 2020, were new borders DE-BE and DE-NO2 due to new interconnectors and go-live of SwePol link in SIDC. Multi NEMO implementation was completed in Poland and in the Nordic delivery areas. This was made possible by a set of functional and technical changes to allow improvement of certain SIDC functionalities.
- Several product extension in many market areas have been implemented during 2020.
- In 2020, SIDC also implemented new releases including couple of updates

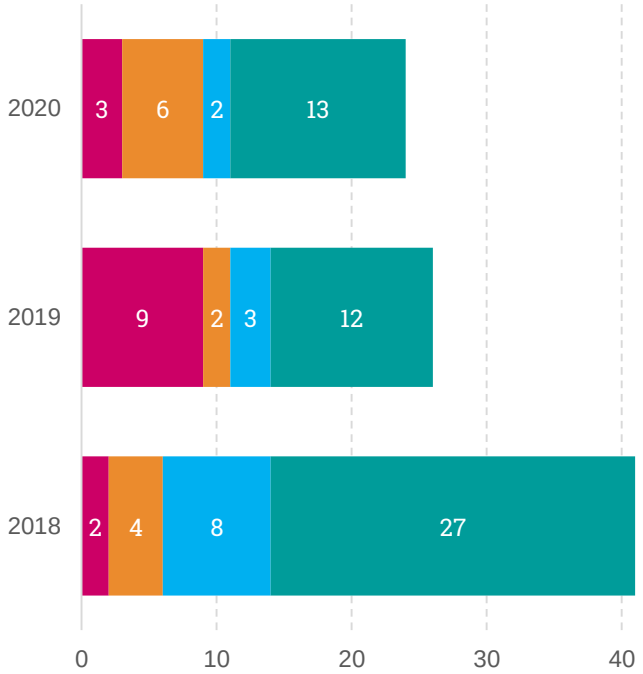
CORRECTIVE MEASURE

- No CM has been applied in SIDC during 2020, as no relevant performance deteriorations have been recorded during the year.

Monthly



Annual



Severity 1
Incidents that lead to stopping ID trading

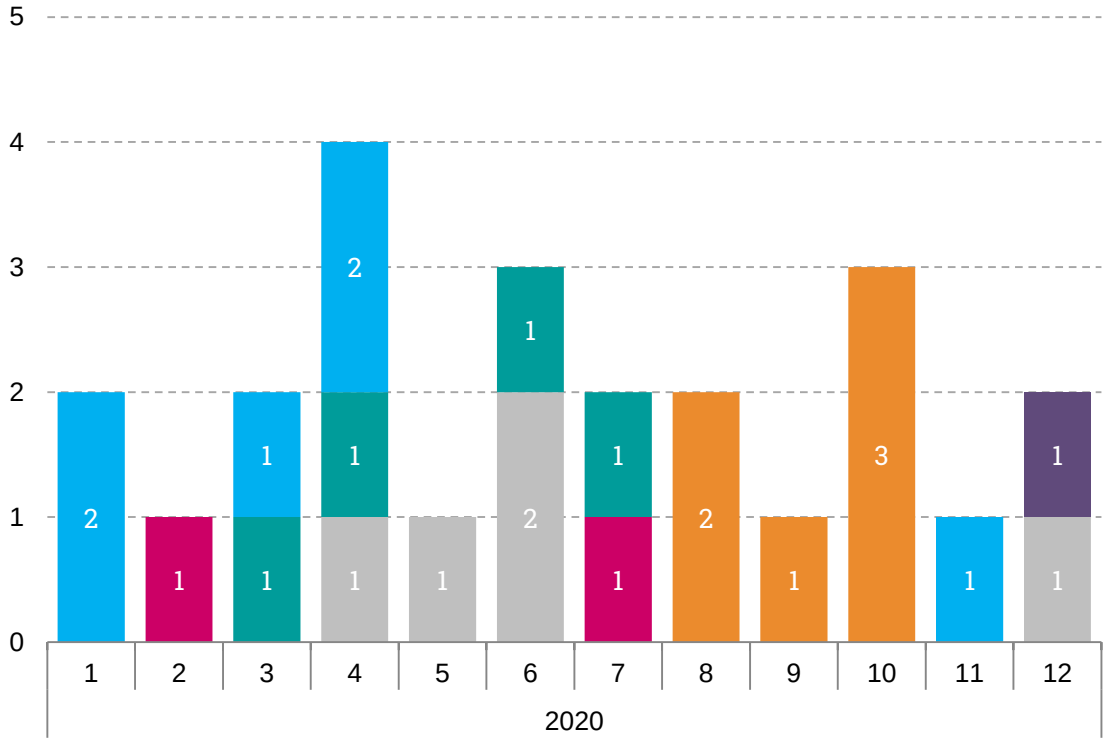
Severity 2
Incidents that lead to closing interconnector(s)/area(s)

Severity 3
Incidents that were visible to participants

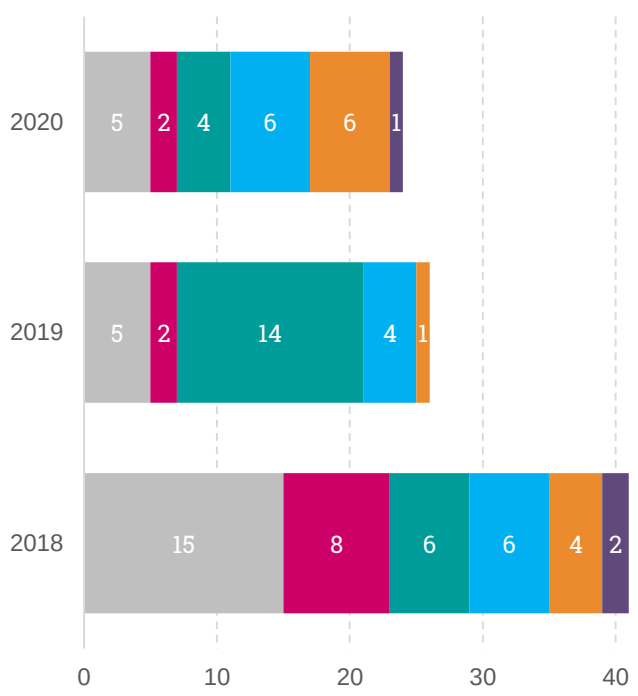
Severity 4
Incidents that caused the breach of a critical deadline or any other major incident

Operations Report: Incidents – causes [1)]

Monthly



Annual



Other

Human error

Unusual process

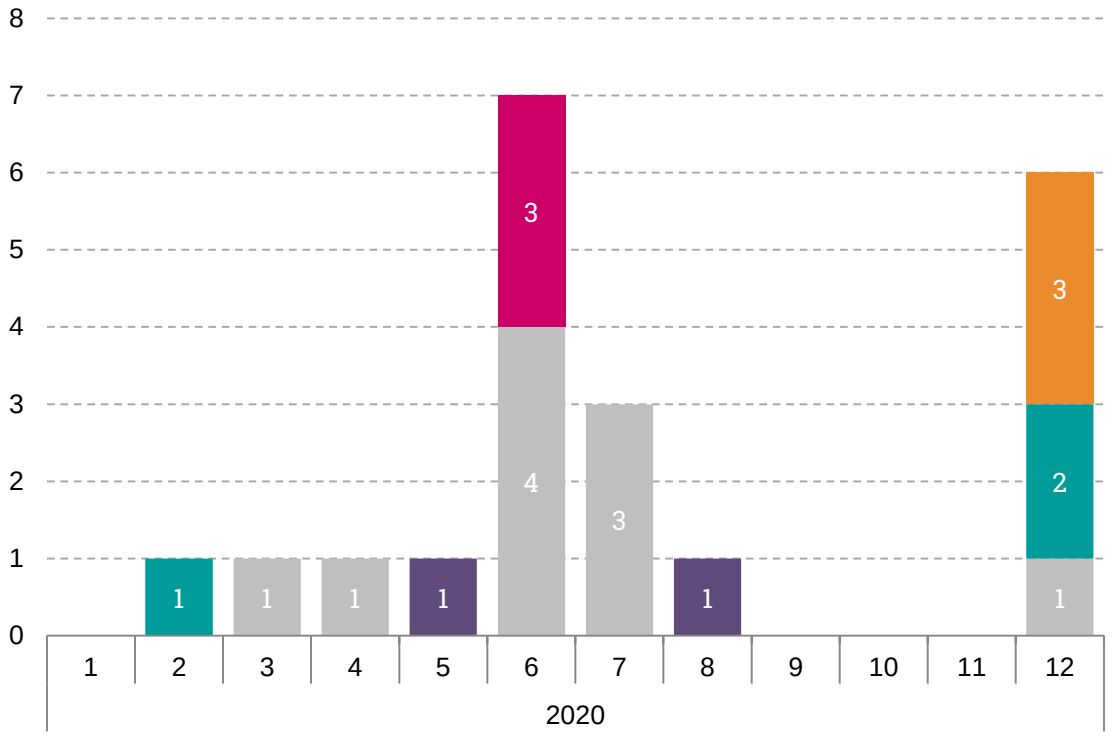
Interface issue

System bug

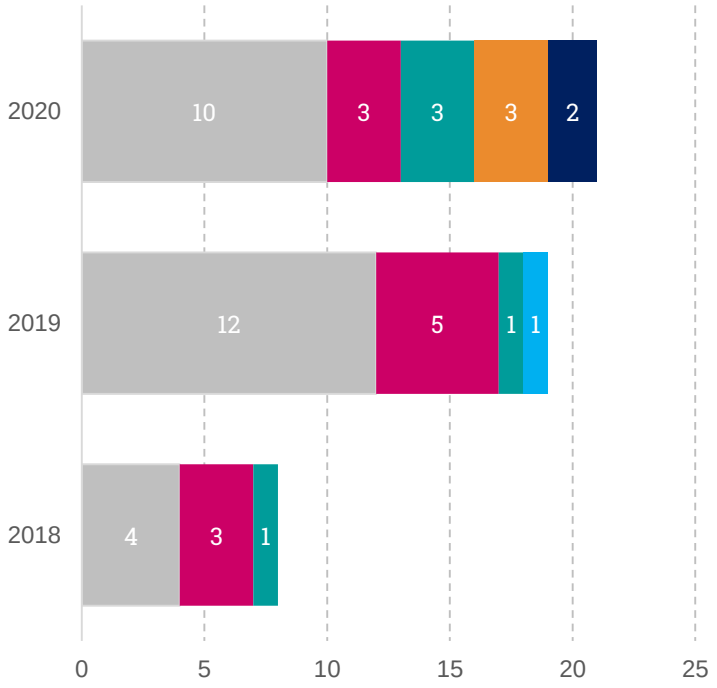
Configuration

Operations Report: Request for change (RfCs) 2)

Monthly



Annual



Other

System Release

Network topology

Geographical extension

Products extension

MNA implementation

Flow based

Operations Report: Request for change (RfCs) [2)]

Requirement	Name	Go-live Date	Reason	Initiator/Owner	Details
Network topology	SWEPOL link go live	2020/01/21	CACM	NEMOs/TSOs	New interconnector
Other	Decrease of capacity on the Bidding Zone Border DK1-SE3	2020/03/17	Other	TSOs	Interconnector update
Other	Decrease of BG allocation limit DK1-DE	2020/04/22	Other	TSOs	Interconnector update
MNA implementation	CCP role activation for ECC in Nordic delivery areas	2020/05/26	Other	NEMOs/TSOs	CCP extension
Other	Change of Product closing time in Trading Schedule for Czech Republic	2020/05/28	Other	NEMOs	Local change / NRA
Other	Increase of Max NTC on the Bidding Zone Border DK1-DE	2020/06/11	Other	TSOs	Interconnector update
Other	Increase NTC limit DE-FR	2020/06/15	Other	TSOs	FB prerequisite
System release	Certificates and password expiration management change	2020/06/16	Other	NEMOs/TSOs	Improve usability
System release	Preview Function before Publish Capacity	2020/06/16	Other	TSOs	Improve usability
System release	FullOrderCaptureReq overview	2020/06/16	Other	NEMOs	Improve usability
Other	Preview function enable DE-FR	2020/06/29	Other	TSOs	Improve usability
Other	Min capacity alignment TNG-RTE	2020/07/01	Other	TSOs	Interconnector update
System release	OCC File Enhancement	2020/07/08	Other	TSOs	Improve transparency
Other	Read Only access to TSO Admin for CCR Hansa CCC's	2020/07/20	CACM	TSOs	CCR implementation
Other	Configuration JAO-ENTSO-E DI in CMM and DBAG Machine User	2020/07/22	CACM	TSOs	Improve transparency
MNA implementation	CCP role activation for EMCO in PL	2020/08/25	CACM	NEMOs	CCP extension
Network topology	New border DE-BE with go-live of the Alegro interconnector	2020/12/08	Other	TSOs	New interconnector
Network topology	New border DE-NO2 for NordLink	2020/12/10	Other	TSOs	New interconnector
Products extension	15 minutes resolution and products for the border (BE-NL)	2020/12/10	CACM	NEMOs/TSOs	IDCZGOT prerequisite
Products extension	30 minutes products and resolution at BE-FR	2020/12/10	CACM	NEMOs/TSOs	IDCZGOT prerequisite
Products extension	15 minutes resolution and products (AT-HU)	2020/12/11	CACM	NEMOs/TSOs	IDCZGOT prerequisite
Other	Increase of Capacity on the Bidding Zone Border DK2-DE	2020/12/15	Other	TSOs	Interconnector update

Performance monitoring report

For performance monitoring, the indicators listed in the annex 4 of the AM have been considered for all the days of 2020.

The maximum, minimum and average values observed throughout the year are reported in the following slides. Where relevant, monthly values are also reported.

Notes and explanations on the calculation of these indicators are included as asterisks below the diagrams in the slides where relevant.

"Rate of executed orders and trades have steadily increased. The time performance of the system remaining stable"

USAGE INDICATORS

- Some of the 2020 data cannot be provided due to the nature of the centralized system and will be provided for the future after related functionalities are implemented. The available data reflects the network topology with 31 market areas, 10 NEMOs and the product types available; hourly, half-hourly, quarter-hourly and blocks.
- The analysis of monthly values regarding executed orders and trades shows an upward trend.

PERFORMANCE INDICATORS *

- The analysis of daily values, in terms of processing time, shows a stability in the values for the lower percentiles in the indicators and an increment of the variations in the values for high percentiles.
- The performance shows stable processing times which is due to algorithm performance optimisation of the SIDC, implemented on the hardware and software levels, and deployed shortly before the start of the 2nd wave in end 2019.

OUTPUT INDICATORS

- The "total matched – hours to delivery" indicator shows that more than 80% of the volumes daily traded are exchanged starting from the fourth hour prior to delivery, and that no traded volumes are recorded before the seventeenth hour prior to delivery.

* Ability to maximise the welfare indicator: As set out in the Title 3, Article 7 of the Annex 4 of the Methodology for monitoring the performance and usage of the continuous trading matching algorithm, the indicators on the continuous trading matching algorithm's ability to maximize economic surplus are not relevant for the continuous trading matching algorithm.

Repeatability indicator: As set out in the Title 1, Article 2, Paragraph 1c of the Annex 4 of the Methodology for monitoring the performance and usage of the continuous trading matching algorithm, the continuous trading matching algorithm is by design optimal and repeatable. For this reason, the monitoring of the continuous trading matching algorithm's optimality and repeatability is not necessary.

Usage indicators		Year 2018	Year 2019	Year 2020		
1) Indicators to describe the Usage of products (Annex 4 of AM Article 8)	Total number of products (per end of year)	4	4			4
	Total number of daily submitted order per product and per bidding zone	Not available	Not available			
	Total daily submitted order volume per bidding zone					
	Total number of explicit capacity allocation request (avg, min, max)		Avg 2 000	Avg 399	Min 170	Max 22 300
2) Indicators to describe the geographical extension (Annex 4 of AM Article 9) (10)	Total number of NEMO* (per end of year)	3	10			10
	Total number of delivery areas** (per end of year)	27	34			32
	Total number of bidding zones** (per end of year)	24	31			29
	Total number of interconnectors (per end of year)	48	62			59
	Total number of borders (per end of year)	36	48			48
3) Indicators to describe Network constraints (Annex 4 of AM Article 10)	Total number of occurrences of ramping constraints on interconnector level	Not available	Not available			
	Total number of occurrence of Biding Zone net position ramping constraints***		-	-	-	-
	Total number of occurrence of Biding Zone net position volume constraints***		-	-	-	-

* Total number of NEMOs count number operational NEMOs. Operational NEMOs in 1st wave were EMCO, EPEX SPOT SE and OMIE. After 2nd wave operational NEMOs were: BSP, Cropex, EMCO, EPEX Spot SE, HUPX, IBEX, OMIE, OPCOM, OTE, and TGE.'

** Overall number of the bidding zones and delivery areas includes Morocco and Finland-Russia which have a special status and are necessary for the technical operation of the power grid. However, from the market perspective those 2 zones are not used for bidding purposes.

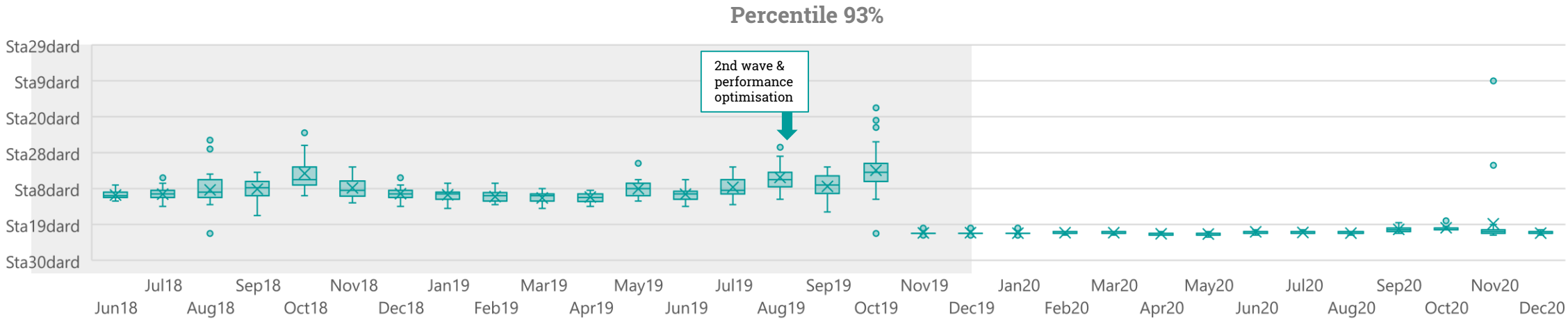
*** The net position ramping constraint and the net position volume constraint are not in use in SIDC today, i.e. no values to be reported for these two indicators.

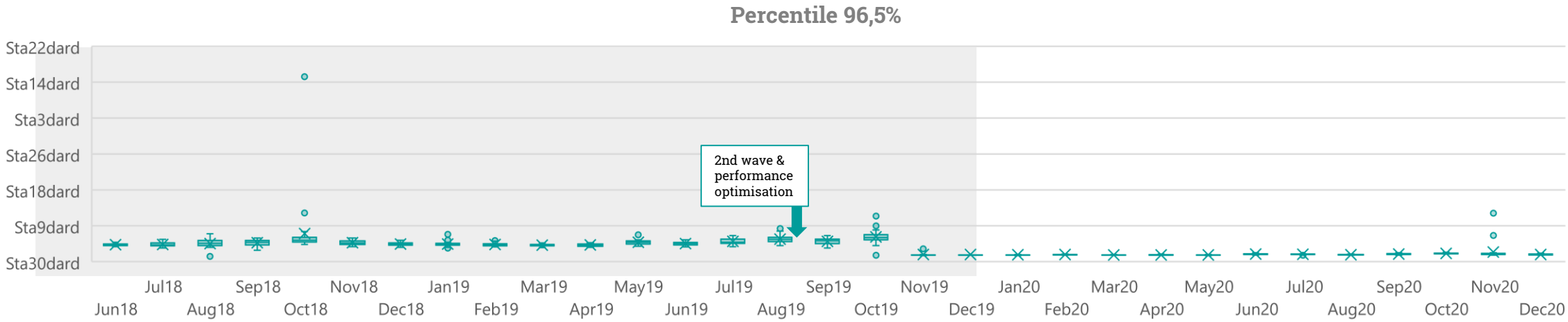
Performance			Year 2018	Year 2019	Year 2020		
			Avg	Avg	Avg	min	max
Algorithm scalability (Annex 4 of AM Art. 7)	(a) Time for the execution of an order (milliseconds)*	Lower percentile 93%	40	36	16	13	100
		Upper percentile 96,5%	55	48	21	17	135
	(b) Rate of executed orders (number per day)		451 760	708 934	1 645 724	809 669	3 206 601
	(c) Time for the execution of a trade *		Equal to (a)	Equal to (a)	Equal to (a)	Equal to (a)	Equal to (a)
	(d) Rate of executed trade (number per hour)		38 607	63 898	109 965	64 947	175 026
	(e) Time for generation of post coupling files (milliseconds)		7 375	10 917	15 001	7734	64 256
	(f) Time for processing an order book update (milliseconds)**	Lower percentile 93%	66	63	28	20	86
		Upper percentile 96,5%	79	113	36	26	109

* This indicator measures the time between the moment that an order receives a timestamp from the system and the moment that it is reported by the system as executed. As of today, there is no separate value for the execution of a trade and for execution of an order. The parameter includes together order and trade execution (trades executions are a subset of order executions in the existing reporting.)

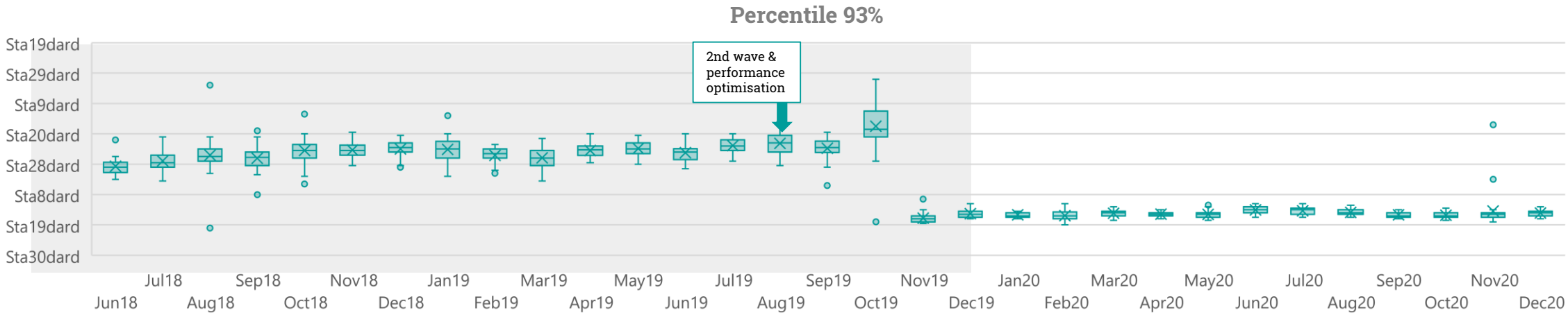
** For each orderbook update, this indicator measures the longest time lapse between the moment that an order enters the system and the moment that the system sends the order book update comprising that order.

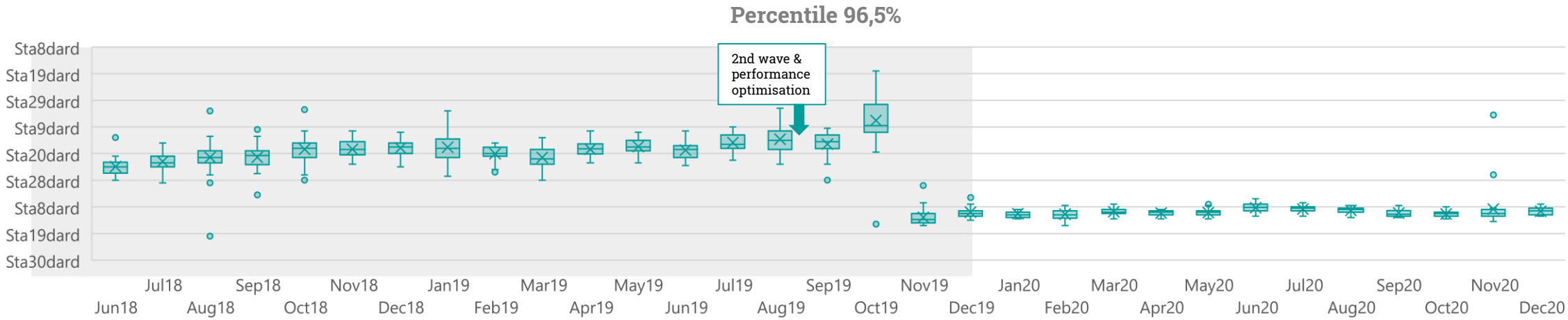
Time for the execution of an order/trade (millisec)



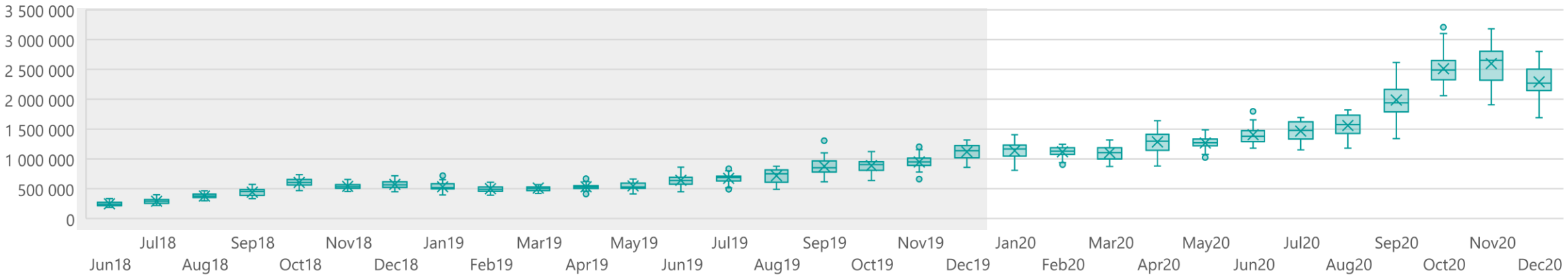


Time for processing an order book update (millisec)

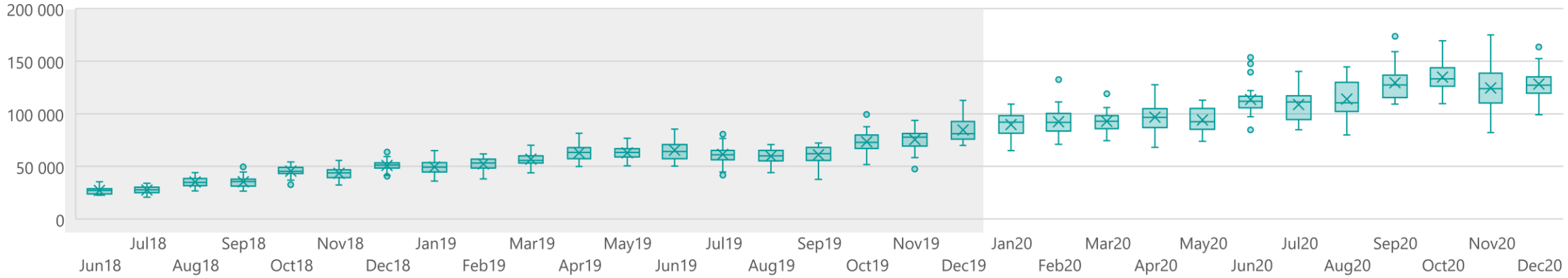




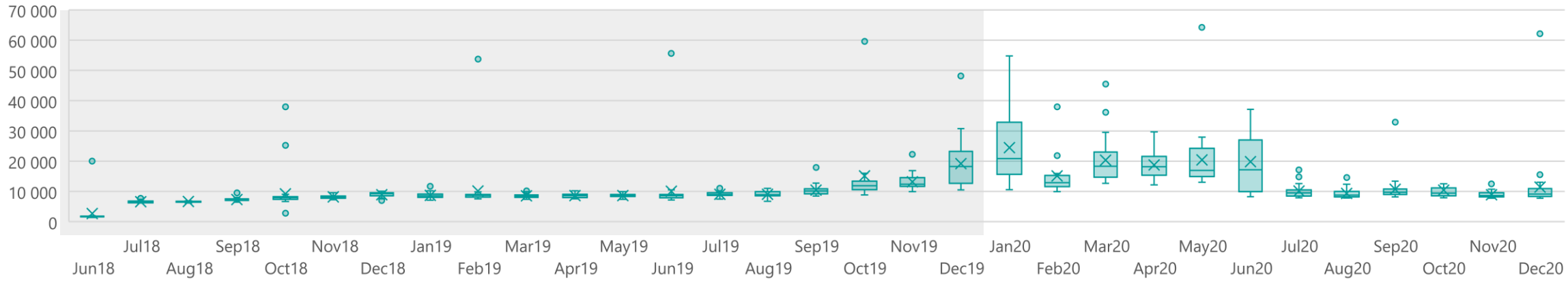
Rate of executed orders (number per day)



Rate of executed orders (number per hour)



Time for generation of post coupling files (millisec)



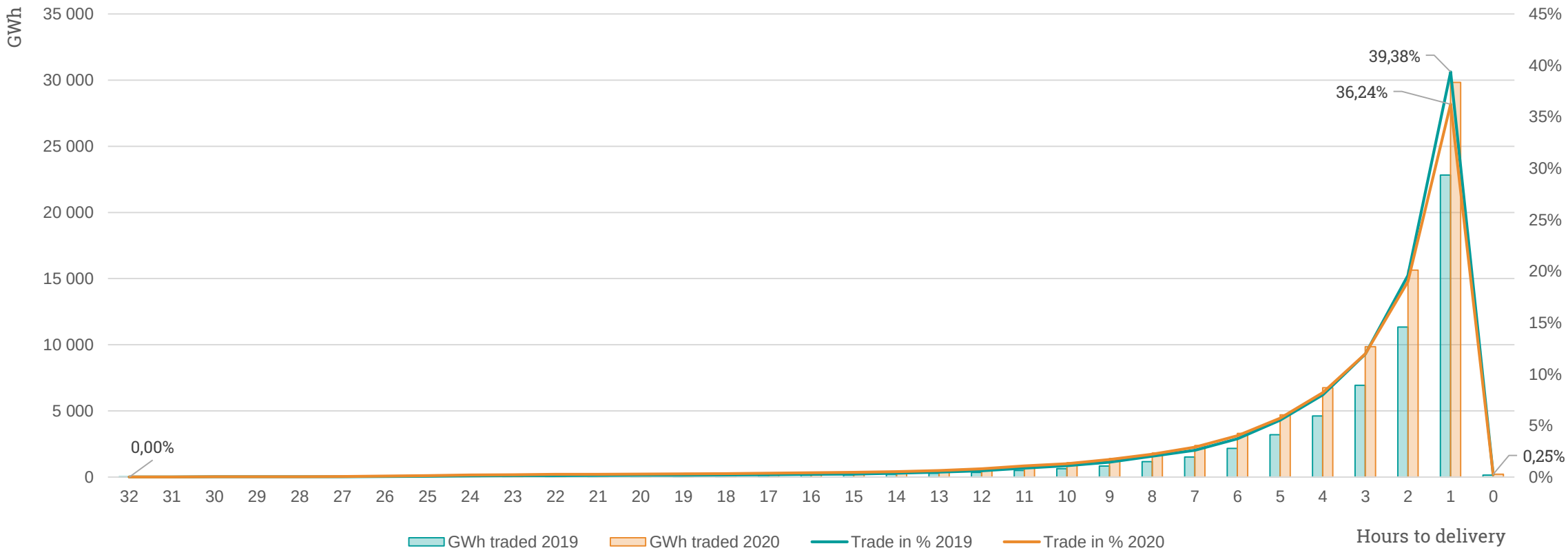
Performance monitoring report: Output indicators [12)]

Output indicators			Year 2019				Year 2020		
			Avg	Min	Max		Avg	Min	Max
Indicators on the maximisation of economic surplus (Annex 4 of AM Article 11)	Number of matched orders of each contract	Total matched volume (MWh) – daily value (MWh)*	161 425	80 536	371 432		224 956	126 770	442 761
		Total matched volumes – hours to delivery (MWh)	See separate graph						
		Total number of trades per contracts	Not available						
		Total number of trades per contract – hours to delivery							
	Number of explicit capacity allocation	Total number of daily explicit capacity allocations	2 124	1 203	5 871		5 209	3 555	7469
	Prices	Volume-Weighted Average Intraday Prices (€/MWh)	39.93	-178.69	414.58	Hour	29.23	-130.9	666.3
						Half-hour	34.63	-250.1	600
						1/4-hour	32.44	-149.38	795.36
						Block	25.23	-70.0	400
		Volume-Weighted Average Intraday Prices – last trading hour (€/MWh)	40.02	-331.79	836.73	Hour	32.0	-217.14	921.12
						Half-hour	33.74	-138.97	400
						1/4-hour	31.58	-186.98	1 722.79
						Block	23.67	-60	190
		Bid-Ask Spread (€/MWh) From November 2019	21.58	0.04	1 526.84	Hour	24.30	0.01	6 176.64
						Half-hour	123.11	4.1	19 996.0
						1/4-hour	38.98	0,01	3 616.48
						Block	204.61	-2	19 998.0

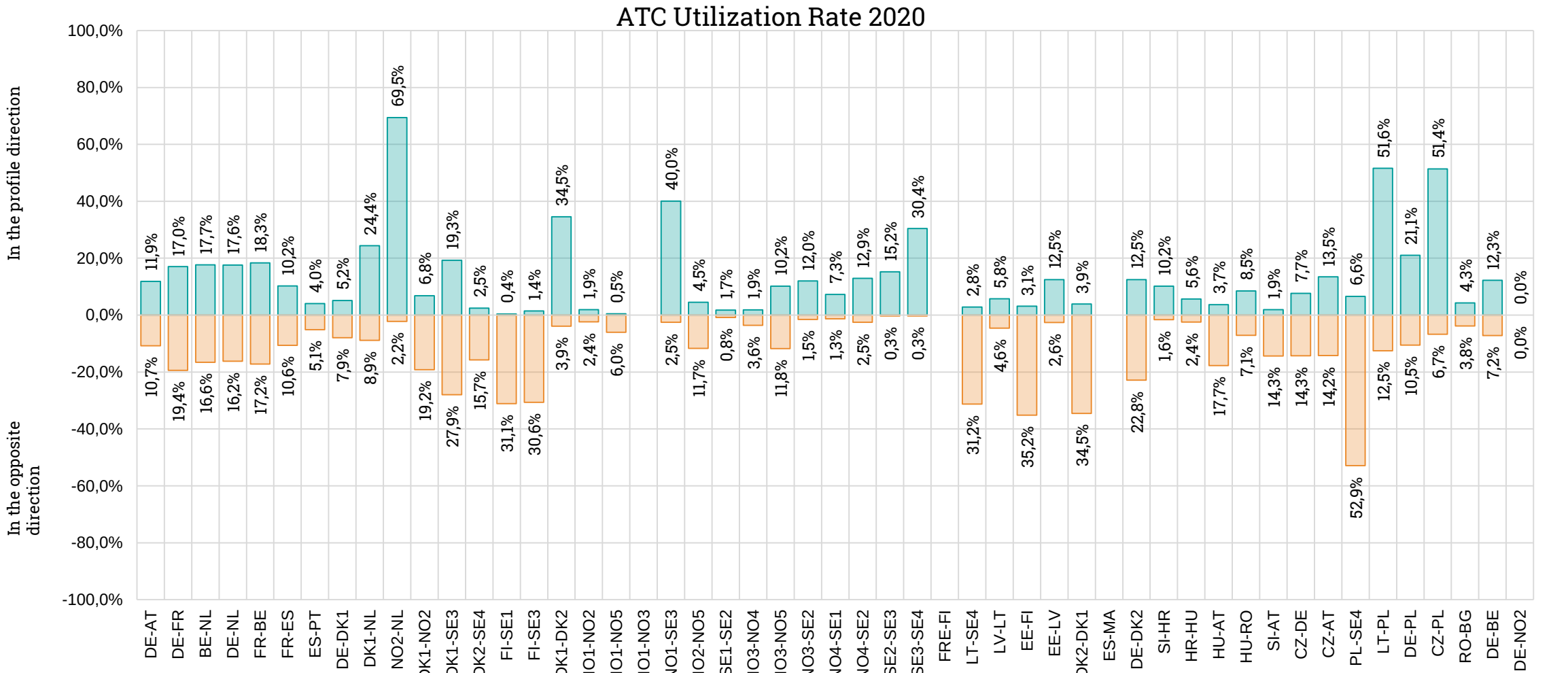
*Total matched volume is in the table shown as a daily value – average traded volume in MWh per day and the min and max volume in MWh traded in one day.

**Data for Bid ask Spread is available only from November 2019. Average, min and max

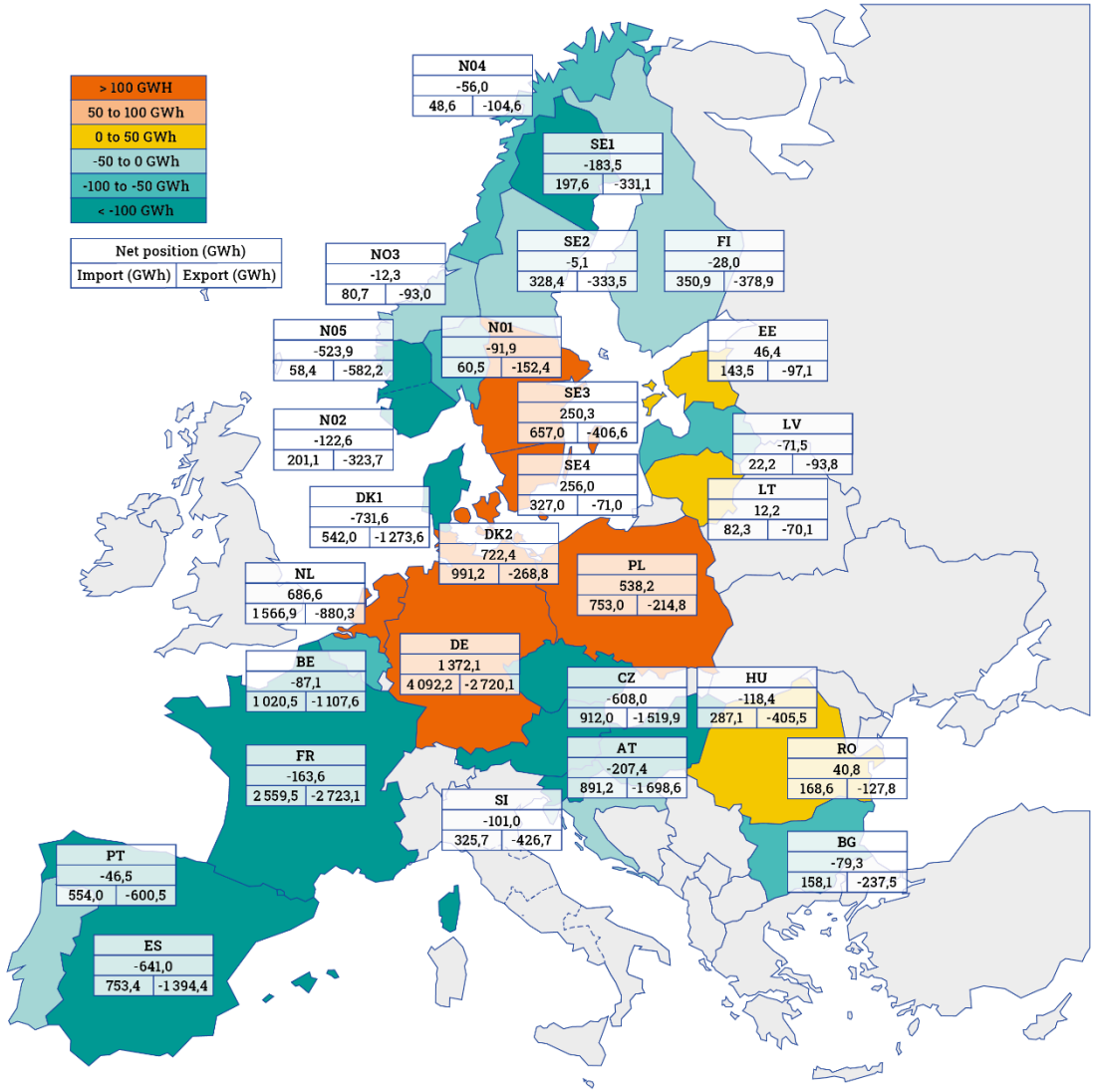
Total volume matched hours before delivery



Total matched volumes – hours to delivery – this indicator counts the traded volumes, grouped per contract with same "delivery time start-end", per combination of Bidding Zones and grouped according to the hours left to delivery and aggregated per month.


ATC Utilization Rate 2020
In the profile direction
In the opposite direction
100,0%
80,0%
60,0%
40,0%
20,0%
0,0%
-20,0%
-40,0%
-60,0%
-80,0%
-100,0%
DE-AT 11,9% 10,7%
DE-FR 17,0% 19,4%
BE-NL 17,7% 16,6%
DE-NL 17,6% 16,2%
FR-BE 18,3% 17,2%
FR-ES 10,2% 10,6%
ES-PT 4,0% 5,1%
DE-DK1 5,2% 7,9%
DK1-NL 24,4% 8,9%
NO2-NL 69,5% 2,2%
DK1-NO2 6,8% 19,2%
DK1-SE3 19,3% 27,9%
DK2-SE4 2,5% 15,7%
FI-SE1 0,4% 31,1%
FI-SE3 1,4% 30,6%
DK1-DK2 34,5% 3,9%
NO1-NO2 1,9% 2,4%
NO1-NO5 0,5% 6,0%
NO1-NO3
NO1-SE3 40,0% 2,5%
NO2-NO5 4,5% 11,7%
SE1-SE2 1,7% 0,8%
NO3-NO4 1,9% 3,6%
NO3-NO5 10,2% 11,8%
NO3-SE2 12,0% 1,5%
NO4-SE1 7,3% 1,3%
NO4-SE2 12,9% 2,5%
SE2-SE3 15,2% 0,3%
SE3-SE4 30,4% 0,3%
FRE-FI
LT-SE4 2,8% 31,2%
LV-LT 5,8% 4,6%
EE-FI 3,1% 35,2%
EE-LV 12,5% 2,6%
DK2-DK1 3,9% 34,5%
ES-MA
DE-DK2 12,5% 22,8%
SI-HR 10,2% 1,6%
HR-HU 5,6% 2,4%
HU-AT 3,7% 17,7%
HU-RO 8,5% 7,1%
SI-AT 1,9% 14,3%
CZ-DE 7,7% 14,3%
CZ-AT 13,5% 14,2%
PL-SE4 6,6% 52,9%
LT-PL 51,6% 12,5%
DE-PL 21,1% 10,5%
CZ-PL 51,4% 6,7%
RO-BG 4,3% 3,8%
DE-BE 12,3% 7,2%
DE-NO2 0,0% 0,0%

Performance monitoring report: Output indicators [12)]



Scalability report [8), 9), 11)]

SIDC monitors operational data related to the agreed SLA (service level agreement) regarding time and indicators on a monthly basis. These are used for the prediction of the future load of the system for the period of one year, as well as for future usage of products. The predictions are compared with the results of different stress tests which were executed to explore the behaviour of the system along different stress test scenarios. The stress tests always represent a busy hour of the day and 100% of the results must respect the agreed SLA regarding time indicators. The predictions are provided to the SIDC Solution vendor who is obliged to propose optimisation of improvements/measures in case the predictions indicate a negative impact on the performance of the SIDC Solution.

Along different releases, stress tests included realistic tests scenarios which represented different distribution of orders along a different mix of products, variations along different combinations of base load, number, duration and quantity of rate of orders per second which are sent to the system. The stress tests included a realistic topology, reflecting the future geographical extension, including changes foreseen in the road map and the anticipated growth.

The stress tests, or parts of them, were performed using the latest available version of the SIDC algorithm and did not cover the performance impact of some future RfCs as it is impossible to measure or model the impact of such RfCs in advance.

"Time for execution of an order for 2020 was faster by more than 50 percent in comparison to the previous years"

It is expected that the RfC on Cross-product matching, may have an impact on system performance and therefore this RfC will be subject to a performance analysis and/or potentially to a step-wise implementation process.

The natural market growth, further geographical extension and impact of the 15/30 resolution products on the specific borders is subject to an ongoing impact analysis which is expected to deliver indications for the further performance improvements during this year. The impact analysis intends, among others, to validate a possibility of the extension of the number of process transaction orders (event that manipulates with orders – creation, modification, removal) by 500 – 1000 percent in comparison to the currently contractually agreed boundaries in order to ensure sufficient scalability for the outlook of the next 3 years.

It shall be noted that the technical threshold of the system is above the agreed SLA however these boundaries are not explicitly defined. The design of the SIDC Solution handles high peak situations by queuing up the incoming orders which may lead to the extension of the Time for execution of an order. Time for the execution of an order is measured for every order and evaluated on the regular basis. As stated in the performance report the Time for execution of an order for 2020 was faster by more than 50 percent in comparison to the previous years (consequence of the performance optimisations deployed at the end of 2019).

Response time indicators contractually agreed via SLA for Order execution and trade capture response are 895 milliseconds for Lower percentile (93%) respectively 1790 milliseconds for Higher percentile (96.5%). Hence the current average utilisation of the SIDC solution in terms of the response times is well below 5% of the contractually agreed parameters.

The ongoing impact analysis in combination with the average response time ensures scalability of the SIDC solution for both the short and longer-time framework.

The scalability report of the roadmap provides an indication of the intended go-live period for listed RfCs. The go-live period may be subject to revisions reflecting the SIDC prioritisation process which considers the regulatory, technical and commercial aspects of RfCs and introduces an aspect of planning flexibility.

Requirement	Name	Go-live Date	Reason	Initiator/Owner	Details	Outcome	Included in scalability study – yes/no
MNA implementation	CCP & Shipper role activation for EPEX/ECC in Poland	Q4 2021	CCP extension	EPEX NEMO	Configuration update	Included to assessment	No
Products extension	15 minutes resolution and products for internal Nordic ICs and BZs	Q2 2023	IDCZGOT prerequisite	Affected TSOs	Configuration update	Included to assessment	Yes
	15 minutes resolution and products (RO-HU)	Q1 2021	IDCZGOT prerequisite	Affected TSOs	Configuration update	Approved for development and testing	No
Geographical extensions	Italian Northern Borders + other interconnector extensions	Q3 2021	Geographical extension	Affected TSOs	Configuration update	Included to assessment	Yes
	Greece-Italy and Greece Bulgaria	Q1 2022	Geographical extension	Affected TSOs	Configuration update	Included to assessment	Yes
	Slovak interconnectors	Q4 2022	Geographical extension	Affected TSOs	Configuration update	Included to assessment	Yes
Other	Utilization of TSO MPLS for GUI access to XBID	Q2 2021	Improve usability	Affected TSOs	Configuration update	Included to assessment	No
	Configuration of TTN as Data Intermediary and Outbound FTC (abbrev. TTN DI)	Q1 2021	Improve transparency	TSOs	Configuration update	Approved for development and testing	No
Network Topology	Hungarian-Slovenian Interconnector	Q1 2022	Geographical extension	Affected TSOs	Configuration update	Included to assessment	Yes
System release	SM GUI Improvements	Q2 2022	Improve usability	NEMOs/TSOs	System development	Included to assessment	No

Requirement	Name	Go-live Date	Reason	Initiator/Owner	Details	Outcome	Included in scalability study – yes/no
System release	SM late files alarm	Q2 2022	Improve usability	NEMOs	System development	Included to assessment	No
	SM Sent Files FTC revamp II	2021	Improve usability	NEMOs	System development	Included to assessment	No
	Zeroes/negative capacity allowed as def. cap.	Q2 2021	Improve usability	TSOs	System development	Approved for development and testing	No
	Common ATC/NTC for Bidding Zone borders	Q2 2022	Improve usability	TSOs	System development	Included to assessment	No
	Extend Contract Halt function with a selection of direction(s)	Q2 2022	Improve usability	TSOs	System development	Included to assessment	No
	Shipping module handover enduring solution improvement	2023	Improve usability	NEMOs/TSOs	System development	Included to assessment	No
	CMM GUI refresh function	Q2 2021	Improve usability	TSOs	System development	Approved for development and testing	No
	CMM Process Execution after System failure	Q2 2022	Improve usability	TSOs	System development	Included to assessment	No
	Order execution timestamp	Q2 2021	CACM	NEMOs	System development	Approved for development and testing	No
	Scheduled Service Halt	Q2 2022	Improve usability	TSOs	System development	Included to assessment	No
	OCC Files Missing Attribute	Q2 2021	Improve usability	NEMOs/TSOs	System development	Approved for development and testing	No
	Reporting indicators	Q2 2021	CACM	NEMOs/TSOs	System development	Approved for development and testing	No
	AM Indicators extension	Q2 2021	CACM	NEMOs/TSOs	System development	Approved for development and testing	No

Requirement	Name	Go-live Date	Reason	Initiator/Owner	Details	Outcome	Included in scalability study - yes/no
Products extension	Cross-product matching	Q1 2023	CACM	NEMOs/TSOs	part of R & D	Performance impacts mitigations under assessment	Yes
	IDA	Q3 2023	CACM	NEMOs/TSOs	part of R & D	Performance impacts mitigations under assessment	Yes
Flow based	Flow based support	Q1 2025	CACM	NEMOs/TSOs	part of R & D		
Other	RTS4 - Performance optimisation / implementation	Q2 2022	Other	NEMOs	R & D	Included to assessment	No
System release	Usability improvements**	NA	Other	NEMOs/TSOs	System development	Included to assessment	
	Losses		CACM	NEMOs/TSOs	Part of R&D	Performance impacts mitigations under assessment	Yes

* List of RfCs placed in 2019 for future implementation.

R&D report

The discussions on the R&D programme in SIDC are closely linked to the roadmap and operational needs and must reflect flexibility as indicated in the Scalability report. The major future changes which may be subject to R&D are Shipping – Enduring solution, Intraday Auctions, Losses and Cross-product matching, extended use of 15/30 minutes level, Flow Based Allocation.

R&D needs for each item are determined during High Level Design (or during Detailed Analysis depending on the scope of the change). R&D, for functional and technical changes, is executed via a Proof of Concept.

So far the Proof of Concept was concluded for losses and the preparatory steps for the assessment of need for a Proof of Concept were adopted for Cross-product matching.

There is a parallel R&D work stream on the SIDC shipping enduring solution with NRAs cooperation and tests planned for specific borders on 15 min resolution and product extension.

Flow Based R&D concept is expected to be triggered in the future.

MAJOR ITEMS IN SIDC R&D PROGRAMME

R&D topic	Description	R&D budget[1]	Status	Comment
Transit shipping - Enduring solution	Solution which shall resolve current risks associated with the transit transaction (transiting party has a very limited tools to mitigate risks)	RM	Cost benefit analysis is completed. Further elaboration based on NRAs request may follow.	**Foreseen steps:** – NRAs decision on the implementation option – Detailed analysis/design – Proof of concept if needed
IDA	Intraday Auctions - based on commission regulation 2015/1222 of 24 July 2015 - capacity allocation and congestion management - implementation of a methodology to price cross-zonal intraday capacity (Article 55)	RM	Description of implementation options is completed.	**Foreseen steps:** – High Level analysis of the interface and liability clarification – Detailed design – Proof of concept if needed
Losses	in line with Algorithm Methodology requirements the continuous trading matching algorithm shall allow to incorporate losses on interconnector(s) between bidding zones during capacity allocation, if requested by the owner(s) of the relevant interconnector after approval by the relevant NRAs.	RM	High Level design adjustment proposed (balancing account introduction)	**Foreseen steps:** – High Level design review – Detailed design review & Proof of concept including performance analysis review if needed
Cross-product matching	Cross-product matching is required to be enabled between 15-minute and 60-minute products, between 30-minute and 60-minute products, and between 15-minute and 30-minute products and also for any combinations of the products	RM	Detailed design ongoing	**Foreseen steps**: – Need and/or form of Proof of concept subject of agreement
Product extension (15 min)	15 minutes resolution and products for internal Nordic area (Inteconnectors and Bidding Zones) planned for Q2 2023 and for RO-HU Interconnector planned for Q1 2021[2]	N/A	Central XBID system testing completed.	**Foreseen steps:** – End-to-end testing for introduction of 15 minutes products.
System improvements[4]	Represents various system improvement which are scoped for different releases	N/A	R3.1 – deployed in production R4.0 minor items – analysis completed	**Foreseen releases and packages:** – Next release – scoping under clarification

RM – Estimation or status on estimation included in the roadmap | N/A – Not Applicable

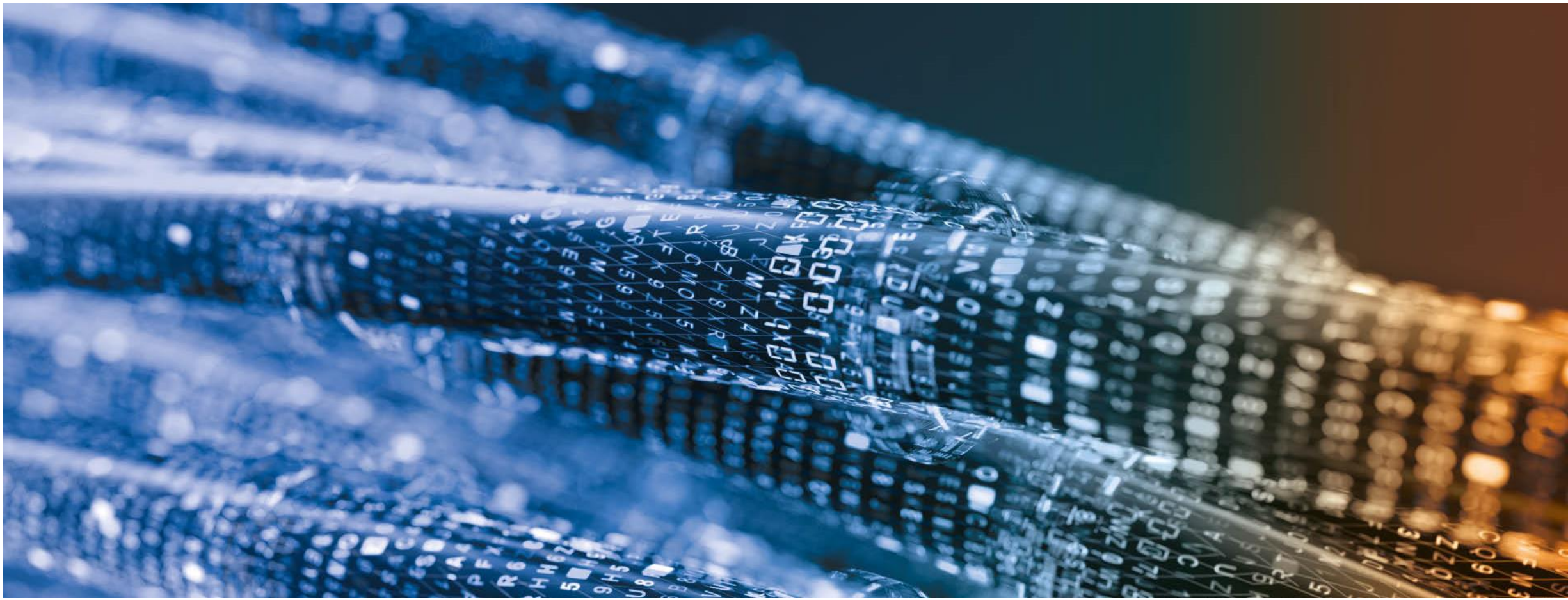
[1] Budget includes 3rd party cost which cannot be made public unless explicit approved by 3rd parties (cost is transparently recorder in SIDC and provided to regulatory authorities)

[2] Expected delivery into production

[3] Priority is not specified explicitly, activities are executed when the items with higher priority are not mature enough for next steps for the research or development

[4] System improvements are not subject of research. However, they are listed in the report as they are part of the flexible approach as explained in the previous slide

Annexes



ALL NEMO COMMITTEE

Annex 1: SDAC parameters

Indicator	Parameter	Description	Value	Purpose	Annex 3 of AM
	K	Number of months which define the recent historical set	3	Definition of recent historical set	Art. 2(a)
Scalability	X%	Minimum percentage of cases which have to comply with the scalability indicator threshold	1. 97% of cases should be below Running time; 2. 100% of cases should be below 180% of running time.	- Monitoring purpose - RfC assessment for the past scenario - RfC assessment for the future scenario - Scalability assessment for the near future scenario - Scalability assessment for distant future scenario - Research and development	Art. 3(4)- Art. 4(2)(a) - Art. 4(2)(b) – Art. 5(2)(a) - Art. 5(2)(b) - Art. 6(2)(a)
	y	Threshold for scalability indicator on the indicator values distribution	1. 12 min; (17 min for scalability and R&D) 2. 21.6 min (30.6 min for scalability and R&D)	- Monitoring purpose - RfC assessment for the past scenario - RfC assessment for the future scenario - Scalability assessment for the near future scenario - Scalability assessment for distant future scenario - Research and development	Art. 3(4)- Art. 4(2)(a)- Art. 4(2)(b)- Art. 5(2)(a)- Art. 5(2)(b)- Art. 6(2)(a)
	Z	Threshold for scalability indicator on the average value	∞	- Monitoring purpose - RfC assessment for the past scenario - Scalability assessment for the near future scenario - Scalability assessment for distant future scenario - Research and development	Art. 3(4)- Art. 4(2)(a)- Art. 5(2)(a)- Art. 5(2)(b)- Art. 6(2)(a)
Ability to maximise economic surplus	T	Time extension for first OK-solution calculation	10 min		Art. 7(2)
Repeatability	pi	Weight for the different component of the repeatability indicator	1	- Clearing prices - Products output	Art. 8

Annex 1: SIDC parameters

Parameter	Value	Scope	Proposed Annex 4 of AM
K	3	Number of months which define the recent historical set	Art. 2(3)(a)
t	n.a. [8)]	Scalability threshold as defined in the service agreement with the service provider	Art. 3(4)(a)- Art.4(3)(a)- Art.4(3)(b)- Art.5(3)(a)- Art.5(3)(a)- Art.6(3)(a)
X%	n.a. [8)]	Minimum percentage of cases which have to comply with the scalability indicator threshold	Art.6(3)(a)

1) **Incidents causes.** "Unusual process" category involves any unattended procedures that may cause delays; "Interface issues" is related with mistakes in the format of offers/results; "System bug" involves problems with common systems; "Configuration" is related with topological configuration; "Human error" is related with incidents caused by an external party (e.g. market participant); "Other" involves any other cause, typically related with technical issues belonging to local NEMO/TSO systems.

2) **Requests for change.** "Geographical extension" category involves any RfC including in the SDAC new MSs; "Network topology" category involves any RfC modifying the topology of the existing MSs (for example by splitting existing BZs, removing BZs, adding or eliminating cables, …); "Flow based" category involves any RfC introducing or modifying the flow based methodology in one or more BZs; "MNA implementation" category involves any RfC introducing MNA in one or more BZs; "product extension" category involves any RfC extending the usage of existing products in further BZs; "System release" category involves any RfC introducing the usage of a new version of one or more MCO system; "other" category involves any RfC non included in the previous categories, among which especially related to procedural changes. When a single RfC impacts more than one category among those reported in the graphs, they are conventionally counted for the number of categories impacted. Typical is the example of the "Geographical extension" RfCs, which, by definition, are impacting also product extension to different BZs. Note that the Non-notifiable changes are not included in the list provided. These changes are not directly affecting the MCO function assets, and not causing a detriment to the performance of the relevant algorithm and not relevant to market participants.

3) **Box plot.** The monthly trend of the indicators is reported through "box and whisker" chart (or box blot). The chart shows the distribution of data into quartiles, highlighting the median, mean and outliers. The boxes have lines extending vertically called "whiskers" which indicate variability outside the upper and lower quartiles, and any point outside those lines or whiskers is considered an outlier. The reported charts show the mean markers (X symbol) and the quartile calculation uses the exclusive median method (i.e. The median is excluded from the calculation if the number of values in the data is odd.

4) **Performance indicators.**

1) Ability to maximise the welfare indicator. The first indicator illustrates the economic improvements realised in production, from the first valid solution find (corresponding to the TTFS solution) and the finally chosen solution. The second indicator shows foregone economic surplus improvements, identifying the incremental welfare which would have derived from prolonging calculation time by 10 minutes after the maximum allowed time (currently 12 minutes). These latter results were obtained re-running the sessions on a simulation environment. For individual sessions the economic surplus gain after increasing allowed calculation time by 10 minutes can be negative, i.e. a decrease. This is evidenced by the reported minimum values (-0.002395%), as well as the plot with differences, which has a tail with some negative values. Such effects may stem from differences between the production and simulation machine, lack of reproducibility or different paths followed when exploring the branch & bound tree.

2) Repeatability indicator: A session is repeatable if Euphemia returns, for each iteration, the same value for all the relevant variables in both runs when comparing solutions with the same solution id. Potential differences are calculated using the same inputs, configuration of hardware and software and at the and comparing the last common solutions in both runs. Comparison is made on the latest common solution over two consecutive runs of production input data in a production like machine. The machine used for the study fulfils the minimum requirements set for machines used in production. Comparisons are done considering 6 decimal places precision (1e-6 tolerance). One indicator measures what is the proportion of the values equal with respect the total number of indicators, the other indicator measures the average impact on the relevant results when differences exist. One of the three versions of the SDAC algorithm used in 2020 didn't support yet fully repeatability. Since Euphemia 10.4, there exist the possibility of activating a parameter named "deterministic time" that allows to use an internal clock that can be used to assure that the decisions are taken in the same time sequence in two consecutive runs on the same input data on the same machine. For 2019 repeatability study, it was run using E10.5 and time limit as stopping criterion. The same input data has been run with and without the "deterministic time" parameter activated, but only the case without the parameter activated has been plotted because when using "deterministic time" activated the results were able to obtain the same relevant results in all cases.

5) **Ability to maximise the welfare indicator.** The indicator on foregone welfare due to limiting calculation shows for some sessions the economic surplus decreases with the time extensions. This effect reflects the non full repeatability of the SDAC Algorithm when the parameter "deterministic time" is not activated.

6) **Scalability report**

   1) Indicator. This indicator for SDAC applies the standard scalability indicator (TTFS) and relative thresholds currently applied to approve RfCs to future scenarios (namely the near future scenario representing Y+1, namely 2022, and distant future scenario representing Y+3, namely 2024), which includes anticipated growth of historical usages and anticipated Requests for Changes. The simulations are calculated using the latest available version of the SDAC algorithm (Euphemia 10.6), which means that by construction this indicator under-estimate the future level of scalability, as it cannot consider the expected impact of the future releases of the SDAC algorithm which will be used in production in Y+1 and Y+3. Furthermore it may be impossible to model the impact of some RfCs, whenever they request new releases of the algorithm or network data not already modelled at the time of the simulation. Note that roadmap RfCs are split in operation and functional tables. Functional RfCs cannot be included in scalability studies due to they require new functionalities to be implemented in the algorithm. Anticipated usage of operational RfCs that are included in the scalability scenarios are either directly included or emulated when the RfCs are requesting new algorithm requirements not available yet.

   2) Curve points in the 2022 scenario decrease relative to the 2020 usage. This is linked to Brexit, where the removal of British curves resulted in this reduction. For the 2024 scenario the curve points were meant to increase, but due to an issue in the data preparation this change did not come through. Since curve points are not the primary drive of complexity the simulation results are not expected to significantly underestimate performances.

7) **Unharmonised derogations.** According to article 8.2 of Regulation (EU) 2019/943, SDAC and SIDC shall implement MTUs aligned with the Imbalance Settlement Period (ISP), which according to Article 8.4 shall be 15 mins since 01/01/2021, with possibility for derogations until 31/12/2024. This shall induce a significant increase in the demand for scalability, due to the quadruplication of the size of the market (from 24 to 96 MTUs). Furthermore according to article 62.2 d) of Balancing Regulation, TSOs may apply for a derogation to this term up to 2025 and, in case different MTUs temporarily apply on two sides of a border, the cross border capacity should be allocated on the longer MTU of the two. Hence, depending on local TSOs' applications for derogations and NRAs' decisions, this shall need a stepwise implementation of 15 mins MTU throughout the EU, with different products durations being traded in different BZs and with cross-border capacity being allocated on different MTUs on the different borders of a same BZs. This shall require the SDAC algorithm to incorporate a new functionality in order to support the so called "cross-matching" of products with different MTUs but also of net positions and cross border flows with different MTUs, which is not existing at the moment for the current industrialized versions of Euphemia and which can be expected to prove even more demanding in terms of scalability.

8) **SIDC.** Technical operation of SIDC is fully regulated by the Master Service Agreement (MSA) between NEMOs and the XBID system vendor. MSA's contractual arrangements stipulate that the vendor is the sole party having access to the XBID technical components as e.g. XBID databases. Hence, the data which are included in this report are mainly based on the technical regular reports provided by vendor to SIDC parties. This also implies that all requests on the extension of the reporting obligation (including the existing reporting obligations which are not implemented yet), and which require extension of XBID source data provided by the vendor, are subject of the change management process and release management process stipulated with the vendor. It shall be also noted that the MSA sets out principles of confidentiality which, among others, apply to the provisions of the Service Level Agreement regulating e.g. availability and performance of the XBID system. Based on the confidentially principles, the details may be, and are, shared with SIDC stakeholders (NRAs, ACER, EC) but cannot be revealed to the general public and therefore they are not integrated within this report. Note that NRAs have full access to the MSA.

9) **SIDC R&D commercial information.** The commercial information in the SIDC is subject of the negotiation process with the vendor(s) therefore the information cannot be included in the report. The full transparency towards the SIDC stakeholders (NRAs, ACER, EC) is ensured via sharing a detailed R&D roadmap which shall be considered as an complementary information to the report.

10) **SIDC Usage indicators.** "Total number of daily submitted order per product and per bidding zone", "Total daily submitted order volume per bidding zone" and "Total number of occurrences of ramping constraints on interconnector level" are not included in the report as the necessary implementation changes in the SIDC System were deployed on 28.4.2021. Therefor the above-mentioned indicators will be available only in the 2021 report covering period May – December 2021.

11) **SIDC Performance indicators & Performance monitoring.** The evaluation of the performance indicators is carried out in SIDC on a monthly basis in line with the processes stipulated in the MSA. As a basis for the evaluation of the performance the Service Level Agreement (SLA) applies. The SLA represents contractually agreed parameters and in combination with agreed system boundaries it defines the performance of SIDC guaranteed by the vendor. The technical thresholds of SIDC are not defined (known) though it is assumed that they are well above the SLAs (which is also proven by the scalability report). Every month the vendor provides an evaluation of the performance indicators, based on the production data, in the form of a performance report. SIDC parties review the performance report and provide the vendor with anticipated changes of the processed data, as e.g. changes/growth in the number of implicit and explicit orders. The vendor analyses the provided data and in case the analysis indicates a risk or need of the optimisation measures the vendor provides a proposal for the SIDC Solution improvements which are jointly discussed.

12) **SIDC Output indicators.** "Total number of trades per contracts" and "Total number of trades per contract – hours to delivery" are not included in the report as the necessary implementation changes in the SIDC System were deployed on 28.4.2021. Therefor the above-mentioned indicators will be available only in the 2021 report covering period May – December 2021.

Disclaimer

The data source of this report has been provided by SDAC and SIDC respectively.

The All NEMO Committee accept no responsibility or liability for any consequences arising from the use of the data contained in this document.

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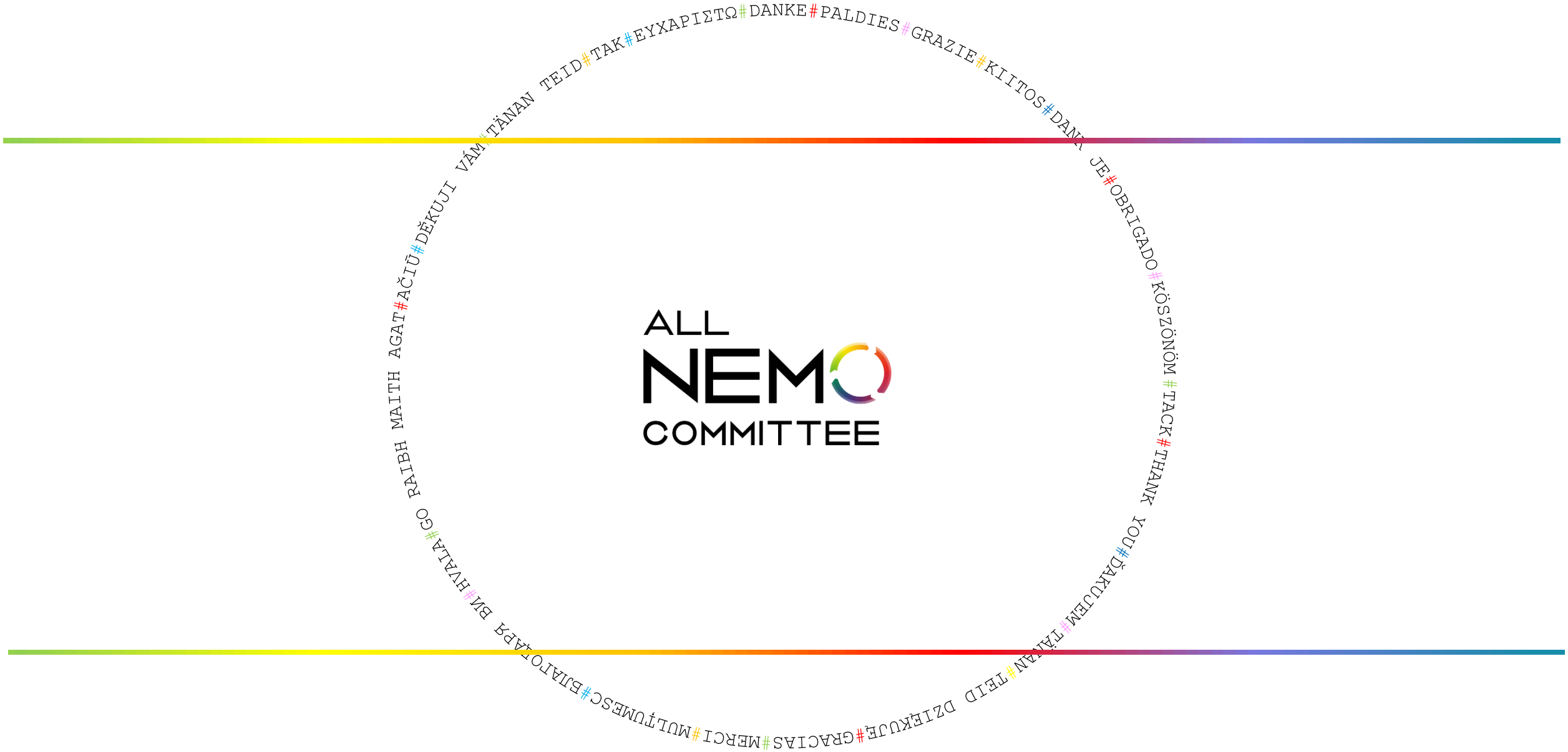
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