ACER

European Union Agency for the Cooperation of Energy Regulators

Economic surplus analysis

2026 Monitoring Report - Annex

4 November 2026



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Table of Contents

List of acronyms **4**

Overview **5**

1. Methodologies for estimating economic surplus **6**

1.1. Scope, objectives, assumptions and limitations 6

1.2. Congestion income as a rescaling factor for economic surplus 7

1.3. Methodologies (Forward Capacity Allocation related projects) 10

1.3.1. Long term flow-based (Core CCR) 10

1.4. Methodologies (Capacity Allocation and Congestion Management related projects) 15

1.4.1. Minimum 70% requirement (Core CCR) 15

1.4.2. Nordic flow-based in the single day-ahead coupling 17

1.4.3. Core flow-based in the single day-ahead coupling 20

1.4.4. Bidding zone review and Central Europe ROSC-RDCT 23

1.4.5. Energy Community accession to the single day-ahead coupling 27

1.4.6. Flow-Based allocation in intraday auctions (Core CCR) 32

1.5. Methodologies (Capacity Allocation and Congestion Management and Electricity Balancing related projects) 36

1.5.1. Co-optimisation and market-based allocation 36

1.6. Methodologies (Electricity Balancing related projects) 42

1.6.1. IGCC, PICASSO and MARI implementation (TSOs' accession) 42

1.7. Categories of economic surplus 47

1.7.1. Unrealised economic surplus from delayed implementation 48

2. Qualitative case study: computing economic surplus and the benefits of market integration **50**

2.1. Scenario 1: Markets operating in isolation 50

2.2. Scenario 2: Market coupling with full price convergence 51

2.3. Scenario 3: Market coupling with partial price convergence 52

List of acronyms

Abbreviation	Term in full
ACER	European Union Agency for the Cooperation of Energy Regulators
aFRR	Automatic frequency restoration reserves
AMR	Adjustment for minimum RAM
ATC	Available transfer capacity
CACM	Capacity allocation and congestion management
CCR	Capacity calculation region
CGM	Common grid model
CNE	Critical network element
CNEC	Critical network element with contingency
CNTC	Coordinated net transfer capacity
CP	(Energy Community) contracting party
ENTSO-E	European Network of Transmission System Operators for Electricity
FCA	Forward capacity allocation
FCR	Frequency containment reserve
FRR	Frequency restoration reserve
GL	Guideline
EB GL	Electricity balancing guideline
IDA	Pan-European intraday auctions
IDCC	Intraday capacity calculation
IGCC	International grid control cooperation
ITN	Italy North
JAO	Joint Allocation Office
LTA	Long-term allocation
LTTRs	Long-term transmission right
MARI	Manually activated reserves initiative
mFRR	Manual frequency restoration reserves
MTUs	Market time units
NC	Network code
NEMO	Nominated Electricity Market Operator
NRA	National regulatory authority
NTC	Net transfer capacity
PTDF	Power transfer distribution factor
RAM	Remaining available margin
RCC	Regional coordination centre
RES	Renewable energy sources
ROSC	Regional operational security coordination
PICASSO	Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation
SDAC	Single day-ahead coupling
SIDC	Single intraday coupling
SOGL	System operation guideline
TSO	Transmission system operator

Overview

This annex accompanies the economic surplus analysis presented in the main body of the 2026 Monitoring Report on the progress of EU electricity wholesale market integration. Its purpose is to enhance transparency and support the interpretation of the findings.

The annex is structured in two chapters:

1. The first chapter provides a detailed description of the methodological approaches used to estimate economic surplus. It begins by setting out the scope of the assessment, its objectives, and the main assumptions and limitations underpinning the analysis. It then describes in detail the methodological process applied to estimate economic surplus for the 13 selected projects. Attention is given to the use of congestion income as a rescaling factor that was used, where necessary, to express economic surplus values on a consistent 2025 basis.
2. The second chapter presents explanatory materials, including visual illustrations of economic surplus and of the benefits arising from the integration of electricity markets.

Together, these chapters are intended to make the analysis more accessible and to enable interested readers to gain a better understanding of what the results represent, how they should be interpreted, and how they were derived.

1. Methodologies for estimating economic surplus

1.1. Scope, objectives, assumptions and limitations

This chapter includes the methodologies developed by ACER to estimate the economic surplus[1] stemming from a selected list of market integration projects. ACER selected 13 market integration projects[2] for this assessment based on the technical feasibility of performing a meaningful estimation or the availability of existing assessments, as well as the importance of the projects in the completion of the internal electricity market.

Since the selected market integration projects are subject to significant differences in terms of implementation status, scope, complexity and legal requirements, different methodological approaches were necessary.

The objective of each methodology is two-fold: (1) to quantify the added value generated by each market integration project considered, and (2) to rescale economic surplus values over time to increase comparability. This way, methodologies make it possible to assess and compare the past, the present and the future value of market integration.

Estimating economic surplus is subject to multiple challenges, ranging from data limitations to project-specific features, often requiring methodological assumptions and caveats. The proposed methodologies rely on different approaches and sources, such as parallel runs (i.e. testing periods performed by the entities implementing the projects), in-house simulations, cost-saving metrics (used as a proxy of economic surplus), and other studies performed by external entities (e.g. academic consultants). This results in different levels of accuracy of the estimates performed.

Therefore, results should be treated only as indicative estimates for the purpose of quantifying economic surplus benefits (and losses due to implementation delays) and to highlight the importance of the market integration process. If results are used for the purpose of comparing the importance of, or assigning implementation priorities to different projects, the differences in accuracy from the different methodological approaches should be considered. Moreover, it is worth noting that this assessment focuses on economic surplus or, where direct estimates are unavailable, appropriate proxy metrics. Economic surplus is considered a key metric for evaluating and comparing market integration projects, while recognizing that other relevant criteria may also be considered.

[1] Please note that economic surplus is a metric for market efficiency expressed in monetary units and should not be interpreted as actual monetary gains (or losses).

[2] List of market integration projects with quantitative assessment: Long-term flow-based (Core CCR), Nordic flow-based in SDAC, Core flow-based in SDAC, TSOs accession to IGCC, Market-based allocation (Nordic CCR), Minimum 70% requirement (estimate for Core CCR only), TSOs accession to MARI, TSOs accession to PICASSO, ROSC-RDCT (Central Europe CCR), Flow-Based allocation in intraday auctions (Core CCR), Energy Community accession to the single day-ahead coupling, Bidding zone review, Co-optimisation.

Please note that the estimates presented in this analysis may result in revisions in future assessments, which will provide a more accurate estimate of economic surplus benefits.

1.2. Congestion income as a rescaling factor for economic surplus

ACER estimated economic surplus for a selection of market integration projects. To enable comparability of the economic surplus stemming from these projects in 2025, it was necessary to rescale some estimates over time. To do so, ACER considers the congestion income generated in SDAC in the relevant region as the most suitable metric for re-scaling economic surplus, as congestion income is a function of zonal price spreads and the volume of cross-border exchanges, reflecting market congestion.

What does the theory say about the relation between congestion income and economic surplus?

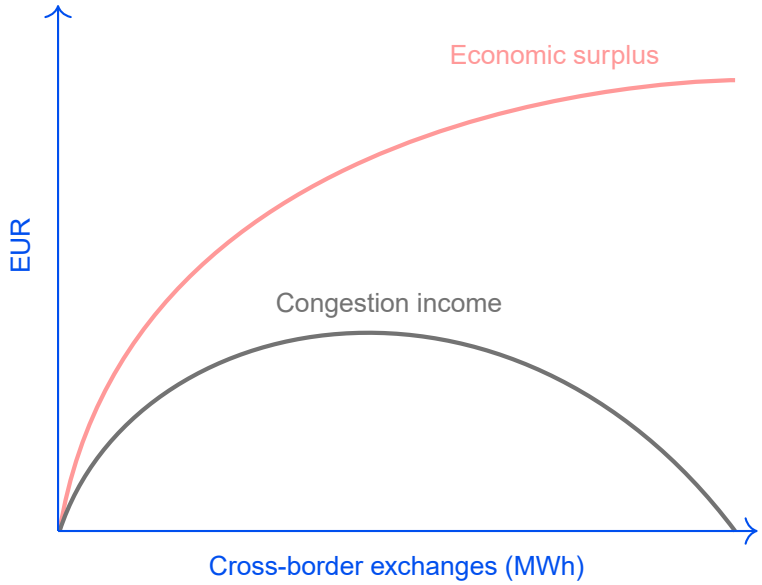
From a theoretical point of view, congestion income can be represented as a function with this pattern:

- **Zero:** when there are no cross-border exchanges, i.e., the product of cross-border exchanges and the zonal price spread is zero.
- **Increasing trend:** congestion income initially increases with growing cross-border exchanges, because the impact of increasing cross-border exchanges is greater than the impact of decreasing zonal price spreads.
- **Decreasing trend:** congestion income decreases with growing cross-border exchanges, because the impact of increasing cross-border exchanges is smaller than the impact of decreasing zonal price spreads.
- **Zero:** when cross-border exchanges are high enough to achieve full price convergence, i.e., the product of cross-border exchanges and the zonal price spread is zero.

By contrast, economic surplus follows a different pattern, increasing rapidly at first and then gradually levelling off. Figure 2 shows a qualitative graphical representation of the congestion income and economic surplus curves.

Therefore, depending on the availability of cross-border exchanges and the level of price spreads, the relation between congestion income and economic surplus vary. When the trend (of congestion income) is increasing, the relationship is positive and can be considered as approximately linear, whereas, when the trend (of congestion income) is decreasing, the two metrics diverge.

Figure 1: Explanatory figure on the relation between congestion income (grey line) and economic surplus (red line)



Source: ACER

The economic surplus displayed in this explanatory figure represents the economic surplus generated by the cross-border exchanges

The sole purpose of the figure is to provide a visual representation of the evolution of economic surplus and congestion income across different levels of cross-border exchanges. Please note that the figure does not account for infrastructure costs and should not be interpreted as implying that the objective is to achieve full price convergence.

From theory to empirical evidence: a case study on the Italy North region

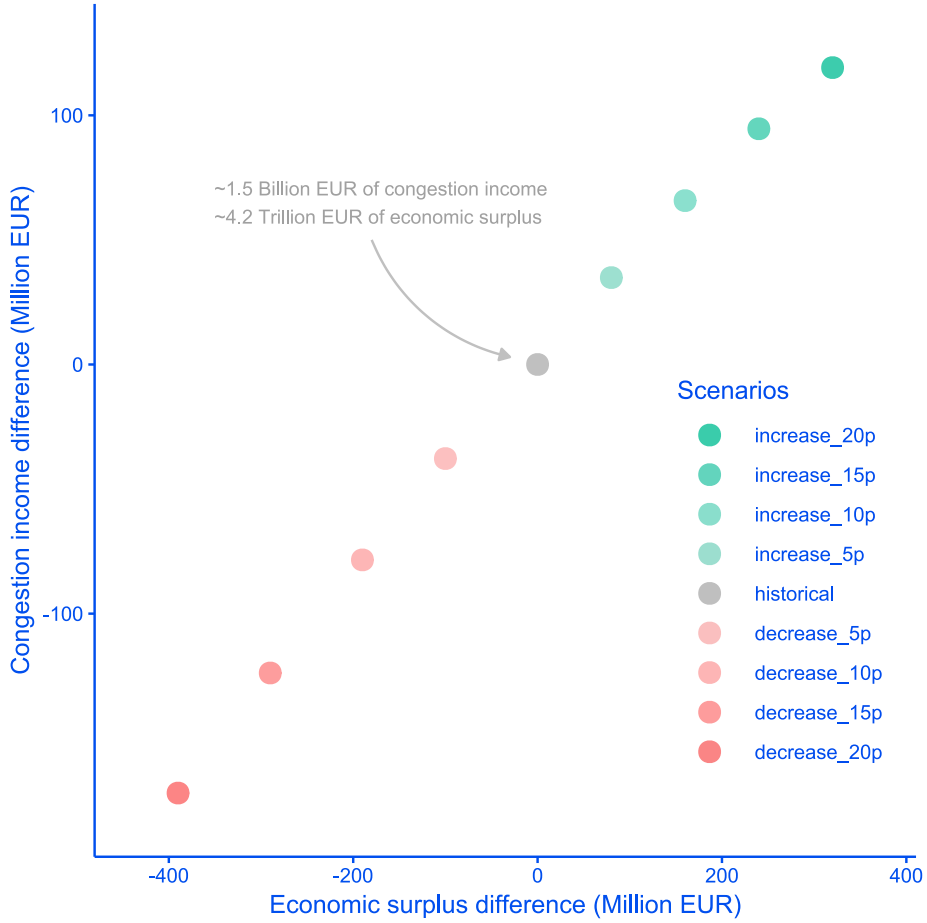
To further investigate this, ACER performed an empirical case study on the Italy North Capacity Calculation Region (ITN CCR) using the Simulation Facility Tool. ACER simulated 9 scenarios[3], increasing and decreasing the levels of available cross-border capacity, and computed the total congestion income for ITN CCR and the SDAC total economic surplus.

In the case of Italy North, the level of cross-border exchanges and price spreads observed in 2025 results in a positive linear relationship between congestion income and economic surplus (Figure 3). This can be explained by the region being in the increasing part of the congestion income curve, as presented in the explanatory section above.

Although these findings are limited to a single region, they support the methodological approach of using congestion income as a rescaling factor for economic surplus at least for the Italy North region.

[3] Nine scenarios were simulated to represent different levels of cross-border capacity in both the import and export directions in the Italy North Capacity Calculation Region: four with reduced cross-border capacity (-20%, -15%, -10%, and -5%), one historical scenario in which the level of cross-border capacity remained unchanged, and four with increased cross-border capacity (+5%, +10%, +15%, and +20%).

Figure 2: Congestion income for ITN CCR economic surplus for SDAC– Case study for ITN CCR in 2025: Nine annual simulations performed with the Simulation Facility, increasing and decreasing cross-border capacities



Source: ACER calculation based on Simulation Facility's simulations

Differences (Million EUR) are computed against the historical scenario

To produce a comprehensive figure for the market monitoring report, the economic surplus estimates generated by the selected market integration projects analysed in this assessment are grouped. This figure is presented in the main body of the report. Where necessary, congestion income is used to rescale economic surplus values of projects to 2025 levels.

1.3. Methodologies (Forward Capacity Allocation related projects)

1.3.1. Long term flow-based (Core CCR)

Introduction

Long term (LT) flow-based capacity calculation and allocation in the Core region is expected to improve hedging opportunities and increase the economic surplus, when compared to long-term ATC calculation and allocation. While it was planned to be implemented by November 2024, it has been delayed several times, with the final goal of being implemented by November 2026 (for yearly and monthly capacities in 2027), i.e. with a delay of two years.

Calculation description

To quantify the expected benefits of implementing the long-term flow-based capacity allocation (LTFBA) in the Core region, ACER simulated the outcome of the LTFBA and compared it with the historic outcome of ATC-based yearly and monthly auctions. For this purpose, ACER used an internal tool for pre-solving the flow-based parameters and simulating the LTFBA outcome. The analysis was carried out in the following steps:

- **Historical data.** The information on yearly and monthly explicit auctions was downloaded from www.jao.eu, for the year 2024.
- **Additional bids:** As there was no LT allocation at Polish borders, the bids for Polish borders are added, as provided by Core TSOs (initially, they were provided by the Polish TSOs).
- **The ATC benchmark:** the ATC benchmark values based on yearly and monthly ATCs from 2025 were provided by the Core TSOs, and amended according to ACER's proposals during the referral of the Core LT capacity calculation methodology, as follows:
    - Half of capacity at DE-AT border;
    - Additional 100 MW at SI-HR border/direction for yearly auction (increase from 500 to 600 MW);
    - ATCs for PL borders, as estimated by PSE.

Table 1: Yearly and monthly ATC benchmark values (MW)

Border (from-to)	Yearly	Monthly, Winter 1	Monthly, Spring	Monthly, Summer	Monthly, Autumn	Monthly, Winter 2
AT-CZ	200	150	150	150	150	150
AT-DE	980	1030	897	897	997	1030
AT-HU	250	152	152	152	152	152
AT-SI	300	300	217	300	300	300
BE-DE	260	240	173	140	173	240

BE-FR	250	438	275	425	275	325
BE-NL	473	146	146	146	146	146
CZ-AT	200	60	40	17	30	40
CZ-DE	600	301	301	301	301	301
CZ-PL	310	128	73	79	70	77
CZ-SK	500	300	300	300	300	300
DE-AT	980	1430	1430	1430	1430	1430
DE-BE	260	240	173	140	173	240
DE-CZ	300	200	187	180	180	180
DE-FR	600	400	400	400	267	400
DE-NL	827	254	254	254	254	254
DE-PL	226	90	53	63	48	50
FR-BE	1600	275	200	200	200	250
FR-DE	1000	260	290	170	173	350
HR-HU	400	50	50	50	50	50
HR-SI	500	150	150	150	150	150
HU-AT	250	90	60	22	50	70
HU-HR	500	50	33	50	50	50
HU-RO	350	120	120	173	173	280
HU-SI	150	50	50	50	50	50
HU-SK	800	50	50	50	50	50
NL-BE	473	146	146	146	146	146
NL-DE	827	254	254	254	254	254
PL-CZ	284	76	84	69	68	66
PL-DE	203	75	62	44	50	63
PL-SK	247	83	69	56	53	101
RO-HU	350	120	120	173	173	280
SI-AT	300	130	83	23	67	100
SI-HR	600	150	150	150	150	150
SI-HU	150	50	50	50	50	50

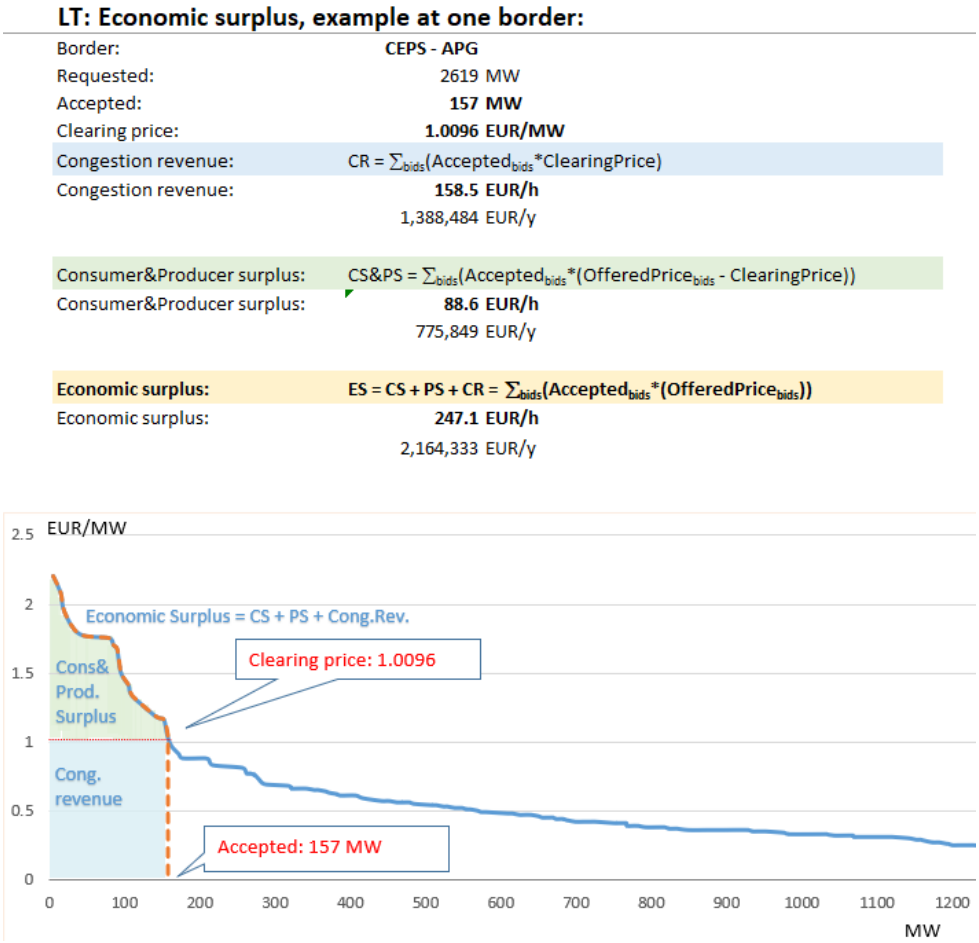
SK-CZ	400	300	300	300	300	300
SK-HU	700	150	150	150	150	150
SK-PL	334	107	105	75	76	85

Source: First amendment of Core long-term capacity calculation methodology

The processed data:

- Input: bids, ATC values, flow-based parameters
- Output: allocated quantities per Core bidding zone borders, market clearing prices per border, congestion income, economic surplus.

Figure 3: Example of the calculation of LT Economic Surplus and Congestion Income



Source: ACER

- **Long-term flow-based calculation simulation.** The yearly and monthly flow-based domains for 2024 were prepared, in line with the approach proposed by the Core TSOs for the 1st amendment of the Core LT capacity calculation methodology:

    - yearly and monthly flow-based domains as provided by the Core TSOs for 2024;
    - ATC benchmark is used to calculate non-netted cumulative flows per each CNEC, representing RAM values. For each CNEC, the "natural" RAM values calculated in the LT FB capacity calculation process (with common grid model scenarios) were replaced with the values obtained as:
      $[RAM_{new}]$ = sum ($[ATC_{benchmark}]$ x $[PTDF_{positive}]$), for each CNEC
- **Long-term flow-based allocation simulation.** LTFBA was simulated in line with the SAP methodology.
- **Long-term ATC-based allocation simulation.** To ensure a fair comparison between the LT flow-based and LT ATC-based allocation, the same level of transmission needs to be considered. Therefore, ACER simulated the ATC-based allocation considering that at each auction the offered capacities correspond to the ATC benchmark values. The same bids were used for the LT FB and the LT ATC simulations.
- **LTTR remuneration cost** was computed by multiplying the LT allocated power at each bidding zone border with the positive day ahead price difference (historical values from 2024).
- **Comparison.** The outcomes of LT ATC benchmark simulation and the LT FB simulation for 2024 have been compared, in particular the accepted bids, congestion income and economic surplus, as well as LTTR remuneration costs.
- Net benefit from applying LTFBA has been obtained as:
  Net Benefit (MEUR) = ΔEconomic Surplus – ΔLTTR remuneration,

  where

  $$\Delta\text{Economic Surplus} = \text{Economic Surplus}_{LTFB_allocation} - \text{Economic Surplus}_{LTATC_allocation}$$
  $$\Delta\text{LTTRremuneration} = \text{LTTRremuneration}_{LTFB_allocation} - \text{LTTRremuneration}_{LTATC_allocation}$$

Results

The analysis i.e. comparison of LTFB and LT-ATC allocation on equivalent capacity domains, has shown that the implementation of the LTFBA in the Core CCR:

- would have allocated lower capacity, with a 6.3% decrease in yearly capacities and a 13.6% decrease in monthly capacities; allocated capacities also show redistributive effects across different borders, where borders with generally higher spread obtain more allocated capacities while borders with lower or zero spread receive lower allocated capacities.
- would increase net total congestion income by 5%, i.e. 75.3 MEUR;
- would have yielded a net economic surplus gain of 94 million EUR in 2024 (both yearly and monthly auctions considered). This value has been obtained by subtracting the increase in LTTR remuneration cost (18.8 MEUR) from the increase in gross economic surplus (112.8 MEUR).

Table 2: Long-term flow-based allocation in the Core CCR - simulation results

Allocated quantities:					
LT CI (sim, ATC-based, ATCs=ATCbench)	Y	[MW]	**17,406**	diff	%diff
LT CI (sim, Flow-based, with ATCbench)	Y	[MW]	**16,313**	-1,094	-6.3%
LT CI (sim, ATC-based, ATCs=ATCbench)	12M	[MW]	**94,570**	diff	%diff
LT CI (sim, Flow-based, with ATCbench)	12M	[MW]	**81,681**	-12,889	-13.6%
Congestion income day-ahead:					
DA historical (with LTA inclusion)	Y+12M	[MEUR]	**1,925**		
Congestion income long-term:					
LT simulated, ATC-based, ATCs=ATCbench	Y+12M	[MEUR]	**993**	diff	%diff
LT simulated, Flow-based, with ATCbench)		[MEUR]	**1,087**	94.1	9%
LTTR remuneration:					
DA (historical) & LT (simulated, ATC-based, ATCs=ATCbench)	Y+12M	[MEUR]	**1,496**	diff	%diff
DA (historical) & LT (simulated, Flow-based, with ATCbench)	Y+12M	[MEUR]	**1,515**	**18.8**	1%
Net total congestion income: (DA CI + LT CI - LTTRr)					
DA (historical) & LT (simulated, ATC-based, ATCs=ATCbench)	Y+12M	[MEUR]	**1,422**	diff	%diff
DA (historical) & LT (simulated, Flow-based, with ATCbench)	Y+12M	[MEUR]	**1,497**	75.3	5%
Gross economic surplus:					
DA (historical) & LT (simulated, ATC-based, ATCs=ATCbench)	Y+12M	[MEUR]	**1,280**	diff	%diff
DA (historical) & LT (simulated, Flow-based, with ATCbench)	Y+12M	[MEUR]	**1,393**	**112.8**	9%
ΔNet economic surplus: (ΔGross Ec.Surplus - ΔLTTRr)	Y+12M	[MEUR]		**94.0**	

Source: ACER

Rescaling economic surplus from 2024 to 2025 using the ratio of Core long-term congestion income in 2025 to that in 2024 results in approximately EUR 100 million of economic surplus.

Caveats

Historic bids from the ATC approach were used, as well as the simulated bids for Poland. It is expected that bidding behaviour may be different upon the go-live of the LTFB approach.

The simulations have been conducted based on bids taken from JAO relating to the year 2024 (plus simulated bids for Polish borders), day-ahead congestion income relating to the year 2024, whereas the ATC benchmark relates to the year 2025. The complete yearly and monthly simulation data (LT common grid models for the flow-based domain) were only available for 2024. It is likely that the outcome for specific years (2025-2027) would be different.

The analysis has been conducted assuming that the LTA inclusion remains in place in the Core day-ahead capacity calculation. Yet, the LTFB is expected to be implemented along with the removal of the LTA inclusion, which might impact day-ahead congestion income.

1.4. Methodologies (Capacity Allocation and Congestion Management related projects)

1.4.1. Minimum 70% requirement (Core CCR)

Introduction

Relieving congested network elements in flow-based market coupling, by increasing the availability of cross-zonal capacity on such elements, enables further electricity trade between bidding zones. Consequently, it results in a more optimal outcome of the EU electricity market, enabling the dispatch of lower-cost generation assets to meet power demand.

In the EU, the main regulatory tool to ensure the maximisation of cross-zonal capacities is the 70% requirement, introduced in the Electricity Regulation. This requirement was introduced to address the discrimination of cross-zonal exchanges in favour of intra-zonal exchanges, inherent to a zonal market design. The 70% requirement is currently being implemented by EU TSOs, with uneven progress across the EU.

Calculation description

To quantify the expected benefits from relieving market congestion in Core flow-based market coupling, through the on-going implementation of the minimum 70% requirement, ACER simulated the outcome of the internal market for electricity under different levels of cross-zonal capacity. For this purpose, ACER made use of the Simulation Facility tool developed jointly by EU nominated electricity market operators (NEMOs) and TSOs. The following scenarios were assessed:

- Historical run. Re-run of market coupling, with no modification to the capacity levels made available by TSOs. This scenario represents the realised market outcomes of 2025.
- 70%. Available capacity is increased so that all CNECs in the pre-solved flow-based domains offer at least 70% of capacity for cross-zonal trade. This scenario corresponds to the levels of capacity in 2025, should the 70% requirement have been fully met across the Core region.
- Natural RAM. Available capacity is decreased for all CNECs in the pre-solved flow-based domains to remove the impact of the adjustment for minimum RAM[4] (or 'virtual capacities'). This scenario estimates the available capacity levels, should TSOs not need to comply with any minimum cross-zonal capacity requirement at all.

Results

The analysis revealed that the finalisation of the implementation of the 70% requirement in the Core CCR would have yielded an economic surplus gain of EUR 150 million in 2025, compared with the actual 2025 levels of capacity. As a comparison, the use of virtual

[4] The adjustment for minimum RAM is the mechanism implemented in the Core day-ahead capacity calculation to ensure that the applicable interim cross-zonal capacity requirements are met.

capacities to guarantee the applicable requirements yielded EUR 620 million of economic surplus in 2025. In 2025, the partial implementation of the 70% minimum requirement generated at least[5] EUR 620 million in economic surplus, while full implementation would have added around EUR 150 million.

Caveats

The Simulation Facility tool replicates the European market coupling algorithm. Due to inherent limitations in its reproducibility, simulation outcomes may vary across different runs, potentially leading to slightly divergent results.

Simulations are performed by modifying the capacity levels on the pre-solved flow-based domain directly. This is a simplification as it assumes that different minimum capacity levels do not result in different CNECs being pre-solved, thus altering the shape of the flow-based domain.

Lastly, it is important to note that the implementation of the minimum 70% requirement may come with associated investment or increased congestion management costs, which would partly offset the economic surplus gains stemming from it.

[5] In this sentence, '*at least'* refers to the fact that the estimation only considers the surplus impact of the virtual capacities offered in 2025, yet the 70% requirement may have resulted in broader capacity gains, such as those resulting from network investments, which are not accounted for.

1.4.2. Nordic flow-based in the single day-ahead coupling

Introduction

Flow-based market coupling allocates scarce transmission capacity across the region by considering the constraints on each critical network element and assigning capacity to the combination of trades that delivers the highest overall economic surplus. Unlike an NTC-based approach, it is not limited by an ex-ante bilateral split of transmission capacity across individual bidding zone borders. This allows the allocation process to better reflect the physical reality of a highly interconnected electricity system and to make more efficient use of available network capacity.

In October 2024, flow-based market coupling was implemented in the Nordic capacity calculation region, replacing the existing NTC-based capacity calculation and allocation in the region.

Calculation description

To quantify the benefits to the day-ahead market derived from the implementation of flow-based market coupling in the Nordic region, ACER relied on the market simulations performed by Nordic TSOs during the parallel run phase of the Nordic flow-based implementation project. During this parallel run, Nordic TSOs calculated daily flow-based capacities for the entire Nordic region in parallel to the operational NTC capacities and performed market simulations under both these cases.

ACER requested the following data items from Nordic TSOs for both the parallel run and operational scenarios:

- Consumer and producer surplus for every bidding zone included in SDAC and MTU included in the flow-based parallel run.
- Congestion income generated at all SDAC bidding zone borders for every MTU included in the flow-based parallel run or, alternatively, the data required to compute it (day-ahead prices and commercial schedules).

With such data, ACER can compute the difference between the economic surplus (calculated as the sum of consumer and producer surplus, and congestion income) in the parallel run and operational market simulation and attribute the difference in those two values to the influence of Nordic flow-based market coupling.

In order to present the realised values of Nordic flow-based market coupling in the years after its implementation, two options are available: either simulating the single day-ahead coupling under the operational flow-based capacities against an assumption of what NTC values would look like after the implementation of flow-based or opting for a rescaling of the values stemming from the parallel run period. Due to the inherent uncertainty of the counterfactual NTC values, ACER decided to rescale the economic surplus impact of Nordic flow-based during the parallel run period to later years, using total congestion income generated on Nordic

bidding zone borders as the weighting factor[6]. The scaling was performed as per the following methodology:

$$Congestion\ Income_{parallel\ run,annualised} = \frac{Congestion\ Income_{parallel\ run}}{Number\ of\ hours\ available} * 8760$$

$$Weighing\ factor = \frac{Congestion\ Income_{2025}}{Congestion\ Income_{parallel\ run,annualised}}$$

$$ES_{2025,rescaled} = \frac{Welfare\ gain_{parallel\ run} * 8760}{Number\ of\ hours\ available} * Weighing\ factor$$

Eventually, this results in:

$$ES_{2025,rescaled} = ES_{parallel\ run} * \frac{Congestion\ Income_{2025}}{Congestion\ Income_{parallel\ run}}$$

Where:

- $ES_{2025,rescaled}$: represents the extrapolated economic surplus benefits of having flow-based in place in the day-ahead market in the Nordic CCR, in 2025
- $ES_{parallel\ run\ period}$: represents the economic surplus benefits quantified during the Nordic flow-based parallel run (i.e. from December 2022 to October 2024), as the difference between a flow-based simulation and the operational NTC alternative.
- $DA\ Congestion\ Income_{2025}$: represents the total SDAC congestion income in the bidding zone borders of the Nordic CCR in 2025.
- $DA\ Congestion\ Income_{parallel\ run\ period}$: represents the total SDAC congestion income obtained from the parallel run in the bidding zone borders of the Nordic CCR during the period of the parallel run.

Results

The analysis revealed that the implementation of flow-based market coupling in the Nordic CCR yielded an economic surplus gain of approximately EUR 200 million in 2025.

Caveats

[6] Congestion income is assumed to be the most appropriate parameter for rescaling estimates of economic surplus across time and regions, as it captures both cross-zonal exchanges and price differentials, thereby reflecting the economic value of scarce cross-zonal capacity under different market conditions.

The Simulation Facility tool replicates the European market coupling algorithm. Due to inherent limitations in its reproducibility, simulation outcomes may vary across different runs, potentially leading to slightly divergent results.

The potential change in bidding patterns of market participants under flow-based market coupling, especially owners of hydro storage facilities in Northern bidding zones, is not reflected in the external parallel run. Therefore, estimates deriving from the external parallel run might overestimate the economic surplus expected from the implementation of flow-based, since the value of water reservoirs is not considered.

The implementation of flow-based market coupling in the day-ahead timeframe may result in lower cross-zonal capacity being available in subsequent market timeframes (intraday and balancing markets), until flow-based can be implemented in those timeframes as well. This may lead to an increase in economic surplus in SDAC but a reduction in later market timeframes.

Operational flow-based domains will vary from parallel run flow-based domains, as the process is still being fine-tuned during the parallel run (i.e. individual validation strategies and tools, input parameters…), leading to more robust results through time.

Rescaling strategies are inherently imprecise as they rely on simplifications, such as the assumption of proportional behaviour of the surplus gain based on the scaling factor. The values calculated for 2025 are thus only indicative.

1.4.3. Core flow-based in the single day-ahead coupling

Introduction

Flow-based market coupling allocates scarce transmission capacity across the region by considering the constraints on each critical network element and assigning capacity to the combination of trades that delivers the highest overall economic surplus. Unlike an NTC-based approach, it is not limited by an ex-ante bilateral split of transmission capacity across individual bidding zone borders. This allows the allocation process to better reflect the physical reality of a highly interconnected electricity system and to make more efficient use of available network capacity.

In June 2022, flow-based market coupling was implemented in the Core capacity calculation region, expanding the area covered under the flow-based approach up until then to all the bidding zone borders in the old CEE region.

Calculation description

To quantify the benefits to the day-ahead market derived from the implementation of flow-based market coupling in the Core region, ACER relied on the market simulations performed by Core TSOs during the parallel run phase of the Core flow-based implementation project. During this parallel run, Core TSOs calculated regularly (daily for the latter part of the parallel run) flow-based capacities for the entire Core region in parallel to the operational capacities (flow-based in CWE and NTC in CEE), and performed market simulations under both these cases.

ACER requested the following data items from Core TSOs for both the parallel run and operational scenarios:

- Consumer and producer surplus for every bidding zone included in SDAC and MTU included in the flow-based parallel run.
- Congestion income generated at all SDAC bidding zone borders for every MTU included in the flow-based parallel run or, alternatively, the data required to compute it (day-ahead prices and commercial schedules).

With such data, ACER can compute the difference between the economic surplus (calculated as the sum of consumer and producer surplus, and congestion income) in the parallel run and operational market simulation and attribute the difference in those two values to the influence of Core flow-based market coupling.

In order to present the realised values of Core flow-based market coupling in the years after its implementation, two options are available: either simulating the single day-ahead coupling under the operational flow-based capacities against an assumption of what NTC values would look like after the implementation of Core flow-based, or opting for a rescaling of the values stemming from the parallel run period. Due to the inherent uncertainty of the counterfactual NTC values, ACER decided to rescale the economic surplus impact of Core flow-based during the parallel run period to later years, using total congestion income generated on Core bidding zone borders as the weighting factor. The scaling was performed as per the following methodology:

$$Congestion\ Income_{parallel\ run,annualised} = \frac{Congestion\ Income_{parallel\ run}}{Number\ of\ hours\ available} * 8760$$

$$Weighting\ factor = \frac{Congestion\ Income_{2025}}{Congestion\ Income_{parallel\ run,annualised}}$$

$$ES_{2025,rescaled} = \frac{ES_{parallel\ run}\ *\ 8760}{Number\ of\ hours\ available} * Weighing\ factor$$

Eventually, this results in:

$$ES_{2025,rescaled} = ES_{parallel\ run\ period}\ *\ \frac{DA\ Congestion\ Income_{2025}}{DA\ Congestion\ Income_{parallel\ run\ period}}$$

Where:

- $ES_{2025,rescaled}$: represents the extrapolated economic surplus benefits of having flow-based in place in the day-ahead market in the Core CCR, in 2025
- $ES_{parallel\ run\ period}$: represents the economic surplus benefits quantified during the Core flow-based parallel run (from January 2022 to June 2022), as the difference between a flow-based simulation and the operational NTC alternative.
- $DA\ Congestion\ Income_{2025}$: represents the total SDAC congestion income in the bidding zone borders of the Core CCR in 2025.
- $DA\ Congestion\ Income_{parallel\ run\ period}$: represents the total SDAC congestion income obtained from the parallel run in the bidding zone borders of the Core CCR during the period of the parallel run.

Results

The analysis revealed that the implementation of flow-based market coupling in the Core CCR yielded an economic surplus gain of approximately EUR 1400 million in 2025.

Caveats

The Simulation Facility tool replicates the European market coupling algorithm. Due to inherent limitations in its reproducibility, simulation outcomes may vary across different runs, potentially leading to slightly divergent results.

Operational flow-based domains will vary from parallel run flow-based domains, as the process is still being fine-tuned during the parallel run (i.e. individual validation strategies and tools, input parameters…), leading to more robust results through time.

Market simulations with operational NTC values were computed specifically by ACER for the purpose of this assessment, using the Simulation Facility tool, potentially leading to slight divergences compared to those performed during the parallel run period.

Rescaling strategies are inherently imprecise as they rely on simplifications, such as the assumption of proportional behaviour of the surplus gain based on the scaling factor. The values calculated for 2025 are thus only indicative.

1.4.4. Bidding zone review and Central Europe ROSC-RDCT

Introduction

The expected economic efficiency gains linked to a potential reconfiguration of the bidding zones in Europe have been derived from the analysis carried out by TSOs (published at the end of April 2025), adjusted based on the assessment included in ACER Opinion No 09/2025 (published in September 2025) of the impact of certain assumptions taken by TSOs in their study.

The alternative bidding zone configurations considered in the TSOs' study are based on Annex I to ACER Decision No 11/2022 and include four alternatives for Germany-Luxembourg (split into two, three, four and five bidding zones), four alternatives for Sweden[7] (split into three and four bidding zones) and one alternative each for France (three bidding zones), Northern Italy and the Netherlands (two bidding zones each). Besides these individual alternative configurations, TSOs were asked to assess (at least) the two most economically efficient combinations, which were i) a split of Germany-Luxembourg into five bidding zones combined with a split of The Netherlands into two bidding zones; and ii) a split of Germany-Luxembourg into four bidding zones combined with a split of The Netherlands into two bidding zones.

The performance of these alternative bidding zone configurations against the status quo has been assessed based on the indicators defined in Annex I to ACER Decision No 29/2020 ('the bidding zone review methodology').

The two bidding zone review regions under analysis, i.e. Central Europe and the Nordics, ran their simulations rather independently, except for the aspects where harmonisation and coordination were prescribed by the bidding zone review methodology. The target year for the study was set to 2025, and three different climate years were simulated to account for different scenarios with regard to temperature, wind, solar and hydro inflows.

The modelling chain can be summarised as follows:

1. The simulation starts with a capacity calculation using a flow-based and coordinated net transmission capacity (cNTC) approach resulting in available capacities for cross-zonal trade.
2. The capacity calculation is followed by a day-ahead flow-based market coupling simulation where dispatch of generation and demand is optimised.
3. Thereafter, a load flow calculation is conducted to determine the physical electricity flows and any resulting operational security violations, e.g. overloads on network elements.
4. A remedial action optimisation is executed, optimising the remedial actions to solve the overloads detected during the load flow calculation in the previous step.
5. Finally, a power flow decomposition is executed to calculate the loop flows after the day-ahead market dispatch and operational security analysis.

The number of indicators to be considered for the evaluation of the relative performance of the alternative configurations against the status quo, as set out in the bidding zone review methodology, is 22, divided into quantitative and qualitative ones. The only quantitative

[7] Sweden is currently divided into four bidding zones.

indicator analysed by TSOs is the economic efficiency, which aims to capture the net benefits when considering the day-ahead market dispatch and the redispatch together. All other 21 indicators were assessed in a qualitative manner, and in some cases the results of one indicator were used for multiple indicators.

Calculation description

The results of the TSOs' study show significant economic efficiency gains for all German-Luxembourgish alternative configurations (and their combinations with a reconfiguration in the Netherlands), ranging from approximately EUR 250 to 340 million per year. The individual split of the Netherlands into two bidding zones has been assessed to yield relatively small benefits (9 MEUR/year), whereas all alternative configurations for Sweden, France and Northern Italy were discarded early on in the analysis due to an expected negative impact in terms of economic efficiency compared to the status quo.

In ACER Opinion No 09/2025, ACER's assessment shows that, while the TSOs' study broadly aligns with the regulatory requirements, an unrealistic assumption on the level of coordination of remedial actions to resolve grid congestions has led to an underestimation of the expected benefits of the German-Luxembourgish alternative bidding zone configurations and their combinations with a bidding zone reconfiguration in the Netherlands, for which the economic efficiency gains would rather be in the order of 450 to 540 MEUR/year, about 70% higher than those estimated by TSOs in their study.

More specifically, in the Central Europe bidding zone review region, TSOs assumed that the remedial actions are fully coordinated across the entire region. In practice, this means that congestions in a Member State can be solved by relying on (cheaper) assets located in another Member State within the same bidding zone review region. While this level of coordination is expected to be implemented in the coming years, i.e. with the go-live of the relevant regional methodologies, this is not in line with the operational practices of the target year 2025, where the level of coordination in congestion management processes is still rather limited.

In this context, the assessment included in ACER Opinion No 09/2025 indirectly estimates the expected benefits of implementing the regional operational security coordination (ROSC) and the redispatching and countertrading (RDCT) methodologies in Central Europe[8]. The benefits stemming from the implementation of these methodologies have been estimated starting from the results of the bidding zone review study performed by TSOs and comparing them with the historical data on congestion management volumes and costs provided by NRAs relative to the year 2024, duly accounting for any biases due to different congestion management volumes and/or price levels, as follows.

Congestion management costs simulated in the bidding zone review study, in Central Europe, for the status quo amount to about EUR 1.2 billion, whereas the operational values for 2024,

[8] The approved methodologies, with final implementation deadlines on 4 June 2025, are currently only applicable to the Core capacity calculation region, which is a subset of the Central Europe bidding zone review region. Nonetheless, since the extension from Core to Central Europe is planned before the expected go-live date of the ROSC and RDCT methodologies, the analysis considers the scenario where those methodologies are directly applicable to the entire Central Europe region.

for the same geographical area, are in the order of EUR 2.4 billion[9]. The total congestion management volumes in the two cases are very similar (20 TWh per direction, i.e. positive and negative); however, the weighted average day-ahead price in 2024 across Central Europe was 79 EUR/MWh, whereas it has been simulated as 48 EUR/MWh in the bidding zone review study, i.e. 40% lower[10]. Accordingly, the total congestion management costs simulated in the bidding zone review study for Central Europe, for the status quo, would have rather added up to EUR 1.7 billion with the price levels experienced in 2024, corresponding to an average congestion management cost of 84 EUR/MWh.

Assuming that the volume of remedial actions in the alternative configurations remains the same as the one simulated in the bidding zone review study, and applying the price correction factor described above, it is possible to derive the adjusted congestion management costs for each alternative bidding zone configuration by multiplying the corresponding congestion management volumes with the adjusted average congestion management cost of 84 EUR/MWh. In turn, this makes it possible to estimate the additional savings in congestion management costs for the German-Luxembourgish alternative configurations and their combinations with a reconfiguration in the Netherlands compared to the status quo under the assumption of full coordination of remedial actions in Central Europe.

Table 3 provides a detailed breakdown per configuration:

Table 3: Additional saving in congestion management costs with full coordination of remedial actions in Central Europe per alternative configuration

Alternative configuration[11]	Congestion management volumes [TWh]	Savings in congestion management costs (compared to the status quo) in TSOs' assessment [million EUR]	Savings in congestion management costs (compared to the status quo) in ACER assessment [million EUR]	Additional savings in congestion management costs with full coordination of remedial actions in Central Europe [million EUR]
DE5	10.3	613	814	201
DE5 + NL2	11.06	576	750	174
DE4	10.45	603	802	199
DE4 + NL2	11.08	566	749	183
DE2 + NL2	10.3	598	814	216
DE2	10	607	839	232
DE3	9.78	641	858	217

Source: ACER calculation based on ENTSO-E data

The average difference, across all these alternative bidding zone configurations, between the adjusted savings in congestion management costs and the corresponding values reported by TSOs in their study, i.e. approximately EUR 200 million per year, can hence be assumed to amount to the annual economic surplus loss (based on data for 2024) due to the delayed implementation of the ROSC and RDCT methodologies in Central Europe. It is important to note that this value has been derived for the alternative bidding zone configurations under analysis (i.e. a reconfiguration in the German-Luxembourgish bidding zone and its combination with a reconfiguration in the Netherlands), hence it does not correspond to an estimate of implementing the ROSC and RDCT methodologies in the case of the current bidding zone configuration in Central Europe, which one could reasonably assume to yield larger benefits.

Results

The estimate for Central Europe ROSC-RDCT rescaled to 2025, using congestion income as a weighting factor, is equal to approximately EUR 200 million.

Caveats

- ACER's assessment has been performed based on data for 2024.
- The analysis covers Central Europe instead of only Core, since the extension from Core to Central Europe capacity calculation region is planned before the expected go-live date of the ROSC and RDCT methodologies in Core.
- The expected economic surplus benefits (and corresponding economic surplus loss due to delayed implementation) of the ROSC and RDCT methodologies in Central Europe have been derived under scenarios with a bidding zone reconfiguration in Germany-Luxembourg and in the Netherlands. The actual benefits under the current bidding zone configuration are expected to be larger.
- The total volume of remedial actions in the alternative bidding zone configurations is assumed to be independent on the level of coordination to address congestions.
- ACER did not have access to all granular input and output data as well as the modelling tools used by TSOs in the bidding zone review process.

[9] Derived from ACER's dashboard complementing the ACER 2025 market monitoring report on transmission capacities for cross-zonal trade of electricity and congestion management in the EU.

[10] The total electricity demand per bidding zone in 2024 has been used as weighting factor in both cases.

[11] The following convention is used when naming alternative bidding zone configurations: country code of the country affected by a bidding zone reconfiguration (in this case, Germany and The Netherlands) and number of bidding zones resulting from the split.

1.4.5. Energy Community accession to the single day-ahead coupling

Introduction

This methodology is developed by ACER for calculating the economic surplus gains from day-ahead (DA) market coupling in non-coupled countries/borders (i.e. with and within the Energy Community).

From an economic point of view, in an optimal electricity market, cross-zonal exchanges should only flow in the valuable direction[12] to maximise economic surplus. Deviations from this (exchanges in the non-economic direction) represent inefficiencies. This methodological paper first assesses how efficiently cross-zonal capacity is used, then estimates potential economic gains from going from non-coupled markets to coupled markets.

Calculation description

Realised efficiencies in the use of cross-zonal capacities are computed by comparing oriented net transfer capacities (NTCs) and nominations in the economic direction. Without market coupling, exchanges are explicit. This means market participants decide on the direction, price and volume to trade. Such trades can occur in the non-economic direction. When a price spread appears across a border, exchanges flowing opposite to the price spread are assumed to be inefficient[13]. With market coupling, this inefficiency disappears and exchanges are expected to always flow according to the economic direction[14].

The economic surplus of introducing market coupling therefore captures:

- The missed gains from unused cross-border capacity (unused NTC in the economic direction).
- Elimination of exchanges in the non-economic direction (avoided losses).

1. **Calculation process**
   The economic surplus calculation in the Energy Community will focus on the day-ahead market timeframe.

   For missed arbitrage opportunities

   This represents the arbitrage opportunity that was not exploited due to suboptimal allocation.

[12] It should usually flow from cheaper areas to more expensive areas (excluding so-called non-intuitive flows coming from flow-based market coupling). Such a direction is also called the economic direction.

[13] Partial use of the valuable cross-zonal capacity is also assumed to be inefficient in this case.

[14] i.e. the direction along which economic surplus increases (which will usually be from lower to higher prices). When a border is coupled for a given time frame, 100% efficiency is assumed.

In day-ahead markets[15], efficiency in the use of cross-zonal capacity can be computed based on cross-zonal capacity use for a given set of borders as using hourly oriented nominations[16] and NTCs on each border.

$$\frac{\sum_{hours}\sum_{borders\ where\ spread(h)>threshold} Nominations_{economic\ direction}(h)}{\sum_{hours}\sum_{borders\ where\ spread(h)>threshold} NTC_{economic\ direction}(h)}$$

The economic direction is defined from low to high price areas. For coupled borders, the numerator and denominator[17] are expected to be the same, as all the NTC values are converted into nominations in the economic direction. The economic surplus benefits of going from a non-coupled market to a coupled market can therefore be calculated in two steps: 1) calculating the missed gain from unused cross-border capacity and 2) calculating the gain from undoing exchanges in the non-economic direction.

Step 1: Missed gain from unused NTC

The simplified potential economic surplus benefits from applying DA market coupling assume 'all else being equal' had the capacity been fully used in the economic direction[18]. The economic surplus benefit for a given border is then computed by combining the historical hourly price spread with the remaining cross-zonal capacity available in the economic direction as:

Economic surplus Gains = ∑(Unused NTC in Economic Direction) × (Price Spread)

Step 2: Elimination of exchanges in the non-economic direction

Avoided Loss = ∑(Nominations in the non-economic direction) × |Price Spread|

Total economic surplus benefits from DA MC

Total economic surplus Gain **=** Missed Gain from the unused NTC **+** Elimination of exchanges in the non-economic direction

2. Data requirement

The calculation requires:

- Hourly oriented NTCs at each side of the border;
- Hourly oriented nominations, nominations opposite to the economic direction being counted as negative;
- Hourly or 15-minute day-ahead market prices at each side of the border;

[15] The day-ahead market is expected to correct any inefficient allocation of cross-border capacity in the previous (long-term) timeframes when day-ahead prices are not yet known; as a result, aggregate cross-border capacities (NTCs) and nominations (from day-ahead and previous timeframes) are used.

[16] Nominations opposite to the economic direction will be counted as negative.

[17] In this case, the nomination is always assumed to be fully efficient.

[18] It means market players' behaviours would have remained the same. It also assumes that marginal orders on both sides of the border have infinite volumes.

- Transmission rights (TR) market clearing prices of auction with bordering countries for BA and MD

Before 1 October 2025 all the data had hourly granularity, therefore, to perform this analysis, data were disaggregated to 15-minute granularity for all the 2025 dataset. This disaggregation was applied to both NTC and nominations, to make possible the calculation of the economic surplus benefit for every MTU. In case of hourly NTC disaggregation, the values were divided by 4 and used across 4 quarter hourly MTUs.

If data is missing over a certain period[19], the total economic surplus computed will be linearly extrapolated on a yearly basis to cover a complete year. This means that, where a complete data set was not available for a given border, economic surplus benefits results were extrapolated per border in order to get the value for 100% of the MTUs per year. For example: if the data availability is 99%, we add 1% of the result value to the final yearly economic surplus benefits for that border.

In cases where there is a negative economic surplus benefit calculated (e.g. higher values of nominations reported compared to NTC in the same direction), the result is set to zero and is not reducing the total amount of economic surplus benefits calculated. For the MTUs where NTC values are zero in both directions and there is no information for the commercial exchanges, we set the calculation result to zero as well, as it means no capacity was given on the border, therefore there is zero economic surplus benefit from market coupling optimisation for that MTU.

In the cases where an hourly day-ahead price was not available for a Contracting Party, ACER estimated the day-ahead hourly price for the relevant Contracting Party using the available day-ahead price in a neighbouring country, and the price of the transmission right for the relevant border. In such a case (as for BA and MD), we consider the averages of hourly prices of all available borders, considering each neighbouring country's DA price and adding or subtracting the transmission rights (market clearing prices of auction, depending on the economic direction). For instance, for the border HR-BA, if the transmission rights from BA to HR is higher than the transmission rights in the opposite direction, that is an indication that the price in HR is lower than the price in BA. So, the assumption is that the price of BA is at least equal to the price of HR plus the price of the TR in the direction BA to HR.

$$DA\ price_{BA} = \begin{cases} DA\ price_{HR} + TR_{BA \to HR}, & TR_{BA \to HR} > TR_{HR \to BA} \\ DA\ price_{HR} - TR_{HR \to BA}, & TR_{BA \to HR} < TR_{HR \to BA} \end{cases}$$

3. Examples

[19] Data availability is ranging from 98.8 % up to 100% for most borders, the lowest data available is on UA-MD border – 95.5%

Table 4: explanatory example considering two bidding zones, i.e. "A" and "B"

	NTC (MW) A-B	NTC (MW) B-A	Day-ahead price A (€/MWh)	Day-ahead price B (€/MWh)	Nomination A->B (MW)	Nomination B->A (MW)
Hour 1	300	500	50	40	0	400
Hour 2	400	200	20	40	100	200

Source: ACER

Economic surplus calculation

Hour 1:

$$\sum_{MTU\ where\ spread\ (MTU) > price_{threshold}} (NTC(MTU)_{economic\ direction} - Nominations(MTU)_{economic\ direction}) \times Spread(MTU)_{price}$$

- Economic direction: from B to A
- Economic surplus calculation: (500 – 400)*(50 – 40) = 1000 EUR

Hour 2:

- Economic direction: from A to B
- Economic surplus calculation: (400-100+200)*(40-20) = 10.000 EUR

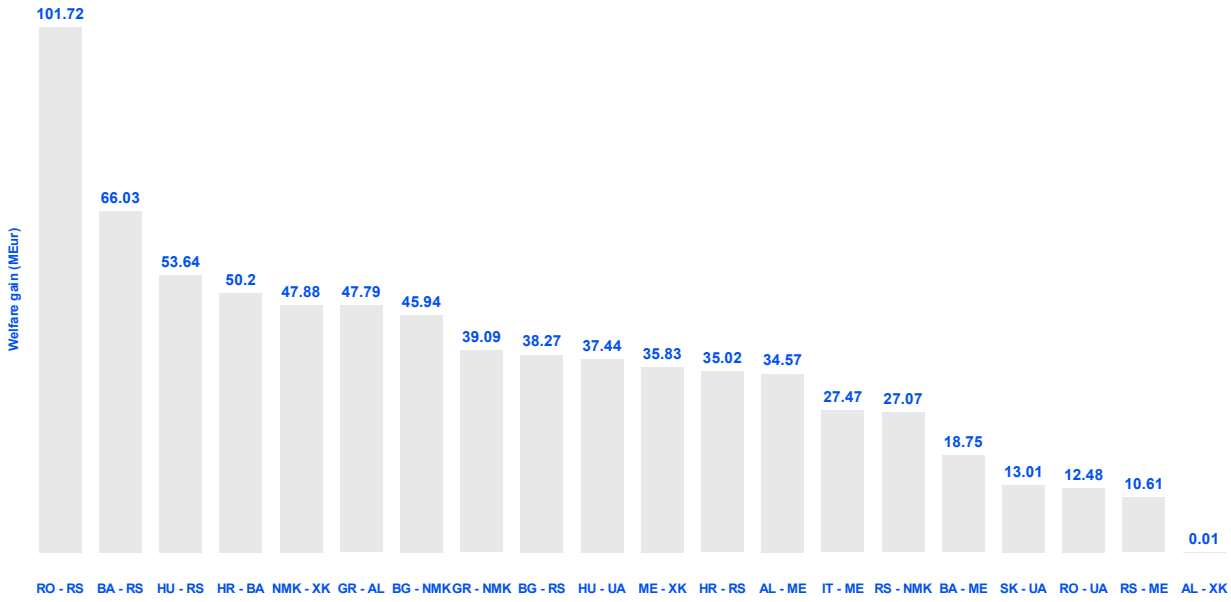
Total economic surplus to be gained going from no market coupling to market coupling (Hour 1 + Hour 2) = 11.000 EUR

Results

The analysis revealed that integrating EnC in SDAC would have yielded an economic surplus gain of approximately EUR 750 million.

The breakdown of the calculated benefits per border is as follows:

Figure 4: Potential economic surplus gains from day-ahead market coupling per Contracting Party border, 2025 (million EUR)



Source: ACER calculation based on ENTSO-E transparency platform data, SEE CAO and Energy Community Regulatory Authorities

Caveats

As the calculation relies on assumptions, the final estimate of economic surplus benefits only represents an order of magnitude. For instance, the calculation does not consider the evolution of price spreads with additional cross-zonal exchange, therefore the outcome is an overestimation of actual economic surplus benefits.

Economic surplus benefits not included in the analysis for the borders due to the absence of power exchange prices or ENTSO-E platform data unavailability in the following EnC countries:

- GE - outside of the scope

This ACER analysis of the potential economic surplus gains from further regional electricity day-ahead market coupling is based on 2025 data for the borders between the Contracting Parties and EU Member States, using a simplified ACER methodology.

Data source:

- ENTSO-E Transparency Platform
- Missing values for prices, day ahead commercial schedule or net transfer capacity and transmission rights provided by NEMOs/TSOs of Contracting Parties
- Currency exchange from UAH to EUR from Ukrainian Central Bank

1.4.6. Flow-Based allocation in intraday auctions (Core CCR)

Introduction

The intraday timeframe in the Core Capacity Calculation Region is currently characterised by a distinction between capacity calculation and capacity allocation. While the Core intraday capacity calculation process is based on a flow-based methodology, the capacities made available to the intraday allocation process are still provided in the form of Available Transfer Capacities (ATCs) extracted from the underlying flow-based domain.

This translation inevitably leads to a loss in the exchange possibilities offered by the flow-based domains. In particular, ATC extraction requires an ex-ante allocation of the available flow-based margin across individual bidding-zone borders and directions. Consequently, the resulting ATC values are typically more restrictive than the original flow-based domain, since they do not allow the market coupling algorithm to optimise across the full set of feasible combinations of cross-zonal exchanges.

This analysis estimates the economic surplus impact of applying Core flow-based capacity domains directly in the intraday auctions, separately for IDA1, IDA2 and IDA3. The objective is to quantify the economic surplus gain associated with the use of flow-based domains in allocation, for each intraday auction, compared with the current ATC-based allocation framework. The analysis was performed for the entire year 2025.

Some days needed to be excluded from this analysis, due to operational issues in the different intraday auctions, leading to auction cancellations or decoupling events:

- IDA1: 1 February 2025, 20 April 2025, 3 June 2025, 29 June 2025, 16 July 2025, 1 November 2025, 14 November 2025, 30 November 2025 and 10 December 2025.
- IDA2: 4 February 2025, 6 April 2025, 17 May 2025 and 17 July 2025.
- IDA3: 22 January 2025, 7 April 2025, 11 April 2025, 11 June 2025 and 9 September 2025.

Methodological aspects

To quantify the effect of flow-based allocation in the intraday auctions for the Core CCR, ACER relied on market simulations performed with the Simulation Facility tool. The Simulation Facility replicates the market coupling algorithm and allows the comparison of different capacity calculation inputs under otherwise equivalent market inputs.

For each intraday auction, the analysis used the most representative flow-based domains derived from published information in the JAO Publication Tool, corresponding to the different Core capacity calculation processes. The economic surplus gain was calculated for each auction as the difference between the economic surplus obtained under the simulated Core flow-based configuration and the economic surplus obtained under the simulated ATC-based alternative.

Depending on the interaction between the calculated flow-based domains and the previously allocated capacities, the resulting RAM could be negative. Whenever the RAM of a CNEC was negative, it was set to zero before running the simulation. This adjustment was necessary to ensure that the flow-based domain was compatible with the auction algorithm.

During the preparation of the simulation inputs, it was observed that for several hours no pre-solved flow-based domain was available. This typically occurs when the intraday capacity calculation produces an empty flow-based domain, often due to the presence of multiple CNECs with zero or negative RAM values. Since the Simulation Facility does not allow the direct loading of fully empty flow-based domains or domains containing negative RAM values, whenever the capacity calculation resulted in an empty flow-based domain, fictitious CNECs with zero RAM were introduced to construct a flow-based domain compatible with the simulation environment.

An additional adjustment was applied to account for equality constraints. Unlike the day-ahead flow-based domain, the IDCC domains do not include the full set of equality constraints required to ensure the consistency of the simulated market outcome. Equality constraints are necessary to impose specific linear restrictions on the domain, such as the balance of net positions and the treatment of specific hubs. In particular, they ensure that the sum of Core net positions and ALEGrO virtual hubs remain balanced.

Allocation constraints corresponding to the net position of the Polish bidding zone are currently enforced in the IDA as a line-set constraint on all bidding zone borders of Poland. Since line-set constraints are not compatible with flow-based allocation, this constraint was modelled as an allocation constraint on the net position, similarly to the way it is modelled in day-ahead, with the same values are the original line-set constraint.

The following subsections describe the specific assumptions applied for IDA1, IDA2 and IDA3.

IDA1 specificities

The first pan-European intraday auction takes place at 15:00 on the day before delivery, three hours after the single day-ahead coupling takes place. This auction receives cross-zonal capacities that are based on the day-ahead flow-based domains, which are adjusted by removing part of the virtual capacities used in day-ahead to comply with the applicable minimum capacity requirements. Since the flow-based domains used for the day-ahead market are balanced at the zero-exchanges point, the RAM values from such domains need to be updated based on the market clearing point of the day-ahead market, as follows:

$$\overrightarrow{RAM}_{UID} = \overrightarrow{RAM}_{f,DA} - PTDF_{f,DA}\overrightarrow{NP}_{AAC,DA}$$

$\overrightarrow{RAM}_{UID}$	Updated remaining available margin for intraday cross-zonal capacities
$\overrightarrow{RAM}_{f,DA}$	Final remaining available margin resulting from the day-ahead capacity calculation
$PTDF_{f,DA}$	Final power transfer distribution factor matrix resulting from the day-ahead capacity calculation
$\overrightarrow{NP}_{AAC,DA}$	Net position resulting from already allocated capacity in SDAC

For the purposes of this analysis, ACER simulated two cases, one using day-ahead flow-based domains that retain all virtual capacities used in the day-ahead capacity calculation

process, and another using flow-based domains that exclude any virtual capacities. The value presented in the surplus figure excludes all virtual capacities.

IDA2 specificities

The second pan-European intraday auction takes place at 22:00 on the day before delivery. In the Core region, a dedicated capacity calculation process releases cross-zonal capacities specifically for this auction. This is the Core IDCC(b) process. For the purpose of this analysis, ACER simulated the full year of 2025 using the flow-based domains resulting from the IDCC(b) process.

It is important to note that the ATC values currently delivered to IDA2 are extracted from IDCC(b) domains that are not balanced at the net positions assumed at the start of the capacity calculation (or RefProg), but rather at the latest net positions including trades that take place in the continuous market, in parallel to the capacity calculation process. To address this inconsistency, ACER requested from Core TSOs the Core net positions used for the ATC extraction, and adjusted the flow-based domains accordingly based on the latest net positions.

IDA3 specificities

The third pan-European intraday auction takes place at 10:00 during the day of delivery and clears all market time units from 12:00 onwards. Currently, Core TSOs perform a dedicated capacity calculation process to release capacities for IDA3, referred to as IDCC(d). However, as such domains were not yet calculated throughout the course of 2025, ACER needed to rely on flow-based domains which are not specific to IDA3, but that are released well-ahead of the third intraday auction.

For the purposes of this analysis, ACER simulated the second half of 2025 using the flow-based domains resulting from the IDCC(c) process, which went live in June 2025, and the first half of 2025 using the flow-based domains resulting from the IDCC(b) process. Similarly to IDA2, IDCC(b) and IDCC(c) domains used to simulate IDA3 needed to be adjusted to consider the latest Core net positions used for the ATC extraction.

Results

The analysis revealed that the implementation of flow-based allocation in IDAs (i.e. IDA1, IDA2, and IDA3), in the Core CCR, would have yielded an economic surplus gain of approximately EUR 500 million in 2025[20].

Caveats

The results of this analysis should be interpreted in light of several methodological limitations.

- The Simulation Facility replicates the market coupling algorithm but may not reproduce all operational features of the production environment. As a result, simulation outcomes may slightly differ from actual market clearing results, especially if the introduction of flow-based allocation would require changes to the algorithm version.

[20] Please note that this number is being refined based on data availability.

- In addition to validating the flow-based domains directly, TSOs can apply validation reductions directly to the ATCs extracted from these domains. Due to insufficient data availability, ACER's simulations do not capture the effects of validation reductions applied directly to the extracted ATCs.
- The flow-based domains resulting from the IDCC(a) process retain a certain amount of virtual capacity, as determined by individual TSOs. ACER's simulations exclude all virtual capacities, which may lead to an underestimation of the benefits of flow-based allocation in IDA1.
- The estimated economic surplus gains should be interpreted as simulation-based values. They reflect the impact of applying the selected Core flow-based domains under the assumptions described above, but they do not capture potential changes in bidding behaviour, liquidity, or market participant strategies resulting from the operational implementation of flow-based allocation in the intraday auctions.
- The analysis relies on flow-based data published by JAO and therefore depends on the completeness, consistency and quality of the published flow-based domains.

1.5. Methodologies (Capacity Allocation and Congestion Management and Electricity Balancing related projects)

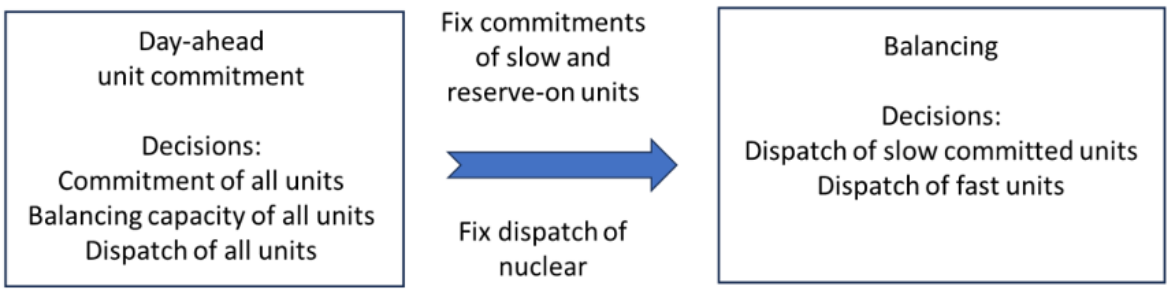
1.5.1. Co-optimisation and market-based allocation

Introduction

The economic surplus benefits of these two projects have been assessed in one single study, carried out by academic consultants from the National Technical University of Athens (Greece) and the Université catholique de Louvain (Belgium), published on ACER's website in May 2024.

The study is based on a two-stage model: a day-ahead market module followed by a real-time module, which aims at replicating the balancing energy market. The focus of the study is on the Core region. While, for co-optimisation, these results have been extrapolated to the entire EU, for the case of market-based allocation, the economic surplus benefits generated in the Nordic region (where market-based allocation for aFRR is live since 8 December 2022) have been used to assess the already attained benefits of this project, as described further below.

Figure 5: Linkage between the day-ahead and balancing energy models



Source: *Welfare Benefits of Co-Optimising Energy and Reserves*

Other assessments related to the implementation of co-optimisation and/or its economic surplus benefits have been carried out since the publication of this study. The study "Assessment of Potential Social Welfare generated by Combining or Coordinating Portfolio-Based Markets for Scheduled Energy and Balancing Capacity", commissioned by the German TSOs and EPEX and performed by Consentec and Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen, was published in July 2025, showing economic surplus benefits in the range of EUR 15.5 to 179 million per year for the Core region. Another study, "Investigation into sequential and co-optimised procurement of energy, reserve and response services", commissioned by NESO and performed by FTI Consulting, was published in February 2026, according to which implementing co-optimisation in GB could lead to £ 3.4 billion system cost savings and £ 4.9 billion consumer cost savings for the period 2025-2035. While a detailed assessment of the assumptions and findings of those studies is outside the scope of the present report, ACER finds it important to emphasise the sensitivity of the results to the assumptions taken as well as the capability to model all relevant factors which are expected to contribute to such economic surplus benefits. Extensive R&D activities performed

by NEMOs and TSOs are currently ongoing, as prescribed by the algorithm methodology adopted with ACER Decision No 11/2024, to assess the feasibility of implementing co-optimisation in SDAC.

Calculation description

The model includes two modules, i.e. (1) day ahead market module and (2) real-time module. The models of both modules are based on a 15-minute time resolution, unit-based, represent both upward and downward aFRR and mFRR, and employ unit commitment constraints that account for minimum up and down times, ramp rates, and planned outages.

1. Day-ahead market module

For the day ahead model, the technologies are distinguished between fast and slow. Fast and slow units can cover the needs of both aFRR and mFRR. Fast units are assumed to be able to cover mFRR even if they are offline.

1.1 Status quo

The status quo is represented by a day-ahead balancing capacity market model which is followed by a day-ahead energy market model. The balancing capacity market model aims at minimising the sum of fixed costs plus opportunity costs. The fixed costs that are included in the objective function of the model include both the minimum load cost of running a unit at its technical minimum plus any additional power generation implied by downward mFRR and aFRR capacity, as well as startup costs.

Once the balancing capacity market model is cleared, the day-ahead energy market model is solved. This model is also unit-based and amounts to a unit commitment model where the aFRR and mFRR allocations of the balancing capacity market model are fixed. A zonal transmission network model with flow-based constraints is employed. Technical minimum and maximum constraints are included in the model, as well as ramp rates and minimum up and down time constraints. The objective function of the day-ahead energy market model aims at minimising load shedding costs plus generating unit fuel costs, startup costs, and minimum load costs.

1.2 Market-based allocation

The model for representing market-based allocation is almost identical to that of the status quo, with the important difference that bidding zones are allowed to trade balancing capacity for aFRR and mFRR. The maximum volume that can be used for balancing capacity exchanges is limited to 10% of the remaining available margin of each critical network element with contingency (in accordance with Article 41(2) of the Balancing Regulation). Moreover, in accordance with Annex VII of the System Operation Regulation, it is enforced that a bidding zone cannot import more than 50% of its balancing capacity requirement from other bidding zones.

1.3 Co-optimisation

The co-optimisation model jointly optimises the allocation of energy and balancing capacity in a single multi-product day-ahead auction. Upward and downward aFRR and mFRR are thus traded jointly with energy in this model. As in the case of the previous models, min up/down

times and ramp rates are represented. The cross-zonal trade of balancing capacity is possible, without any limitations on the use of cross-zonal capacity, and at most 50% of the balancing capacity requirement per bidding zone has to be satisfied within that bidding zone. The network is represented with flow-based constraints.

The objective of this model is to satisfy energy demand and balancing capacity requirements at least cost. Cost is measured as the sum of involuntary load shedding plus fixed minimum load and start-up costs of units plus variable fuel costs.

2. Real-time module

The methodology aims to quantify how distortions in day-ahead market clearing affect the physical operation of the system in real time, which is the ultimate source of inefficiency in the analysis. The real-time model is common to all three market designs (status quo, market-based allocation and co-optimisation), and the only differentiating factor between the market designs is how these designs affect the irrevocable decisions (unit commitment and setpoint of certain technologies) by which we enter real-time operations. The real-time model has the same 15-minute time resolution as the day-ahead models.

To capture the effect of irrevocable unit commitment decisions on real-time operations, it is assumed that whichever units are committed for balancing capacity in the day-ahead time stage still continue to be committed in real time. Moreover, the setpoint of nuclear units is fixed to their day-ahead schedule.

The balancing energy market model is otherwise very similar to the day-ahead models presented above. Samples of balancing energy market operations are simulated by drawing a random realisation of renewable forecast errors, which the system is called to balance in real time.

3. Analysis of the results

Co-optimisation improves costs of system operation by approximately 2.1% relative to the status quo, while the market-based design reaps 0.3% of these cost savings. The efficiency gains of the co-optimisation design translate to EUR 678 million per year for the Core region, while those of the market-based approach translate EUR to 84 million per year for the Core region, relative to the status quo design. Extrapolating these savings to the produced and consumed energy of the entire EU for 2023 indicates a potential cost saving of approximately EUR 1300 million in 2023 from co-optimisation relative to the status quo and a potential cost saving of approximately EUR 160 million per year from market-based relative to the status quo.

The drivers for these efficiency gains relate to the misrepresentation of fixed costs in sequential designs, which result in an inefficient commitment of resources with relatively low fixed costs. Due to their technical minima, these resources take up space from inflexible lower-cost resources that could have been used instead, in real time for serving forecast demand as well as imbalances. Co-optimisation avoids this pitfall by taking into account the fact that fixed costs are incurred once at the day-ahead stage for the provision of both energy and balancing capacity. On the other hand, the role of forecast errors in sequential designs is found to be non-significant since these inefficiencies can largely be corrected through intraday adjustments.

Several sensitivity analyses were carried out to assess the impact of specific assumptions, such as:

- Assuming that the intraday market cannot correct the setpoint of the units following the results of the day-ahead market, thereby representing an upper bound for the expected cost savings that can be attained with market-based allocation and co-optimisation.
- Lifting the 10% limit in the market-based approach.
- Allocating 80 MW to account for the Austrian-German aFRR cooperation.

Results

The estimate re-scaled to 2025, using congestion income as weighting factor, is equal to approximately EUR 1800 million.

Caveats

The following optimistic assumptions have been considered in the study, which tend to favour sequential designs with respect to co-optimisation:

- aFRR and mFRR are cleared jointly in a single balancing capacity market model that accounts for the interdependencies of the two balancing capacity products.
- Fixed costs, min up/down times and ramp rates are accounted for in the balancing capacity market model, even though these are not accounted for at unit level in a portfolio-based design.
- The energy price of the co-optimisation model has been used as input for the computation of opportunity cost for the balancing capacity market of the sequential design, which is an optimistic outlook on the ability of market participants to anticipate efficient opportunity costs.

Other relevant considerations:

- Adopting a unit commitment model is seen as a methodological necessity, given that there is no historical record of bids in the energy and balancing capacity markets in a co-optimised setting.
- Current products of the European day-ahead market (simple bids, block bids, complex orders, etc.) are not modelled, as they are only relevant for portfolio-based bidding.
- Perfect competition and truthful bidding are assumed.
- Sharing of reserves has not been modelled, for both market-based and co-optimisation, hence only balancing capacity exchanges are possible in these two market designs.

Approach to distinguish between realised and additional economic surplus benefits of (Nordic) market-based allocation

As already mentioned, contrarily to co-optimisation which is not yet implemented in any part of Europe, market-based allocation for the exchange of aFRR balancing capacity has been operational in the Nordic region as of 8 December 2022. On a yearly basis, the Nordic TSOs publish an evaluation report which, among other analyses, aims to assess the economic

surplus benefits generated by this cooperation. The evaluation report covering year 2023 can be found here, whereas the most recent one, for the year 2024, can be found here.

From a high-level standpoint, the approach followed by the Nordic TSOs when estimating those benefits is rather simple:

1) Re-run SDAC for the given historical year with higher cross-zonal capacity limits, i.e. by adding the volume allocated for the exchange of balancing capacity. This would allow to estimate the economic surplus loss in SDAC due to providing lower cross-zonal capacity limits to the day-ahead energy market.
2) Re-run the market-based allocation process for the given historical year by setting cross-zonal capacity limits to zero. This would allow to estimate the economic surplus benefits of having a Nordic balancing capacity market for aFRR compared to procuring the needed aFRR volume by relying entirely on local bids per bidding zone.

The net benefits of market-based allocation can then be derived by summing up 1) and 2). In the following table, the results obtained by the Nordic TSOs for 2023 and 2024 are reported.

Table 5: Benefits stemming from market-based allocation in the Nordic region

Year	Change in SDAC economic surplus [MEUR]	Change in aFRR economic surplus [MEUR]	Net economic surplus benefits of market-based allocation [MEUR]
2023	-18.2	46.9	28.7
2024	-22.9	63.7	40.8

Source: *Nordic TSOs evaluation reports for 2023 and 2024*

Results

The estimate re-scaled to 2025, using congestion income as weighting factor, is equal to approximately EUR 60 million.

Caveats

For an exhaustive analysis of the results obtained when applying this approach, the reader is invited to read chapter 4 of the two reports for 2023 and 2024.

In terms of assumptions and caveats of the methodology and its results, the following main considerations are highlighted here:

- Due to the unavailability of the simulation facility for SDAC in 2024, an alternative approach had to be used to estimate the change in SDAC economic surplus for 2023, which is deemed more conservative (i.e. overestimating the SDAC economic surplus loss compared to the case without market-based allocation). Even though the

simulation facility was operational in 2025, for the sake of consistency in reporting, the Nordic TSOs kept using the more conservative approach also for the operational year 2024, but reported the value obtained with the simulation facility in the appendix. For 2024, the difference between the two approaches is rather small (-19.5 MEUR compared to –22.9 MEUR).

- The change in aFRR economic surplus excludes the contribution of SE4, for which a large indivisible and expensive bid is used to satisfy the local aFRR demand in the reference case, resulting in unrealistic high economic surplus benefits when moving to a Nordic aFRR market. In reality, the SE4 reference case situation would make more BSPs put in bids and the large consumer surplus would go down relatively fast.
- Benefits of the aFRR Nordic balancing capacity market have been set to zero if, for a given bidding zone, no local bids exist at all, since in those cases it becomes challenging to value security of supply.[21]
- In practice, if no Nordic aFRR balancing capacity market would exist, the procurement of aFRR would be performed at country level, not per bidding zone, as assumed in the reference case. Consequently, the change in aFRR economic surplus would be more limited.[22]

It is important to note that the Nordic region is not the only one where market-based allocation is already implemented. As of 4 February 2025, the market-based allocation process is also operational in the Baltic region, covering both aFRR and mFRR. One of the key differences between the Nordic and the Baltic cooperation is that, while the Nordic TSOs exchange balancing capacity among them, the Baltic TSOs share their reserve needs, which results in significantly lower procured balancing capacity volumes at the regional level compared to a scenario with national balancing capacity markets. For this reason, providing somewhat realistic figures for the economic surplus benefits of market-based allocation in the Baltic region is significantly more challenging compared to the case of the Nordic region; therefore, the estimated realised economic surplus benefits of market-based allocation considered in this assessment are only based on the evaluation performed by the Nordic TSOs in their yearly reports.

[21] This shortcoming is expected to be (partly) mitigated in the evaluation report covering the year 2025.

[22] A specific re-run for this scenario was conducted for the year 2023, leading to net economic surplus benefits of 20.7 MEUR compared to the 28.7 MEUR reported in the ‘main scenario’. In both cases, SE4 is excluded from the results.

1.6. Methodologies (Electricity Balancing related projects)

1.6.1. IGCC, PICASSO and MARI implementation (TSOs' accession)

Introduction

PICASSO and MARI are the pan-European platforms for the exchange of balancing energy: aFRR for PICASSO and manual frequency restoration reserve (mFRR) for MARI. Both platforms went live in the course of 2022 and since then an increasing number of TSOs have been joining them. Although the regulatory deadline for accession was 24 July 2022, with derogations granted until 24 July 2024, as of 2026, there are still a few TSOs which are not connected to at least one of the two platforms.

The International Grid Control Cooperation (IGCC) is the implementation project, launched back in October 2010, which performs the imbalance netting process as defined by Article 22 of the EB Regulation. Imbalance netting is the process agreed between TSOs of two or more Load Frequency Control (LFC) areas that allows avoiding the simultaneous activation of automatic frequency restoration reserves (aFRR) in opposite directions by taking into account the respective frequency restoration control errors as well as the activated aFRR, and by correcting the input of the involved frequency restoration processes accordingly. As of 2025, all EU TSOs of continental Europe are connected to the imbalance netting platform.

Regarding PICASSO, it is important to note that, when all TSOs will connect to this platform, the imbalance netting process will be fully incorporated within PICASSO. As such, when estimating the economic surplus benefits brought about by the connection of individual TSOs to PICASSO, it is important to disentangle the 'pure' benefits of PICASSO (which are due to the cross-border exchange of balancing energy) from the benefits of aFRR netting which are already attained by IGCC.

Calculation description

The following paragraphs describe the methodology used to estimate the additional economic surplus gains that could be attained once a TSO joins either platform. Two sets of input data are necessary for this analysis:

- The total economic surplus generated by each platform for a given year, which is based on the TSOs connected to that platform by the end of the corresponding year.[23]
- The connection date (if already occurred) and the expected connection date (if still not connected) for all TSOs for all platforms.

The economic surplus generated by MARI and PICASSO for a given year is calculated by comparison with a scenario featuring the same bids, demand and market design, but without exchange of balancing energy among the TSOs connected to the platforms. This aims at simulating the case of non-integrated national balancing energy markets, thereby estimating the benefits of integrating those national markets into a pan-European one. For imbalance netting, the savings are calculated based on the difference between the respective TSO's

[23] A detailed description of how the economic surplus generated by the balancing platforms is estimated can be found here.

aFRR opportunity prices and its imbalance netting settlement prices, for imported or exported energy.

The information mentioned above is published by ENTSO-E every year in their market report or balancing report (see here for the most recent market report, published at the end of June 2025) and periodically reported by TSOs in the relevant meetings with regulatory authorities and stakeholders held during the year.

The (expected) connection date of each TSO to MARI and PICASSO is publicly available on ENTSO-E's website (here for MARI and here for PICASSO). Regarding planned connection dates, every 6 months TSOs publish an updated accession roadmap, reflecting the most recent information at their disposal. As of May 2026, the latest accession roadmap for MARI and PICASSO, published at the end of February 2026, can be found here and here, respectively. Based on this information, one can derive the number of days for which each TSO is connected to MARI and PICASSO in a given calendar year. For this assessment, data for the two most recent years, 2024 and 2025, is used.

Based on the information listed above, the additional economic surplus gains brought about by the connection of a TSO[24] to MARI are calculated as follows:

$$\Delta WG_{MARI} = \frac{ES_{MARI,2025} - ES_{MARI,2024}}{\sum_c \frac{D_{c,2025,MARI}}{D_{2025}} - \sum_c \frac{D_{c,2024,MARI}}{D_{2024}}}$$

Where:

- ΔWG_{MARI} is the estimated additional economic surplus gains brought about by the connection of a TSO to MARI.
- $ES_{MARI,2024}$ and $ES_{MARI,2025}$ is the economic surplus generated by MARI in 2024 and 2025, respectively.
- $D_{c,2024,MARI}$ and $D_{c,2025,MARI}$ is the number of days, in the respective year, during which the TSO of country c was connected to MARI.
- D_{2024} and D_{2025} is the number of days in calendar year 2024 and 2025, respectively.

The same approach applied to MARI can be used for PICASSO and IGCC. In this case, given that the imbalance netting process is the first step done in PICASSO (before selecting bids for cross-border aFRR exchanges), we aim first at estimating the value of 'pure' imbalance netting by looking at the IGCC results for 2024 and 2025. To avoid double counting, we take the savings generated by IGCC in 2024 and 2025 and divide them by the number of countries (and their respective percentage of time of the year) that are connected to IGCC but not to PICASSO in the respective year[25]. This allows to estimate the value of 'pure' imbalance netting

[24] The only exception is Germany, which comprises four TSOs. All German TSOs accessed MARI and PICASSO in 2022.

[25] When the TSO of a country joins PICASSO in the course of the year, only the number of days in the year before the accession date to PICASSO are taken into account in this calculation. In 2024, the TSOs of the following 17 countries were connected to IGCC (and not to PICASSO) for at least 1 day: Belgium, Bulgaria, Croatia, Denmark, France, Greece, Hungary, Italy, The Netherlands, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain

generated by each TSO connected to IGCC, i.e. ΔWG_{IGCC}, which is expressed by the following equation:

$$\Delta WG_{IGCC} = \frac{ES_{IGCC,2025} - ES_{IGCC,2024}}{\sum_c \frac{D_{c,2025,IGCCwoPICASSO}}{D_{2025}} - \sum_c \frac{D_{c,2024,IGCCwoPICASSO}}{D_{2024}}}$$

Where:

- ΔWG_{IGCC} is the estimated additional economic surplus gains brought about by the connection of a TSO to IGCC.
- $ES_{IGCC,2024}$ and $ES_{IGCC,2025}$ is the economic surplus generated by IGCC in 2024 and 2025, respectively.
- $D_{c,2024,IGCCwoPICASSO}$ and $D_{c,2025,IGCCwoPICASSO}$ is the number of days, in the respective year, during which the TSO of country c was connected to IGCC but not to PICASSO.
- D_{2024} and D_{2025} is the number of days in calendar year 2024 and 2025, respectively.

Accordingly, the additional economic surplus gains brought about by the connection of a TSO to PICASSO are calculated as follows (the meaning of each term in the equation is the same as for MARI and IGCC):

$$\Delta WG_{PICASSO} = \frac{ES_{PICASSO,2025} - ES_{PICASSO,2024}}{\sum_c \frac{D_{c,2025,PICASSO}}{D_{2025}} - \sum_c \frac{D_{c,2024,PICASSO}}{D_{2024}}} - \Delta WG_{IGCC}$$

This leads to the following results:

Table 6: Economic surplus benefits brought about by the connection of a TSO to MARI, PICASSO and IGCC

ΔWG_{MARI} [MEUR]	$\Delta WG_{PICASSO}$ [MEUR]	ΔWG_{IGCC} [MEUR]
16.1	11.3	18.7

Source: *ACER computation based on ENTSOE's data*

The economic surplus benefits for MARI and PICASSO (and the corresponding unrealised economic surplus for delayed accession) are calculated as the sum of their respective ΔWG, depending on the (expected) connection date of each TSO to the corresponding platform[26]. Regarding the realised economic surplus gains of PICASSO, the historical value calculated by the TSOs has been scaled down by the ratio $\Delta WG_{PICASSO}/\Delta WG_{IGCC}$ to disentangle the actual contribution of PICASSO compared to the added value provided by imbalance netting (apart

and Switzerland. In 2025, the TSOs of the following 12 countries were connected to IGCC (and not to PICASSO) for at least 1 day: Bulgaria, Croatia, France, Greece, Hungary, Poland, Portugal, Romania, Serbia, Slovenia, Spain and Switzerland.

[26] The number of countries expected to connect to MARI and PICASSO is 24.

from Finland, which is not connected to IGCC). Additionally, the expected economic surplus benefits of PICASSO consider that Norway and Sweden are expected to join PICASSO but not IGCC.

Results

By applying the above-described approach, the following results are obtained:

Table 7: Realised and unrealised economic surplus stemming from MARI, PICASSO and IGCC in 2024 and 2025

Year	Realised economic surplus gains MARI [MEUR]	Unrealised economic surplus gains MARI [MEUR]	Realised economic surplus gains PICASSO [MEUR]	Unrealised economic surplus gains PICASSO [MEUR]	Realised economic surplus gains IGCC [MEUR]	Unrealised economic surplus gains IGCC [MEUR]
2024	12	374	104	222	814	0
2025	104	282	289	37	301	0

Source: *ACER computation based on ENTSOE's data*

Caveats

- For MARI and PICASSO, the calculation is derived by comparison of actual results generated by the platforms with a hypothetical scenario of zero cross-border exchange of balancing energy, but assuming the same bids from market participants, the same volume of TSOs' demand and the same market design as if each balancing energy market would be entirely national.
- Given that, by the end of 2025, not all TSOs have yet accessed MARI and PICASSO, the estimated economic surplus benefits have to be taken as indicative towards the future scenario where all TSOs will be connected to both platforms.
- The expected accession dates to MARI and PICASSO for the remaining TSOs are based on the latest accession roadmaps published on 26 February 2026.
- The benefits generated by MARI and PICASSO are largely driven by two factors: the volume of TSOs' demand and the amount of cross-zonal capacity available. The former is intrinsically linked with the size and energy mix of individual countries as well as the balancing philosophy applied by each TSO, i.e. proactive vs reactive. Proactive TSOs (such as in the Nordics, France and Spain) tend to rely more on mFRR rather than aFRR, whereas for reactive TSOs (such as in Belgium, Germany and The Netherlands) aFRR is by far the most prominent balancing energy product in use. As such, the realised additional economic surplus gains brought about by the connection of individual TSOs to either platform would be strongly dependent on the balancing philosophy of the newly joining TSO. The values calculated with this approach have to be considered representative for an 'average TSO'. In this regard, the stark increase of realised economic surplus gains for MARI when comparing the data between 2024 and 2025 is driven by the large volumes

requested by the Baltic TSOs, REE and REN, which connected to MARI only towards the end of 2024.

- Regarding the amount of cross-zonal capacity, the accession of more TSOs would allow for cross-border exchanges over a larger set of borders[27]. Nonetheless, the overall volume of cross-zonal capacity available in the platforms is currently rather limited and not evenly distributed across all borders.
- The economic surplus for MARI and PICASSO is generally higher for small LFC areas, which get access to a much larger market via the platforms.

[27] Even if not yet connected to the platforms, TSOs may voluntarily apply "ATC sharing" to allow the exchange of balancing energy between non-neighbouring TSOs already on the platforms.

1.7. Categories of economic surplus

This assessment quantifies the economic surplus generated by a selection of 13 market integration projects. These projects differ significantly in terms of their implementation status, scope, complexity, and legal requirements. To accurately present the economic surplus associated with each project, ACER categorised the economic surplus metric into four categories:

1. realised economic surplus generated by those projects that have already been implemented (fully or partially);
2. unrealised economic surplus due to implementation delays, including also the partial non-implementation of operational projects;
3. expected economic surplus deriving from the implementation of currently delayed projects (full or partially) or projects that are scheduled for implementation in the future;
4. additional economic surplus if co-optimisation was implemented and a more efficient configuration of bidding zones was in place.

Table 9 summarises the contribution by project and category:

Table 8: Summary of projects and categories - 2025

	Realised economic surplus	Unrealised economic surplus	Expected economic surplus	Additional economic surplus
TSOs accession in IGCC	x			
Market-based allocation (Nordic CCR)	x			
Nordic FB SDAC	x	x		
Core FB SDAC	x	x		
70% requirement (Core CCR)	x	x	x	
TSOs accession to MARI	x	x	x	
TSOs accession to PICASSO	x	x	x	
ROSC-RDCT (Central Europe CCR)		x	x	
LTFB (Core CCR)		x	x	
FB IDAs (Core CCR)			x	
Integration of Energy Community in SDAC			x	
Bidding zone review				x
Co-optimisation				x

Source: ACER

1.7.1. Unrealised economic surplus from delayed implementation

In this market monitoring report, seven projects are considered contributing to unrealised economic surplus, as highlighted in the Table 9. The period over which the unrealised economic surplus for each individual project is calculated is described below.

Nordic FB SDAC

The project is considered to lead to unrealised economic surplus over the period from 01/05/2023 to the go-live of the project, on 30/10/2024.

The regional capacity calculation methodology approved by Nordic NRAs does not give an explicit implementation deadline. For this reason, and for the purpose of this market monitoring exercise, the date was set by ACER following a reasonable period since the start of the parallel run (i.e. selecting ~5 months after the parallel run go-live).

Core FB SDAC

The project could not generate economic surplus benefits as of the legal implementation deadline of 01/12/2020, as specified in the regional Core day-ahead capacity calculation methodology and established by ACER through amendment of a TSO proposal[28], until its successful go-live on 09/06/2022.

70% requirement (Core CCR)

The implementation deadline from which the project is considered to lead to unrealised economic surplus is 01/01/2020, as the entry into force of Regulation EU 2019/943. However, due to data limitations in NTC allocation, unrealised economic surplus is computed from 01/07/2022 (i.e. approximately as of the start of the Core FB in SDAC) onwards.

Derogations and action plans are not considered for the computation of unrealised economic surplus. The assessment thus considers what would have been the economic surplus impact if 70% could have been implemented as of 1 January 2020.

TSOs accession to MARI and PICASSO

The legal implementation date from which the MARI and PICASSO projects were expected to start generating economic surplus benefits is 24/07/2022, as specified in the implementation framework for the European platform for the exchange of balancing energy from frequency restoration reserves with manual activation and the implementation framework for the European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation and established by ACER following TSOs' proposals. However, due to data limitations, unrealised economic surplus is computed from 01/01/2024 onwards.

ROSC-RDCT (Central Europe CCR)

The project failed to generate economic surplus benefits since the implementation deadline for the Core ROSC-RDCT of 04/06/2025, as specified in the regional CORE methodology for

[28] As described in Article 25(4) of the TSOs proposal (i.e. "[…] *The external parallel run will be followed by an SDAC integration phase and go live preparations aiming for S1-2020 as the go-live window for the market.* […]"), TSOs were aiming the project to go-live in the first semester of 2020. In the ACER decision 02/2019 amending the TSOs proposal, in Annex I Article 28(3), ACER defined the 01/12/2020 as the deadline for the project go-live.

regional operational security coordination and established by ACER through amendment of a TSO proposal[29].

Long term flow-based (Core CCR)

The legal implementation deadline from which the project failed to generate economic surplus benefits is 01/12/2024, as specified in the regional CORE long-term capacity calculation methodology and the requirements for the Single Allocation Platform and established by ACER through amendment of TSO proposals[30].

[29] ACER amendment of the TSOs proposal only negligibly changed the final implementation deadline. In Article 40(6) of their proposal for a common methodology for regional operational security coordination, Core TSOs proposed the full implementation by 55 months after the approval of the methodology. In Article 37 of its Decision 33/2020 on Core ROSC Methodology: Annex I, ACER introduced an intermediate implementation step after 30 months, with the remaining requirements to be implemented after 54 months after the adoption of the decision.

[30] In Article 21(2) of their proposal for a common coordinated long-term capacity calculation methodology, Core TSOs proposed an implementation within 5 years of the approval of the methodology, i.e. around November 2026. In Article 22(3) of its Decision 14/2021 on the long-term capacity calculation methodology of the Core capacity calculation region: Annex I, ACER introduced a requirement the methodology in time for a flow-based yearly auction for 2025 and a flow-based monthly auction for January of 2025, i.e. by 30/11/2024.

2. Qualitative case study: computing economic surplus and the benefits of market integration

This chapter presents explanatory material, including visual illustrations of economic surplus and of the benefits arising from the integration of electricity markets. The purpose of this chapter is solely to provide general educational and informative content for readers interested in gaining a clearer, high-level understanding of these concepts.

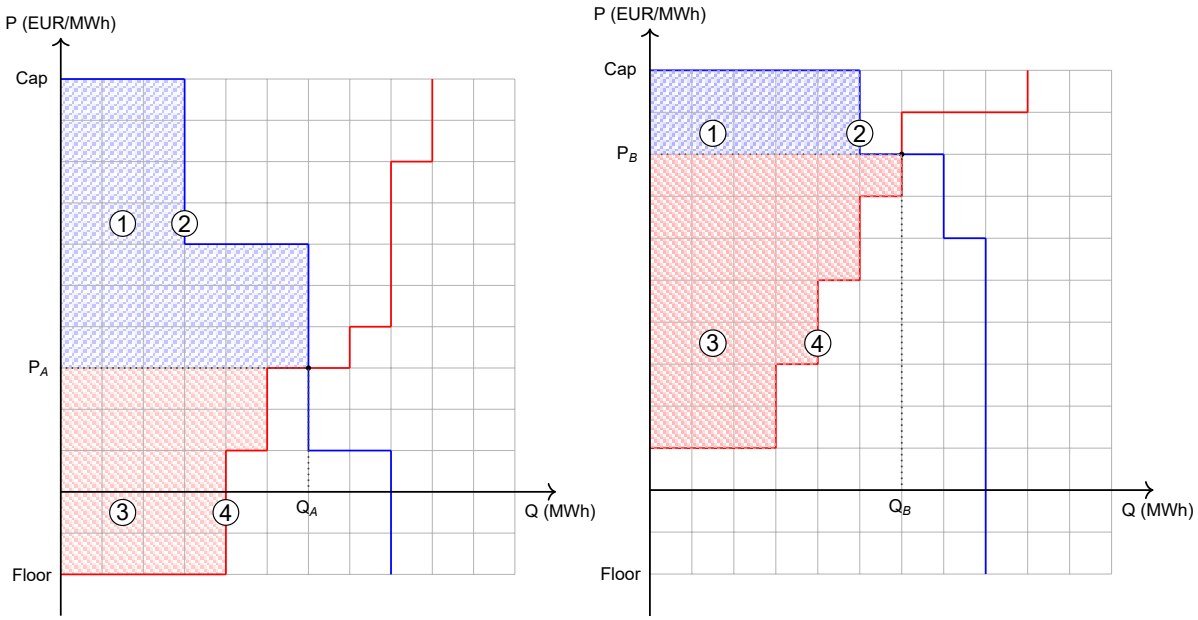
A qualitative explanatory example is presented, considering two bidding zones, A and B (hereinafter referred to as BZ_A and BZ_B, respectively), during a single Market Time Unit (MTU).

2.1. Scenario 1: Markets operating in isolation

If the bidding zones operate as isolated markets, in each bidding zone the market equilibrium is determined by the intersection of local supply and demand curves, as illustrated in Figure 6. The equilibrium electricity price in BZ_A is lower than that in BZ_B.

Definition: economic surplus is defined as the sum of consumer surplus (1) and producer surplus (2). In the following steps, congestion income will also be added to this equation (7).

***Figure 6**: Demand and supply curves for bidding zone A (left) and B (right).*
(1) consumer surplus; (2) demand curve; (3) producer surplus; (4) supply curve. P_A and Q_A stand for the price and quantity in BZ_A; P_B and Q_B stand for the price and quantity in BZ_B



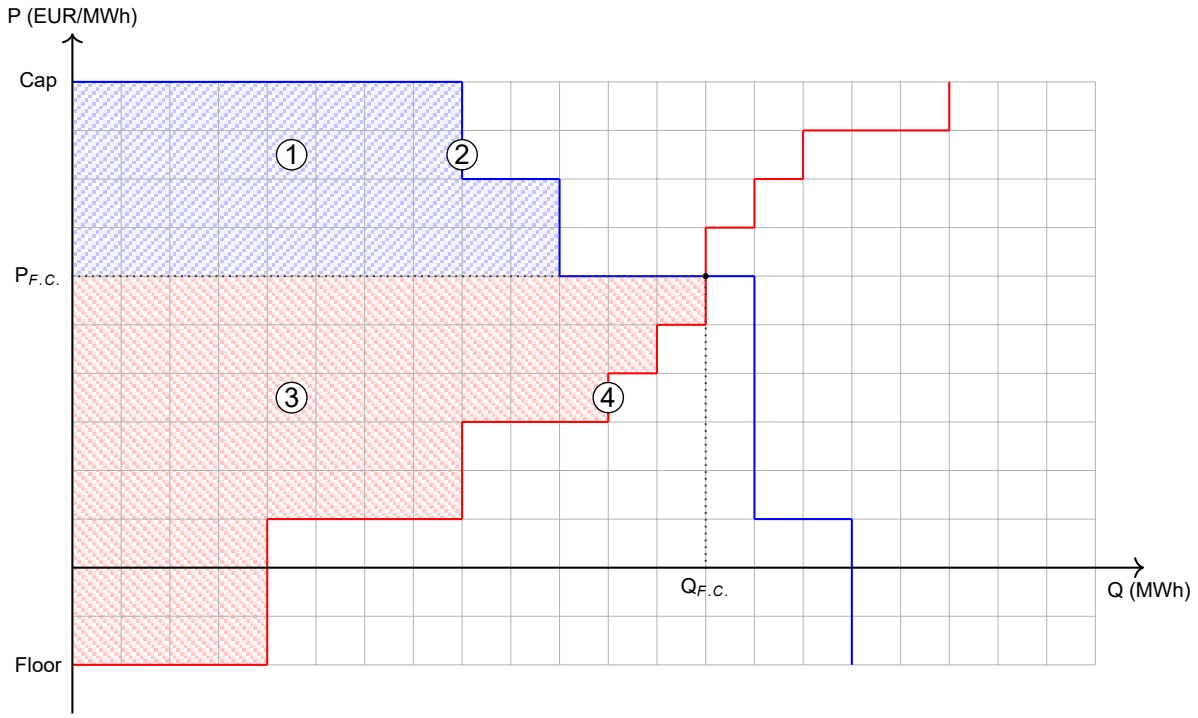
Source: ACER

2.2. Scenario 2: Market coupling with full price convergence

Let's now assume that these two bidding zones are interconnected and that there is sufficient cross-border capacity available to enable enough exchanges for the prices in the two bidding zones to converge to the same level. Under this assumption, it is possible to visualise the two markets as one, as displayed in Figure 7.

Market integration generates more economic surplus - Please note that integrated markets are more efficient than markets operating in isolation, i.e. the economic surplus of coupled markets (i.e. Figure 7) is greater than the sum of the economic surplus of the two isolated bidding zones (i.e. Figure 6).

Figure 7: Demand and supply curves for coupled bidding zones.
(1) consumer surplus; (2) demand curve; (3) producer surplus; (4) supply curve. $P_{F.C.}$ and $Q_{F.C.}$ stand for the price and quantity when there is full convergence.



Source: ACER

F.C. stands for "full price convergence"

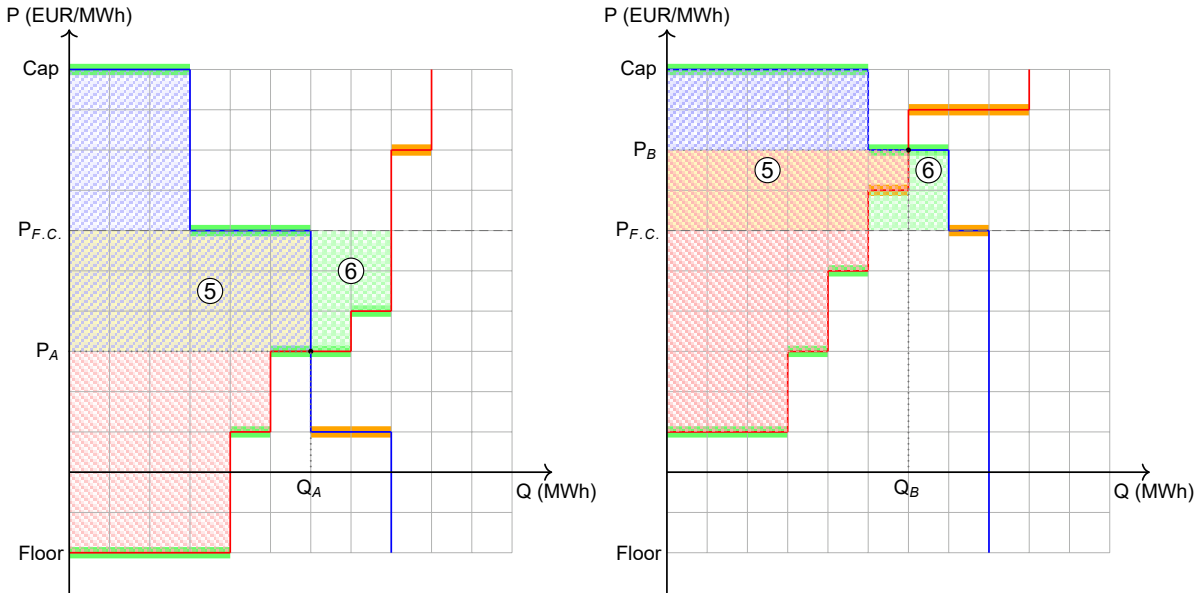
For each bidding zone, it is also possible to visualise the cross-border exchanges, the price convergence, the change in consumer and producer surplus, the additional economic surplus achieved thanks to coupling markets, and the change in the status of the accepted/rejected buy and sell orders (see Figure 8).

Definition: a sell order is a willingness to sell electricity (i.e. a sell order in the supply curve) and a buy order is the willingness to buy electricity (i.e. a buy order in the demand curve).

Market integration leads to more efficient electricity trading - It is worth noting that the integration of the two markets led to more efficient sell orders being accepted, i.e. in BZ_A

additional sell orders in the supply curves are now accepted (to the right of Q_A), while in BZ_B additional buy orders are now accepted in the demand curve (to the right of Q_B), but fewer sell orders are accepted in the supply curve (below P_B).

Figure 7: Demand and supply curves in coupled bidding zones with full convergence. Bidding zone A (left) and B (right).
(5) change in consumer/producer surplus; (6) additional economic surplus generated by coupling markets. Activated buy and sell orders are highlighted in green, while those rejected are highlighted in orange.



Source: ACER

Cross-border exchanges can also be displayed with net import and export curves, as shown in Figure 9. Net import and export curves are built with those buy and sell orders that are activated (and rejected) due to the coupling of the two bidding zones. In this example, the net export curve is built with asks from BZ_A (those highlighted in green to the right of Q_A), while the net import curve is built with rejected sell orders (highlighted in orange to the left of Q_B) and accepted buy orders (highlighted in green to the right of Q_B) from BZ_B.

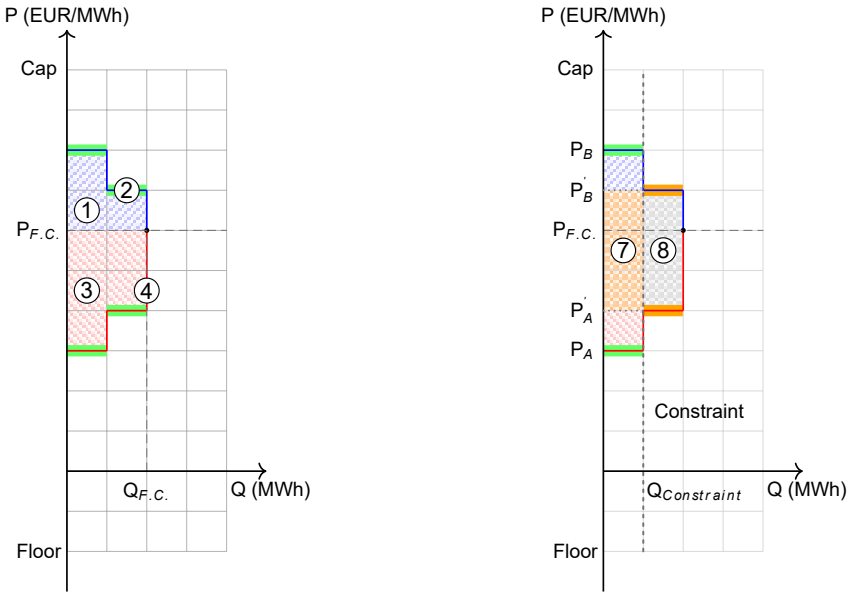
2.3. Scenario 3: Market coupling with partial price convergence

In the scenario in which a constraint prevents the full convergence (i.e. Figure 9, image on the right), there is an erosion of economic surplus compared to the scenario with full convergence (8). Moreover, in this case, the congestion income contributes to the economic surplus (7).

These changes can also be visualised by looking at the two bidding zones, as shown in Figure 10. Compared to the scenario in which the cross-border exchange leads to a full convergence, it now has a limited impact on the equilibria of the two bidding zones. In other words, if we look at the impact on prices, we can observe that $P_{F.C.} > P'_A > P_A$ and $P_{F.C.} < P'_B < P_B$.

Further market integration results in additional generated economic surplus – Market integration projects lead to more efficient market outcomes and unlock additional economic surplus.

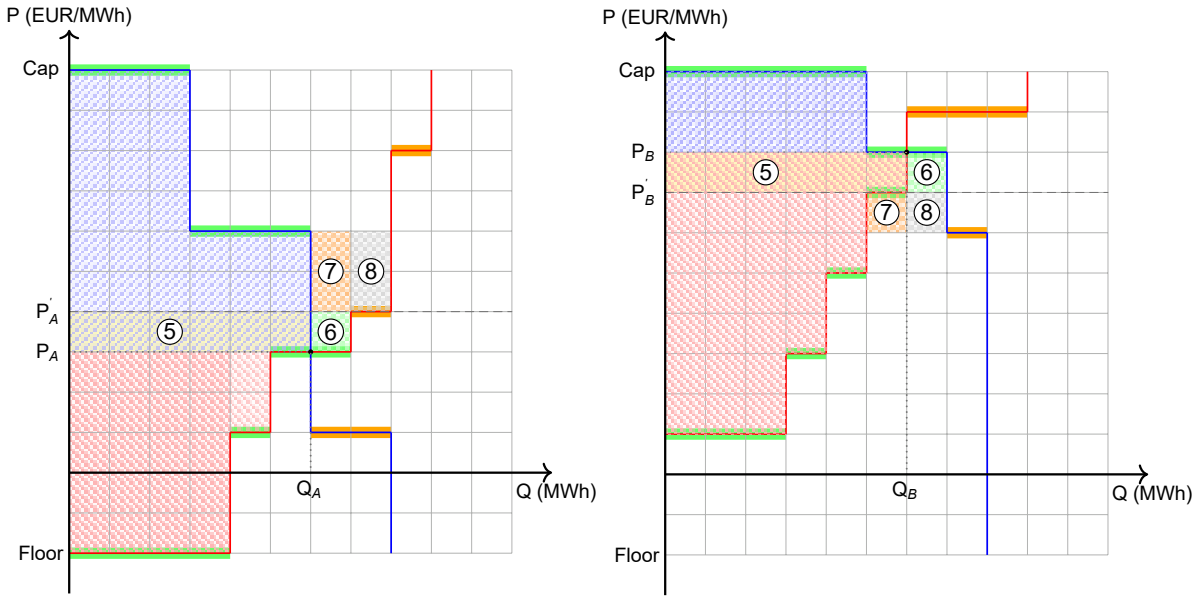
Figure 8: Cross-border exchanges, net import and export curves. Full convergence (left), partial convergence (right).
(1) consumer surplus; (2) net import curve; (3) producer surplus; (4) net export curve; (7) congestion income; (8) unrealised economic surplus due to congestion



Source: ACER

F.C. stands for "full price convergence"

Figure 9: Demand and supply curves in coupled bidding zones with partial convergence. Bidding zone A (left) and B (right).
(5) change in consumer/producer surplus; (6) additional economic surplus generated by coupling markets; (7) congestion income; (8) unrealised economic surplus due to congestion. Activated buy and sell orders are highlighted in green, while those rejected are highlighted in orange.



Source: ACER