



**Manage the
Present
and prepare for
the Future**

entsoe

Annual Report
2023 Edition

Foreword

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the association of the European TSOs. The 40 members, representing 36 European countries, are jointly responsible for planning, for building and for the secure and efficient operation of Europe's transmission electricity system, the largest interconnected electrical grid in the world.

Before ENTSO-E was established in 2009, there was a long history of cooperation among European transmission operators, dating back to the 1950s and the creation of the electrical synchronous areas and interconnections.

In its present form, ENTSO-E was founded to help fulfil the common mission of the European TSO community: to power our society. At its core, Europe's consumers rely upon an interconnected, secure and efficient electricity system. Our electricity transmission grids are the backbone of the power system, as demonstrated again in 2023 with the secure and efficient operation of the power system with no major issue. This secure and efficient operation solidly supports the vitality of our society.

ENTSO-E is working to prepare a power system fit for a carbon-neutral and energy independent Europe. The transition is a shared political objective across the continent and necessitates a much more electrified economy where sustainable, efficient and secure electricity becomes even more important. Our Vision: “a power system for a carbon-neutral Europe” shows that this is within our reach, but additional work is necessary to make it a reality.

With our new Strategic Roadmap, ENTSO-E has reorganised its activities around two interlinked pillars:

- › **“Prepare for the future”** to organise a power system for a carbon-neutral Europe; and
- › **“Manage the present”** to ensure a secure and efficient power system for Europe.

ENTSO-E is ready to meet the ambitions and challenges of today and of tomorrow for the benefit of European consumers, by working together with all stakeholders and policymakers.



Zbyněk Boldiš
President

Damian Cortinas
Chair of the Board





Introduction
ENTSO-E in 2023



This Annual Report covers the period from January 2023 to December 2023. It focuses on ENTSO-E's important role in facilitating the energy transition and the implementation of the legal mandates given to ENTSO-E and on the Pan-European All TSOs tasks, which are facilitated by ENTSO-E.

The activities covered in this report were performed thanks to 39 TSO that were members of ENTSO-E in 2023, who provide funding and expertise to the Association. The successful implementation of these activities also relies on the input provided by stakeholders through the public consultation processes and various stakeholders groups.

The definition of a new Strategic Roadmap to guide the future work ENTSO-E and its member TSOs was a key deliverable of 2023. The roadmap provides a clear framework to address the challenges and ambitions of the European Power system between 2023 and 2025. The strategy is based on two interconnected pillars: the preparation of a European power system fit for the decarbonised economy of the future and the provision of secure and efficient power system in Europe.

The priorities set in the strategic roadmap are aligned with ENTSO-E and TSOs legal mandates and propose a vision that will ensure that the organisation also contributes to the achievement of the net-zero energy targets set by the European Union.

The present annual report is based on the structure of the Strategic Roadmap and describes the achievements and state of the play in areas (“building blocks”) defined in the Roadmap. The Strategic Roadmap is built around two interconnected pillars, which reflect the shared twofold mission of TSOs in Europe: preparing a future Power System fit for a Carbon-Neutral Europe (Pillar 1), all the while managing a Secure and Efficient Power System for the whole of Europe (Pillar 2). The first chapters (1 to 5) therefore refer to the work delivered to address the challenges arising from the energy transition and cover the Pillar 1 activities led in 2023 by the ENTSO-E teams in the field of energy system flexibility, operation

of a secure and efficient power system, planning and development of the infrastructure, market design as well as innovation.

The second part of the annual report 2023 (chapters 6 to 9) looks into the work delivered as part of Pillar 2: operation of the system, the operation of the market, the regional cooperation and ICT.

As a key deliverable of 2023, the new Strategic Roadmap is also presented in detail (chapter 11). The greater responsibility that the energy transition conferred to ENTSO-E and the TSO community goes hand in hand with an increased and necessary engagement with stakeholders of the European energy landscape. Such engagement has culminated in 2023 with the EU Grid Forum organised on 7 September. The report therefore also proposes a review of the main activities led in policy, communication and stakeholder management (chapter 12).

Finally, chapter 13 provides an update on the governance of ENTSO-E, including the outcome of the elections that took place in June 2023 and changes in the membership of the organisation.

In various aspects, 2023 was a pivotal year for ENTSO-E. The present report is a snapshot of the work accomplished by the ENTSO-E teams to navigate the complexities and challenges of preparing for the power system of the future, while continuing to deliver a reliable and secure energy electricity system.

This Annual Report will be submitted for stakeholders' views in a public consultation from 12 June to 10 July 2024. The consultation results and responses will be considered, and the Annual Report will be subsequently submitted to the Agency for the Cooperation of Energy Regulators (ACER) for opinion.

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1

Managing Complexity:
Energy System Flexibility

A carbon-neutral energy system, based on renewable energy sources and with increased electrified consumption, will become highly weather dependent and complex. Flexibility sources, allowing for management of this complexity (e.g. flexible generation, active management of the demand for electricity, storage, etc.), should be promptly deployed.

The electricity grid will facilitate resource exchange, thus reducing flexibility needs. With this new paradigm, an accurate assessment of flexibility needs and potential at national and European levels is vital for a cost-effective and reliable power system.

As suggested by the [ENTSO-E Vision](#) and by the [ENTSO-E Strategic Roadmap 2023 – 2025](#), a comprehensive “system of systems” approach involving TSOs, Distribution System Operators (DSOs) and other sectors is necessary to coordinate the deployment and efficient use of flexibility resources.

This chapter describes ENTSO-E’s activities concerning the Transmission System Operator (TSO)–Distribution System Operator (DSO) partnership and demand-side flexibility. Such continuously growing partnership is requisite for meeting the requirements stemming from Regulations and relevant European Action Plans and consequently developing a power system fit for a carbon-neutral Europe.



Picture from left to right: ENTSO-E Vice-Chair of the Board, Tahir Kapetanovic, EU DSO Entity President, Vincenzo Ranieri, ENTSO-E President Zbynek Boldis, and ENTSO-E Chair of the Board, Damian Cortinas.

The TSO–DSO cooperation is essential in a comprehensive system of systems approach to coordinate the deployment and use of the most efficient flexibility resources. ”

Tahir Kapetanovic, Former convenor of the TSO–DSO Expert Group and Vice-Chair of ENTSO-E Board

1.1 Integration of distributed flexibilities

A key area for TSO–DSO cooperation is active system management and the coordinated use of distributed flexibility. Storage, distributed generation and customer participation through the demand-side response have the potential to provide new services for the grid and the energy system. These are known as distributed flexibilities, and their integration into the operation and market process will be key to the efficient management of the electrical system of the future.

In 2023, ENTSO-E started working in effective cooperation with the DSO Entity on a proposal for the Network Code on Demand Response (NC DR). This work had been mandated by the Regulation 2019/943 and fulfilled the draft guidelines proposed by ACER in August 2022. Pursuant to the mandate received, ENTSO-E and DSO Entity formed the TSO–DSO Development Team to draft the joint NC DR proposal and established

a drafting committee to consult key stakeholder associations at European level. To foster transparency, enable the public to present their views, and collect the views of stakeholders, ENTSO-E and the DSO Entity held a public consultation from 29 September to 10 November 2023 and organised two public workshops on 24 April and 13 October 2023.

1.2 Other areas of cooperation

ENTSO-E continued to cooperate with the DSO Entity on the 10-Year Network Development Plan (TYNDP) 2024 at expert group level. The support and input received from the DSO Entity experts was important in delivering a more comprehensive plan. With the entry into force of the Implementing Regulation (EU) 2023/1162 the cooperation on data interoperability topics intensified. A Joint Working Group on Data Interoperability and Access was established in 2023 as a new legal mandate for both ENTSO-E and the DSO Entity and several

workshops were held to develop guidance to assist EU Member States in the reporting of national practices. Following the signature of the Declaration of Intent to jointly develop the framework for a Digital Twin of the EU electricity grid as suggested in the Digitalising the Energy System Action Plan proposed by the EU Commission in October 2022, ENTSO-E and EU DSO Entity set up a Joint Task Force and project proposal in 2023 that will guide the work for the next two years.

We can conclude that 2023 has been the year of grid momentum. The entire system for transmission and distribution is now at the top of policy agenda's, also illustrating the relevance of DSO-grids to facilitate the decentralised nature of the future energy system. Both ENTSO-E and DSO Entity can build on the efficient and energetic cooperation in 2023 in order to use this momentum to further advance energy transition.

*Peter Vermaat,
EU DSO Entity Secretary General*



In 2023, ENTSO-E and DSO Entity collaborated on the common work programme. The interaction between the transmission and the distribution grid systems will be key to support the energy transition. The EU Grid Action Plan emphasised the importance of this collaborative effort through important deliverables set for ENTSO-E and DSO entity.

*Sonya Twohig,
ENTSO-E Secretary-General*



With the constant increase of renewable generation, storage and active customers largely connected to the distribution grid, DSOs and TSOs must strengthen their coordination and exchange the necessary information for operating their networks securely while ensuring that distributed flexibilities are used when and where they provide the most value to the whole electricity system.



2

Operating the Grids of the Future:
Beyond current practices

In overseeing the grids of the future, TSOs must address evolving challenges in grid operations, stability management and modelling and simulation tools. As Europe transitions towards a more sustainable energy system, TSOs face the task of ensuring the secure operations and the stability of the power system amid a changing energy landscape. This involves grappling with both traditional stability phenomena, such as rotor angle and frequency stability, in addition to emerging issues such as converter-driven instability and resonance stability.

Conducting a gap analysis is essential for TSOs to identify the requirements for effectively addressing some of the stability phenomena, such as resonance and converter-driven stability, in system modelling, asset modelling and simulation tools aimed at assessing grid behaviour. This involves evaluating the capabilities of tools to simulate power system dynamic responses in scenarios with significant renewable energy sources (RES) integration. In addition, it entails ensuring the adequate provision of data to monitor and detect both known and unforeseen stability issues. Furthermore, there is a need to establish robust data model exchange mechanisms encompassing

security and hosting solutions to facilitate the seamless sharing of critical information. Lastly, understanding how various parameters influence stability phenomena is crucial for TSOs to develop accurate models and simulations. By addressing these gaps, TSOs can better equip themselves to manage the complexities of future power grids.

To tackle these complexities, TSOs are also using probabilistic methods to gain deeper insights into system behaviour. By investing in advanced tools and methodologies, TSOs aim to safeguard the reliability and resilience of Europe's power grids in the face of rapid energy transitions.

2.1 Probabilistic risk assessment methodology

The current practices for operating the grid are deterministic and rely on the N-1 approach for maintaining grid security. The N-1 criterion refers to the N-state minus 1 contingency, whose impact needs to be kept in the accepted range by means

of remedial actions. A probabilistic approach estimates the risk of a contingency by considering both the impact and the probability of that contingency.

KEY DATES & DOCUMENTS

13 Feb 2023

Publication of the 2023 Biennial PRA report

Developing a pan-European probabilistic risk assessment (PRA) methodology would assist the TSOs in their decision-making process. This may provide the ability to better anticipate the behaviour of the grid, whereby uncertainties (threats of weather, variations in generation, etc.) can be proactively managed. It may also allow TSOs to identify optimal maintenance and outage timing in addition to choosing the optimal remedial action. This may increase socioeconomic benefits and optimise operational expenditures.

The development of such a methodology is complex and would challenge the TSOs to change their current internal, regional and pan-European processes; requiring a move from a well-proven and comprehensible deterministic N-1 approach to a more complex probabilistic one.

The ongoing work on PRA presents the first step toward a probabilistic methodology. It aims to ensure the development of a methodology consistent with the legal mandate and that strikes a balance between complexity, practicality, network security and socioeconomic benefits.

Legal background

The overarching framework that governs the move towards PRA for security assessment is set out in the System Operation Guideline (SOGL). SO Regulation Article 33 (2) requires TSOs to include in their contingency list an exceptional contingency when operational or weather conditions significantly increase its probability of occurrence. SO Regulation Article 75 (1) mandates the creation of the Methodology for Coordinating Operational Security Analysis (CSAM).

As prescribed by the SO Regulation (Article 75(1) (b)), the CSAM includes the 'Towards probabilistic risk assessment' (art.44) Also in line with the Regulation, ENTSO-E has been publishing in 2023 the second biennial progress report on the PRA methodology pursuant to the CSAM. The report presents the main achievements made in upgrading the infrastructure for the PRA data collection platform; and in setting the basis for the development of the PRA methodology which is due to be developed by 2027.

2.2 Frequency stability analysis in long-term scenarios, relevant solutions and mitigation measures – Project Inertia Phase II – Solutions for a future-ready decarbonised system

Building on the conclusions of the 2021 report [Frequency Stability in Long term scenarios](#), ENTSO-E is now working on a follow-up project named “Project Inertia phase II”. The activity provides a more in-depth analysis of the impact of system splits on the future “low inertia” configuration of the Continental Europe (CE) Synchronous Area (SA). The Project has updated and improved the existing methodology from 2021, assessing system split cases based on pan-European market studies for long-term future scenarios (TYNDP 2022 scenarios).

The realisation of a decarbonised energy system will require the transmission infrastructure to adapt to new generation mixes and demand profiles. Together with this effort, the mission of the TSOs to operate a secure and resilient transmission system remains the same. Project Inertia, while supporting a global discussion on the resilience level of the future decarbonised system, is studying today the necessary foundations for delivering a secure decarbonised system of tomorrow.

*Joao Moreira, Convenor of the
ENTSO-E Project Inertia*

In 2023, concluding its first milestone, the project reviewed a significant number of combinations of cases of system split in the CE synchronous area, separating the interconnected system into two parts, and confirmed the trends identified in the previous report “Frequency stability in long-term scenarios and relevant requirements”. Splits, where at least one island exceeds the Rate of Change of Frequency (RoCoF) limit of 1 Hz/s and splits where both islands exceed this threshold, are identified in large numbers and with a visible increase from 2030 to 2040. This demonstrates the progressive decline in the system resilience against system splits if no action is taken. Together with the above assessment, Project Inertia identified the range and structure of the necessary solution measures.

The accepted level of grid resilience and accepted risk of blackout must involve all the stakeholders and the relevant institutions as it is not for the TSOs only to define these aspects. In 2024, the project aims to propose decision-making information and a quantified roadmap to the solution measures as part of a step-by-step, non-regret approach to deliver secure and efficient operation for a future-ready decarbonised system.





3

Grid Infrastructures

ENTSO-E is delivering a pan-European Outlook of the power system in the short-, mid-, and long-term. This Outlook allows the TSO community to coordinate actions at the pan-European level. ENTSO-E's studies also provides technically-sound information to policymakers and stakeholders to support them in their decision making.

In addition, ENTSO-E also monitors the implementation of Connection Network Codes, which aim to ensure the integration of decentralised RES and demand response while maintaining security of supply and facilitating the internal electricity market by creating a level playing field for grid users in different Member States.

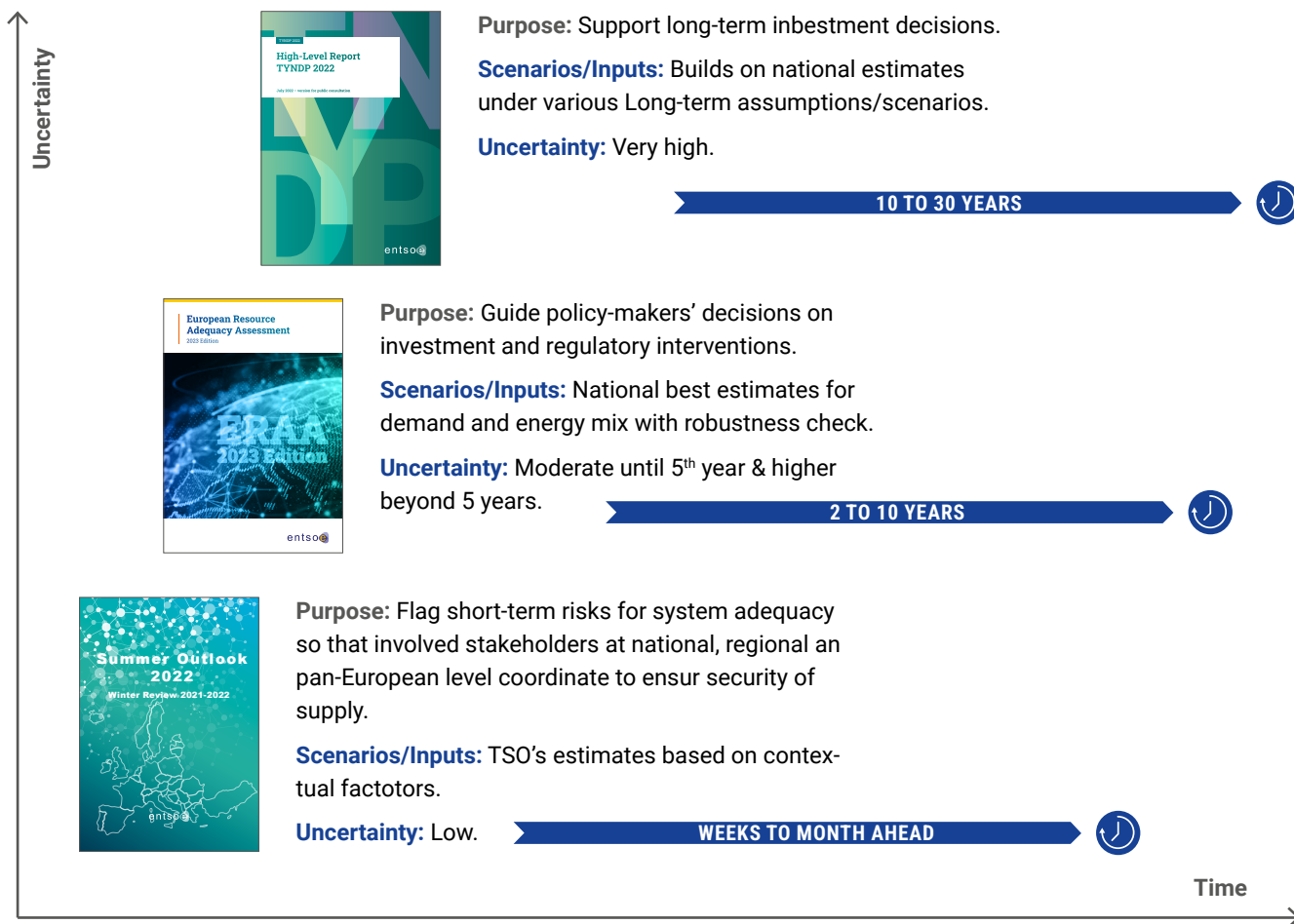


Figure 1 – Overview of the ENTSO-E grid infrastructure publications

3.1 Ensuring resource adequacy in the short- to mid-term: European Resource Adequacy Assessment (ERAA) and the Seasonal Outlook reports

Resource adequacy can be defined as the continuous balance between supply and demand levels, including storage and the demand-side response. Assessing the ability of a power system to cover demand in all conditions is part of the TSOs' tasks, and, consequently, one of ENTSO-E's most important mandates.

Due to the increasing level of variable RES, new demand patterns and ever-stronger integration of energy markets across the European power system and the associated challenges for system development and operation, a pan-European

analysis of resource adequacy has become increasingly important.

Cooperation across Europe is necessary to accelerate the development of common methodological standards; in other words, a common "language" is required to perform these studies. Resource adequacy requires advanced methodologies to capture and analyse rare events with adverse consequences for the supply of electric power. Europe's efforts provide leading examples worldwide of how to undertake advanced assessments at a large geographic perimeter.

KEY DATES & DOCUMENTS

31 May 2023

Publication

[Publication of the Summer Outlook 2023 & Winter Review 2022-2023](#)

16 Nov 2023

[Publication of the Winter Outlook 2023-2024 and Summer Review 2023](#)

3.1.1 The Seasonal Outlook

ENTSO-E's Seasonal Outlook (Article 30 (1) f, Regulation 943/2019) investigates, at the pan-European level, the security of electricity supply ahead of each winter and summer period. They are released twice a year, with a Summer Outlook in June and a Winter Outlook in December. The role of the Outlook is to identify when and where system adequacy – the balance between supply and demand for electricity – is at risk. The Outlook is not a forecast of the future. Rather, the Outlook identifies potential vulnerabilities for the upcoming season which can be addressed proactively with preparation or mitigation measures.

Each outlook is accompanied by a review of what occurred during the previous season.

The ENTSO-E Outlook is a product of cooperation between 40 European electricity TSOs. Because of their pan-European scope, the Outlook complements the analysis carried out in national and regional assessments, which provide a more detailed picture of adequacy at the local level. They promote cooperation across Europe and between regional and national stakeholders.

Performing the Seasonal Outlook (Seasonal Adequacy Assessments) is one of ENTSO-E's legal mandates as specified in the Clean Energy Package (CEP) and as defined in Article 9 of the Risk Preparedness Regulation (Regulation (EU) 2019/941). ENTSO-E performs this assessment to inform national authorities, TSOs and relevant stakeholders of the potential risks related to the security of electricity supply in the coming season. The Seasonal Outlook reflects the implementation of the methodology as developed by ENTSO-E as per Article 8 of the Risk Preparedness Regulation and as approved by ACER on 6 March 2020.

ENTSO-E's Summer Outlook 2023 confirmed that generation capacity in Europe to supply consumers was sufficient to meet the energy needs during the summer months, although some countries would have to rely on imports. The Winter Outlook 2023–2024 highlighted an improved adequacy Outlook compared with winter 2022–2023, with limited electricity supply risks in remote areas driven by weather conditions.

3.1.2 The European Resources Adequacy Assessment (ERAA)

The Clean Energy Package (CEP) places resource adequacy in a central position in the European energy policy context. ENTSO-E's yearly ERAA investigates whether the electricity system has sufficient resources to meet demand – also referred to as power system resource adequacy – in the coming decade, which sets us on a net-zero pathway. The report is built upon models and analyses of possible events that could adversely impact the balance between the supply and demand of electric power.

The ERAA 2023 shows that in the given scenario and methodology framework, high volumes of fossil-fuelled capacity are at risk of becoming economically non-viable in the next five years. In that context, the right incentives and/or targeted intervention will be necessary to avoid adequacy risks. Adequacy issues in one country are highly dependent on assumptions in neighbouring countries – and, reciprocally, any capacity investment in one country can greatly influence its neighbours. This highlights the importance of regional coordination in decision making.

Growing variability in supply requires the implementation of new flexibility tools that facilitate the management of demand (ramps and peaks). It further necessitates capacity that can quickly respond to a sudden variation of demand and supply, for example to meet demand spikes in the evening with decreasing photovoltaic supply.

In the short- and mid-term (2025 and 2028), the economic viability assessment points to significant capacities at risk of being decommissioned. This decommissioned capacity notably decreases the available margins and leads to adequacy risks in some countries. It most importantly highlights the criticality of maintaining the pace of integrating new renewable energy sources capacities as depicted in the input data to the scenarios studied. In the mid-term, adequacy risks appear in central and north Europe, in addition to island states. In the longer term (2033), significant adequacy risks are observed in many European countries.

KEY DATES & DOCUMENTS

**14 Mar 2023 –
05 Apr 2023**

[Call for evidence
on ERAA 2023
preliminary input
data](#) **16 Nov 2023**

18 Dec 2023

Publication of
[ERAA 2023](#), for
public consul-
tation until 31
January 2024

3.2 Building Europe's Future Power System: the 10-Year Network Development Plan (TYNDP)

The TYNDP is ENTSO-E's network planning tool and the European electricity infrastructure development plan. Mandated by Regulation (EU) 2022/869, it provides a pan-European vision of the future power system and investigates how power links and storage can be used to make the energy transition happen in a cost-effective and secure manner.

The TYNDP is published by ENTSO-E every two years and contributes to the process of European Projects of Common Interest (PCIs) and Projects of Mutual Interest (PMIs), run by the European Commission (EC). The TYNDP is the outcome of a three-year long process with three major steps, starting with the development of scenarios

outlining how the European energy system might evolve towards 2050. The main role of the TYNDP is to identify where investments in various technical solutions in the electricity system would help to release the expected system constraints, and by doing so provide a fit-for-purpose infrastructure across diverse scenarios. This is accomplished in two stages: first, by performing a system needs analysis that identifies a high-level overview of constraint relief options to allow the decarbonisation of the EU power system at the lowest cost, followed by a call for transmission and storage projects (under different stages of development) across Europe, complemented by a cost-benefit analysis (CBA) of their impacts under different scenarios.

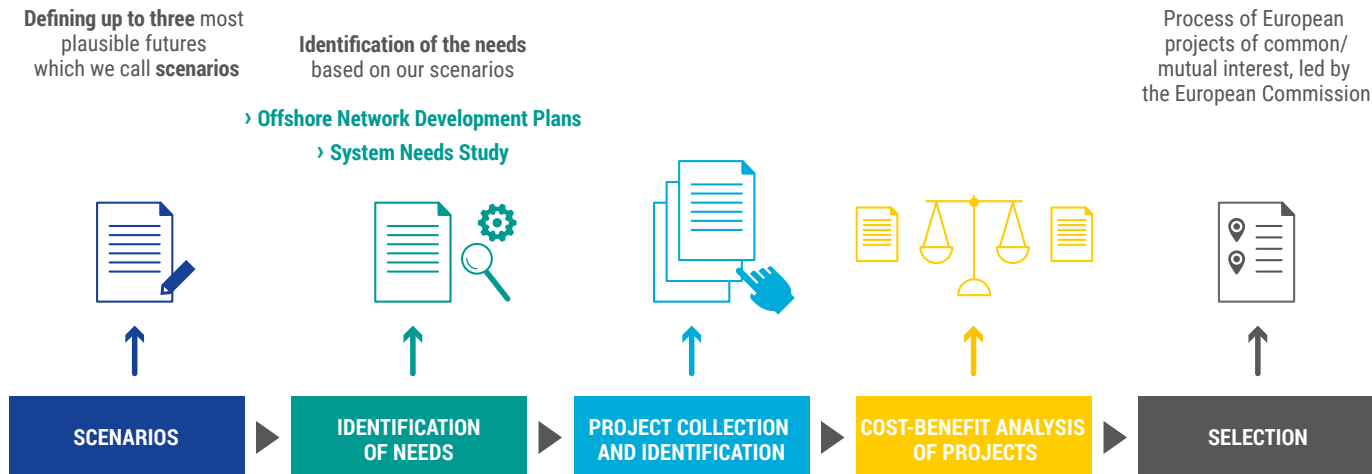


Figure 2 – The TYNDP process. It feeds into the European Projects of Common Interest, led by the EC.

Each step/component of the TYNDP aims to answer a different question, which informs the methodology employed.

	TYNDP Scenarios	TYNDP Offshore Network Development Plans	TYNDP System needs study	TYNDP CBA of infrastructure projects
Question answered	What would the European Energy System look like in the storylines National Trends, Distributed Energy and Global Ambition in 2040/2050?	What does it take to integrate 360 GW to 496 GW of offshore RES in 2040 and 2050?	Where could the (onshore and offshore) power system be more economically efficient?	How does this project impact the pan-European energy system?
Method	<p>The investment model can invest in generation, infrastructure, DSR, flexibility measures etc. All-in-one optimisation, not including offshore hybrid.</p> <p>The Scenarios are developed together with ENTSOG.</p>	<p>The investment model is only allowed to invest in offshore infrastructure, starting from candidate links without a specified transmission capacity. All other parameters remain locked in this first edition. Implications for the onshore systems will be part of the TYNDP System needs study.</p>	<p>The optimiser can invest in transmission, storage, peaking capacity and offshore hybrid, based on a list of candidate investments having a fixed capacity value. The outcome will be a fully integrated onshore-offshore needs assessment. Without the project.</p>	<p>We assess a series of indicators including RES integration, CO₂ and other emissions, electricity losses, security of electricity supply ... with and without the project.</p>

In May 2023, ENTSO-E consulted stakeholders on the planned scope of studies and stakeholder engagement plan of TYNDP 2024. Stakeholders welcomed the consultation and especially the early publication of an engagement plan.

Considering stakeholder feedback, ENTSO-E implemented several changes to the TYNDP 2024 engagement plan, including the postponing of reviewing plans for public consultations.

KEY DATES & DOCUMENTS

08 May 2023 – 08 Jun 2023

Public consultation on TYNDP 2024 scope of studies and stakeholder engagement plan ([consultation document](#))

3.2.1 Step 1. Imagine and model future electricity and gas systems scenarios

KEY DATES & DOCUMENTS

05 May 2023 –
05 Jun 2023

Call for interest for the scenarios stakeholder group ([Link to all SRG documents](#))

04 Jul 2023 –
08 Aug 2023

[Public consultation](#) on TYN-DP2024 Scenarios input data and methodologies

Jan 2024

[Summary report](#) of the public consultation

Scenarios are the first key step and a crucial outcome of the TYNDP process. As outlined in Regulation 2022/869, the European Network of Transmission System Operators for Gas (ENTSO-G) and ENTSO-E are required to use joint scenarios as the basis for their respective TYNDPs and for the calculation of the CBA used to determine EU funding for electricity and gas infrastructure PCIs and PMIs. The scenarios are designed specifically for this purpose. Where possible, they are derived from official EU and Member State data sources and are intended to provide a quantitative basis for infrastructure investment planning.

Due to the importance of the TYNDP scenarios for European infrastructure planning, the scenarios benefit from thorough and inclusive stakeholder engagement. Article 12 (3) of Regulation 2022/869 specifies that ENTSO-E and ENTSOG shall invite the organisations representing all relevant stakeholders [...] to participate in the scenarios development process, in particular on key elements such as assumptions and how they are reflected in the scenarios data. ACER's Framework Guidelines on the joint TYNDP scenarios released in January 2023 add that ENTSO-E and ENTSOG should

create a stakeholder reference group.

ENTSO-E and ENTSOG initiated the process to create a stakeholder reference group with a first call for interest issued in May 2023, and a second shorter call in June 2023 because there were insufficient numbers of applicants in some stakeholder categories. After assessing the relevance of applications received with the requirements specified in ACER's Framework guidelines and in the proposed Terms of Reference, ENTSOG and ENTSO-E released a draft list of 22 members in August 2023 and organised the first call of the group. The Scenarios Stakeholder Reference Group was set up and has operated independently from ENTSO-E and ENTSOG since the end of 2023.

In parallel, ENTSO-E and ENTSOG consulted stakeholders on the input data and methodologies of scenarios of the TYNDP 2024. Over 30 stakeholders provided feedback in a public consultation and stakeholder roundtables were organised in the summer of 2023. A summary of the consultation feedback received and how it was considered was released in January 2024.



3.2.2 Step 2. Assessing future system needs

“System needs” are opportunities to make Europe’s power system more efficient. Since 2012, the TYNDP has included a study of system needs in different time horizons, in one or several scenarios, with a focus on cross-border needs.

Starting with TYNDP 2024, the TEN-E Regulation (2022/869 EU) tasks ENTSO-E with an additional assessment of system needs, focused on offshore needs, cross-border and internal. That is why the focus on 2023 was largely on developing the very first edition of the Offshore Network Development Plans.

Offshore Network Development Plans (ONDP) 2024

The ONDP is a new component of the TYNDP, focused on needs for offshore transmission infrastructure. It translates the EU Member States’ non-binding agreements on offshore goals from January 2023 into offshore transmission corridors, transmission equipment needs and related costs. ONDP is mandated by the TEN-E Regulation (2022/869 EU Reg Art 14.2).

KEY DATES & DOCUMENTS

06 Sep 2022

ENTSO-E releases Guidance to EU Member States

23 Jan 2023

Deadline for EU Member States to provide non-binding agreements on offshore RES

23 Jan 2024

Publication of the ONDP 2024

TYNDP Scenarios are essential for planning European grids for the coming decades. Opening up the TYNDP process for external experts that compose the Stakeholder Reference Group (SRG) can not only increase the legitimacy of the Scenarios’ results but also improve their quality and robustness. We are very proud that within just a few months from the establishment of the SRG in 2023, we delivered our first proposals and ideas on the evolution of the TYNDP Scenario process.

*Andrzej Ceglarz and Eva Hennig,
Co-Convenors of the ENTSO-E Stakeholder
Reference Group*



” One of the main achievements of ENTSO-E in 2023 to plan the future was without a doubt the release of the first ONDPs. Realising the connection of all offshore wind generation to the grid represents a real challenge for TSOs, as well as for generators, manufacturers, national governments and all stakeholders involved. The ONDP emphasises the need for the close coordination and involvement of all European stakeholders. Only by acting together will we be able to meet this tremendous challenge. ”



*Gerald Kaendler, Chair of the ENTSO-E
System Development Committee*

The European Union has set ambitious goals for the development of a decarbonised energy system and offshore RES are a key step on the path for carbon neutrality. In line with the EC's Offshore RES Strategy from 19 November 2020 and Regulation (EU) 2022/869, EU Member States agreed to increase their efforts to integrate up to 354 GW of offshore RES generation capacities by 2050 in European energy systems. Moreover, the ONDP integrates the national targets of Norway and the United Kingdom to appropriately assess infrastructure needs. In total, 496 GW of generation capacity will be deployed in European waters and connected through the offshore transmission infrastructure by 2050. The considerable energy potential of European waters requires a strong transmission system to harness this potential.

ENTSO-E released the very first edition of the ONDP on 23 January 2024. The ONDP finds that a total investment of upward of 400 billion Euros will be needed for offshore transmission assets. Offshore transmission infrastructure necessary to connect offshore RES might cover up to 54,000 km of routes in European waters, equal to almost 1.5 times the length of the equator. Direct connection of offshore generation to shore (radial connections) will continue to be the most common connection solution throughout Europe reflecting 86 % of all connections. Hybrid infrastructure – which connects offshore generation while also interconnecting energy markets – will play an important role in efficiently integrating the energy produced, especially in the Northern Seas and Baltic Sea.

ONDP only considers the connection of RES to the shore. It does not investigate the investments needed onshore to connect to electricity demand centres nor reinforcements of the onshore transmission networks that will be needed to support the additional electricity flows throughout Europe. As an immediate next step, ENTSO-E will assess the impact on the onshore transmission network in the TYNDP System Needs study, to be released at the end of 2024.

System Needs Study/Identification of Gaps

The TYNDP System Needs Study investigates needs for transmission capacity increase across borders, examining where the opportunities exist to make Europe's power system more efficient. It is an optimisation exercise that shows where new solutions are needed to reach European decarbonisation targets and keep security of electricity supply and costs under control.

The System Needs Study is an evolving tool to manage increasing uncertainty in the context of the energy transition and the EU Green Deal ambitions. Its methodology and scope improve with each new edition. In 2023, ENTSO-E started working on improvements to the System Needs Methodology for the TYNDP 2024. To that end, stakeholders were consulted via a webinar and invited to send comments in November 2023. The TYNDP 2024 System Needs Study will be released in the 4th quarter of 2024.

KEY DATES & DOCUMENTS

06 Nov 2022

[Webinar on the TYNDP 2024 System Needs Methodology \(slides\)](#)

3.2.3 Step 3. The Cost–Benefit Analysis

KEY DATES & DOCUMENTS

**16 Dec 2022 –
15 Feb 2023**

Public consultation on [draft CBA 4](#) | [Comments received & assessment](#)

24 Apr 2023

Submission of [draft CBA 4 \(v4.1\)](#) to ACER, the EC and EU Member States

18 Jul 2023

ACER Opinion on the draft CBA 4

18 Oct 2023

Submission of [draft CBA 4 \(v4.2\)](#) to the EC.

26 Mar 2024

The EC approves the CBA 4

9 Apr 2024:

ENTSO-E publishes the final CBA 4

The assessment of system needs and the cost-benefit analysis (CBA) of projects are two distinct steps in the TYNDP process that complete each other to help policymakers identify the most relevant projects at a given time. While the System Needs Study considers the European electrical system in its entirety, from a global perspective, the CBA of projects evaluates each infrastructure project individually by assessing its specific impact on the overall system. The CBA assesses factors such as the potential for reducing emissions, stability, flexibility, capital and operating costs, mitigation of loss of power over long-distance transmission and integration of renewable energy into existing systems, for example by connecting offshore power to a grid.

The cost–benefit analysis methodology

The assessment of transmission infrastructure projects performed in the TYNDP uses a CBA methodology drafted by ENTSO-E in consultation with stakeholders. The methodology is proposed to ACER and the EC for an opinion, further recommendations and a final decision. The main objective of the CBA methodology is to provide a common basis for project assessment with regard to their value for European society in line with Europe’s energy goals.

Throughout 2022 and 2023, ENTSO-E developed the 4th version of the CBA methodology, as requested by Regulation (EC) 2022/869. The main improvements compared to CBA 3.0 include the addition of an explanation on how the Energy Efficiency First principle is considered in the assessment process, the inclusion of additional sensitivities, the insertion of a methodology for “Contribution to Union Energy Targets”, elaboration on generalised multi-sectorial modelling, and the insertion of a section on climate adaptation measures, among others.

The draft CBA 4.0 was submitted to a formal public consultation from December 2022 to February 2023. ENTSO-E welcomed the engagement with stakeholders and in particular the recommendations provided by the European Scientific Advisory Board on Climate Change. These engagements have enriched the CBA Guidelines and overall confirmed that the adaptations made by ENTSO-E in CBA 4.0 are in line with stakeholder expectations.

The draft CBA 4.1 was then submitted to ACER, the EC and EU Member States on the legal deadline of 24 April 2023. Following the reception of the ACER Opinion in July 2023, ENTSO-E submitted the revised draft CBA 4.2 to the EC on 18 October 2023. The CBA 4.2 was approved by the European Commission on 26 March 2024.

Implementation Guidelines for the TYNDP 2024

In 2023, ENTSO-E consulted stakeholders on the draft Implementation Guidelines for the TYNDP 2024. Implementation Guidelines detail the implementation of the CBA methodology for a specific TYNDP cycle. Enhancements made to the Implementation Guidelines compared to the 2022 edition stem from the transition from CBA 3 to CBA 4 and from comments made by stakeholders in previous consultations. They include, for example, the inclusion of a new security of supply loop for the calibration of the scenarios and the generalisation of the social economic welfare (SEW) indicator through the formulation of a global SEW. Four stakeholders provided feedback. ENTSO-E has reviewed the draft Guidelines and will release an updated version in March 2024.

TYNDP 2024 portfolio of infrastructure projects

In June 2023, ENTSO-E released the draft Guidance for promoters who wish to submit a project in the TYNDP 2024. The Guidance specifies the procedure and the timeline for projects promoters to apply to the TYNDP 2024, the technical and administrative criteria their projects will be required to meet, the documents and information project promoters will be required to submit to fulfil these criteria, and the use and circulation of the information submitted.

After consideration of stakeholders' comments, ENTSO-E released the final version of the Guidance in September 2023 and opened a call for transmission and storage projects. After verification of the compliance of the applications received with the Guidance, ENTSO-E accepted 176 transmission projects and 33 storage projects in the project portfolio of TYNDP 2024, while five projects were found not compliant with the administrative pass-fail criteria.

KEY DATES & DOCUMENTS

**11 Sep 2023 –
16 Oct 2023**

Public consultation on the [draft TYNDP 2024 Implementation](#)

15 Mar 2024

ENTSO-E publishes updated TYNDP 2024 Implementation Guidelines after consultation

KEY DATES & DOCUMENTS

**26 Jun 2023 –
07 Aug 2023**

Public consultation on the [draft Guidance for promoters](#)

08 Sep 2024

Publication of final [Guidance for promoters](#)

**15 Sep 2024 –
16 Oct 2024**

Call for projects



Figure 3 – TYNDP 2024 projects portfolio (in green) and the offshore corridors identified by the ONDP 2024 (in blue)

3.3 Towards more integrated modelling with the Interlinked Model

The rationale for developing an interlinked model is to ensure that the mutual influence of gas, hydrogen and electricity sectors are considered during the evaluation of infrastructure projects in the CBA of ENTSO-E and ENTSOG's respective TYNDPs. Article 11 (10) of Regulation 2022/869 states that ENTSO-E and ENTSOG must jointly submit to the Commission and ACER a consistent and progressively integrated model that will provide consistency between single sector methodologies based on common assumptions including electricity, gas and hydrogen transmission infrastructure in addition to storage facilities, liquefied gas and electrolysers.

Since 2016, ENTSO-E and ENTSOG have been working on the development of a consistent process for the inclusion of a dual infrastructure assessment in TYNDPs in addition to a methodology for its application. After the release of a first version of an interlinked model in 2016, further studies took place and a first progress report was released in 2021. Following the revised TEN-E Regulation, in 2023 ENTSO-E and ENTSOG explored methodologies for the next steps of the development of an 'Integrated Model' that provides consistency between single sector methodologies based on common assumptions including electricity, gas and hydrogen transmission infrastructure.

3.4 Connection Network Codes: The evolution of the regulatory framework

The objectives of the three Connection Network Codes (CNCs) – NC Demand Connection (DC), NC Requirements for Generators (RfG) and NC HVDC – are to ensure the integration of decentralised RES and the increased demand response into the power system while simultaneously maintaining the security of supply and resilience at all times, and to facilitate the internal electricity market by levelling the playing field of grid users in different Member States.

The DC Code sets harmonised requirements for connecting large renewable energy production plants and demand response facilities, while the HVDC code specifies requirements for long distance direct current (DC) connections and the RfG Code harmonises standards that generators must respect to connect to the grid.

3.4.1 Amendment Process of Connection Codes

In 2022, ACER and the European Commission (EC) initiated the process to amend NC RfG and NC DC. Based on Article 60 of the Electricity Regulation, proposals for amendments may be submitted by ENTSO-E, the EU DSO entity, National Regulatory Authorities (NRAs), system users and consumers. In recent years, ENTSO-E has analysed present and future system needs and taken TSOs' and experts groups' feedback into consideration regarding the recommended improvements in the current CNCs.

In 2023, ENTSO-E intensified the exchange with ACER, NRAs, the EC, EU DSO Entity, and other stakeholders through regular meetings and workshops. Consequently, in September 2023, ENTSO-E submitted the proposals to ACER considering the detailed high priority proposals for amending NC RfG and NC DC. After evaluating the proposals of stakeholders, ACER published its final recommendation to the EC on 19 December 2023.

KEY DATES & DOCUMENTS

Sep 2023

[ENTSO-E submitted the amendments proposal to ACER](#)

Dec 2023

[ACER submitted the final recommendation to the European Commission](#)



3.4.2 Implementing Connection Codes

The implementation of connection codes is the responsibility of each EU Member State. In this context, ENTSO-E acts as a platform to maintain and eventually amend CNCs; share information, guidance, and best practices for national implementation processes; and monitor the national implementation of the NCs, in particular by developing and delivering non-binding written guidance – Implementation Guidance Documents

(IGDs) – to its members and other system operators. In 2023, ENTSO-E published the update of two IGDs, “Compliance Verification – Compliance Monitoring after operational notification” and “Compliance Verification – use of Simulation Models”. Both IGDs are fuelled by discussions with stakeholders and consulted through public consultation in Q1 2023, in accordance with Article 58 RfG.

KEY DATES & DOCUMENTS

May 2023

[Responses to the public Consultation](#)

Jun 2023

[IGDs publication](#)

3.4.3 Implementation Monitoring

ENTSO-E regularly monitors the implementation activities in each country via its [Active library](#), examining divergences in national implementation, and this is being enhanced through the [Implementation Monitoring Platform](#), which has been improved with [new functionalities](#) during 2023.

This tool promotes ENTSO-E’s transparency and allows stakeholders to easily consult relevant implementation data as the national values of the parameters are non-exhaustively defined in the Connection Codes.

In accordance with Article 59 (2) RfG and 76 (2) HVDC, ENTSO-E shall provide ACER with the information required to monitor the implementation of these two network codes. In response to ACER’s requests, ENTSO-E maintains summary tables for each Member State, clarifying the type of information that needs to be collected by the TSOs and DSOs. The information is then aggregated and submitted to ACER each year by 30 June.





4

Facilitating the Energy Transition: A Fit for Purpose Market Design

ENTSO-E and TSOs are fully committed to the implementation of the current legislative framework on electricity markets, based on the Clean Energy Package Regulations and Directives, related Network Codes and Guidelines, as further detailed in chapter 7. It is nevertheless ENTSO-E's role to continuously attempt to anticipate future challenges for the power system and to identify possible market design solutions which may require adjustments to the current framework. Building on the ENTSO-E Vision of October 2022, in the course of 2023 ENTSO-E was particularly active in the area of market design, namely providing technical input to the EC, and subsequently to the European Parliament and the EU Council, on the legislative proposals to reform the design of European electricity markets.

Already before the energy price crisis of 2022, ENTSO-E had concluded that the design of European electricity markets needed to significantly adapt to the upcoming challenges and opportunities to achieve a carbon-neutral energy system. Against this background, ENTSO-E supported the EU's plan to reform Electricity Regulation 943/2019 and Electricity Directive 944/2019 in 2023.

ENTSO-E responded on 13 February 2023 to the EC Public Consultation on Electricity Market Design. In this context, ENTSO-E highlighted its main priorities for a future-proof market design to facilitate a carbon-neutral European power system:

1. Investments in renewable and low-carbon generation, as well as in flexibility resources, must accelerate via stronger long term price signals;
2. Undistorted short-term price signals, market integration and liquidity are essential to ensure an efficient dispatch of generation and flexibility resources;
3. Market design needs to properly reflect grid constraints and operational challenges to ensure system resilience and efficient use of infrastructure; and
4. Regulation and market design should evolve in line with the different consumers' needs, increasing affordability and engagement opportunities.

” During 2023, the Electricity Market Design Reform was agreed. From the TSOs’ point of view this is, in general, a good development in the right direction, in particular the recognition that capacity mechanisms are part of the standard toolbox, and that changes to the long-term market are properly assessed before any solution is chosen. ”

Kjell A. Barmsnes, Chair of the ENTSO-E Market Committee



KEY DATES & DOCUMENTS

03 Apr 2023

Publication of the ENTSO-E Position on the EC proposals on Market Design

Later in March, the EC published its legislative proposals to reform electricity markets. ENTSO-E reacted by generally welcoming the EC’s work as the priorities outlined by the proposals were mostly aligned with those ENTSO-E identified in its Vision of a Power System for a Carbon Neutral Europe. However, ENTSO-E also identified some key elements that were either missing or included without a proper impact assessment, which might have had detrimental effects on market functioning, system security or the costs borne by consumers.

ENTSO-E positions were further explained and detailed in its Position Paper published in April, where 10 priority topics to be addressed in the legislative package were identified.

Among these, ENTSO-E welcomed:

- › Proposals to better protect and empower European consumers by facilitating their access to renewable and low-carbon electricity, to a wide range of retail offers with transparent contractual information, as well as to new services and engagement opportunities;
- › The promotion of well-designed two-sided Contracts for Difference (CfDs) and Power Purchasing Agreements to strengthen long-term investment signals for renewable and low-carbon generation, to provide hedging opportunities for demand and avoiding market distortions;
- › The preservation of well-functioning, liquid and integrated European short-term markets (day-ahead (DA) intraday (ID) and balancing) which ensure the efficient use of generation and flexibility resources, in addition to incentives for energy savings;
- › The introduction of flexibility needs assessments, as proposed in the ENTSO-E Vision, to complement system adequacy studies building on existing roles & responsibilities, to guide market design choices, investments and innovation in all sources of flexibility; and
- › An improved regulatory framework for TSOs, aimed at duly recognising anticipatory investments of TSOs and operational expenditures (along capital investments) in addition to fostering innovation and use of flexibility solutions.

Among the areas of improvement, ENTSO-E suggested the following:

- › Market mechanisms to ensure adequacy should be reinforced. In particular, the framework for Capacity Remuneration Mechanisms (CRMs) must be simplified to allow their quicker and more stable introduction: CRMs, as structural elements of national markets, can be essential to support investments in the resources needed to balance and secure the system;
- › Implementing Regional Virtual Hubs, a theoretical and still untested approach, would require long implementation times (5–10 years as estimated by ACER) and may lead to significant costs and risks for TSOs, grid users and market participants. More practical solutions can be implemented in shorter lead times to improve current forward markets;
- › Using congestion income to support offshore generators in hybrid projects would be discriminatory as this would imply a non-transparent subsidy paid by consumers to specific producer category. As an alternative solution, we recommended building on already existing support frameworks, such as two-sided capability-based Contracts for Difference (CfDs);
- › Shortening of the ID cross-zonal gate closure to 30' ahead of real time without adequate implementation deadlines and derogations would have severe consequences for many TSOs in Europe, requiring a complete change in how they operate their systems and potentially compromising system security; and
- › The strengthening of the REMIT regulation should be accompanied by a balanced approach that carefully considers the proportionality of the new obligations.

During spring and summer, to support the work of the European Parliament and Council, ENTSO-E provided additional input and feedback to the legislators during public events and by explaining the views of European TSOs.

Later in October, ENTSO-E welcomed the work of the European Parliament and of the Council which resulted in further improvements of the initial EC legislative proposals on Electricity Market Design. As interinstitutional negotiations (“trilogues”) were starting, ENTSO-E offered further technical expertise in assessing some of the outstanding issues, with the objective of facilitating a swift and constructive EU level agreement, instrumental to designing electricity markets fit for the energy transition.

On this basis, ENTSO-E was particularly pleased when the European Parliament and Council reached a provisional political agreement on 14 December. ENTSO-E praised the efforts made by the negotiating team and congratulated all parties involved. A number of crucial elements were incorporated in the provisional agreement. Among these:

- › The agreed framework for two-sided CfDs – or equivalent schemes – for public investments in new power generating facilities reflects a forward-looking approach to strengthening long-term investment signals for renewable and low-carbon generation. Nevertheless, throughout implementation CfDs will need to be carefully designed to avoid distortions in short-term and balancing markets or increases in system costs; and
- › The inclusion of capacity mechanisms as a possible structural element of the electricity markets is welcomed by TSOs as these can be essential to support investments in the resources needed to balance and secure the system on the path to carbon neutrality, and not as a last resort.

The current market design reform puts Europe on the right track for carbon neutrality by strengthening investment signals for renewables and low-carbon generation, promoting flexibility and demand response, improving consumer protection and reducing their exposure to fossil fuel prices volatility. However, this is only the first step and more will need to be done in the coming years.

ENTSO-E looks forward to the successful implementation of these reforms and continues to support initiatives that contribute to a power system for a carbon-neutral Europe.

”

The European Union has responded to the challenge of the energy crisis by accelerating the ecological transition and incorporating lessons learned into legislation. With the reform of the electricity market design, we are better prepared to avoid new price crises, accelerate the deployment of renewable energies, protect consumers, and advance the greater integration of the power system, in which ENTSO-E plays a crucial role.

”



*Nicolás González Casares,
European Parliament
Rapporteur of the Electricity
Market Design Reform*

A person is shown from the chest up, wearing a dark long-sleeved shirt. They are holding a glowing yellow lightbulb in their right hand. A network of white dots connected by thin lines is overlaid on the scene, centered around the lightbulb. The background is a bright, out-of-focus sky. In the bottom left corner, there is a large white number '5' inside a semi-transparent grey circle.

5

Innovative Solutions

ENTSO-E promotes and supports the TSOs' innovation activities (national, regional or EU funded) to transform the European energy system into an integrated one, with an emphasis on smart sector integration, enhanced grid usage, market development and digitalisation to allow for the integration of vast amounts of renewable energy and to enable the development of a system of integrated systems.

KEY DATES & DOCUMENTS

Mar 2023

Publication of the [RDI Monitoring Report](#)

The following sections describe ENTSO-E activities in Research, Development and Innovation (RDI) that occurred in 2023.

5.1 Research, Development and Innovation Monitoring Report

In 2023, ENTSO-E published the new edition of its RDI Monitoring Report. The document provides a detailed statistical analysis of the current development of the TSOs' RDI activities and monitors their alignment with the ENTSO-E RDI Roadmap 2020 – 2030 (RDI Roadmap) and other strategic documents, such as the RDI Implementation Report 2021 – 2025 and the Acceleration Mission paper, as well as with the business areas in the ENTSO-E Vision: A Power System for a Carbon Neutral Europe.

The information used in this monitoring activity was collected from questionnaires given to ENTSO-E members, and responses were received until April 2022, representing a total of 117 projects. The results show a very good alignment with the milestones from the RDI Roadmap, with over 80 % of these milestones already addressed on different levels by the current RDI efforts, demonstrating a strong commitment from TSOs to deliver the necessary innovations towards carbon neutrality in 2050. Figure 8 summarises the alignment of the current research activities with the RDI Roadmap.

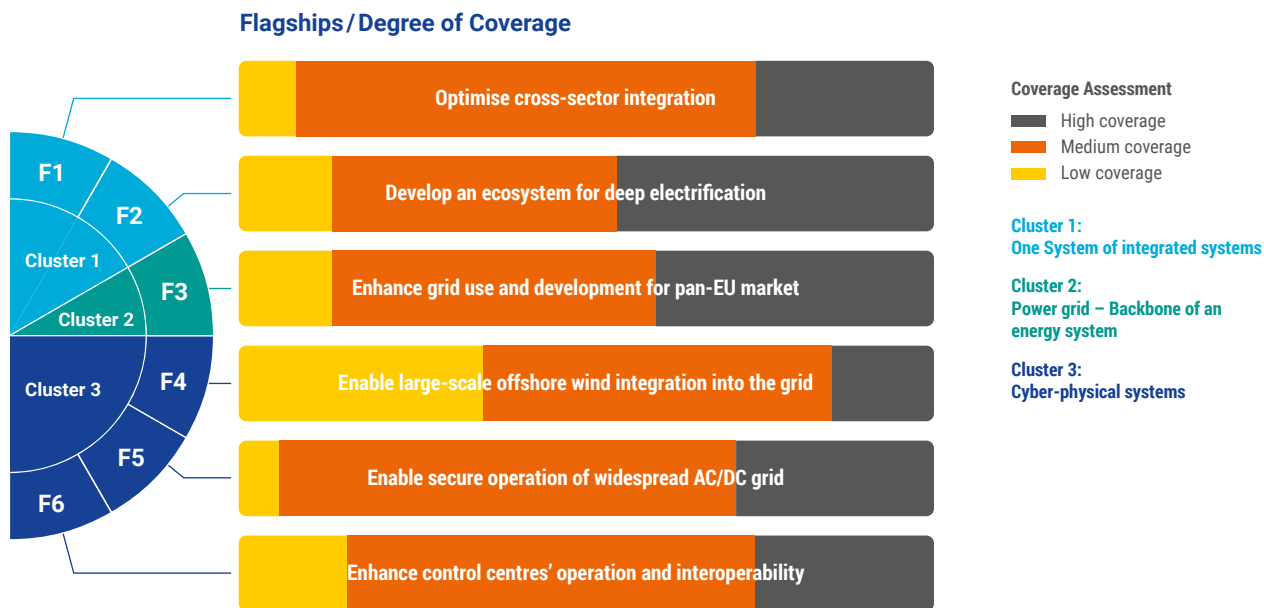


Figure 4 – RDI Monitoring Report: Assessment of almost 120 TSO research and innovation projects

5.2 Position Papers and Reports

ENTSO-E has also been finalising a study related to the power and heat sectors and kicked off an analysis on the electrification of the heavy-duty segment, both due in 2023.

The **study on power and heat sectors** analyses the current situation of the heating and cooling (H&C) sector in the EU and its objectives for 2030 and 2050; it provides a comparative description of the H&C technologies, including prospects for the integration of RES and thermal storage. The main aim is to analyse the impact of these future evolutions on the energy system, the power system and the TSO practices.

The paper found that although direct electrification can benefit from mature and efficient technologies such as heat pumps, compared to the fast electrification rate of the mobility sector, the H&C sector will take more time to electrify for several reasons. Heating systems show distinctive and peculiar characteristics in different countries regarding technologies, sources utilised, and national trends and, therefore, a supportive framework for innovation is crucial to speed-up the developments. Regarding synergies between the H&C and electricity sector regarding the services needed by the power system (demand response, short- and long-term flexibility), a harmonised market regulation will be necessary in addition to strong cooperation among various stakeholders and TSOs.

The **Deployment of Heavy-Duty Electric Vehicles and their Impact on the Power System** position paper addresses, from a TSO perspective,

emerging technologies and trends for the uptake of zero-emission heavy-duty vehicles and their recharging/refuelling stations (both battery electric and hydrogen fuel-cell heavy-duty vehicles). It is based on a technical/economic analysis which covers projections for vehicles and charging infrastructure uptake, consumers' operational requirements and economics, and regulation and market issues. The paper identifies a taxonomy of charging use cases, their impact on the electric grids and on the broader power system, and flexibility potential, and recommends actions to be taken in a coordinated manner by the various actors of a wide and cohesive ecosystem (vehicles and battery manufacturers, charging operators and energy aggregators operators, logistic operators, fleet managers, road and urban planners, regulators) under the fast evolution of European policy frameworks.

KEY DATES & DOCUMENTS

Feb 2023

Publication of the Study on Power and Heat Sectors: Interactions and Synergies

Oct 2023

Publication of the position paper on Deployment of Heavy-Duty Electric Vehicles and their Impact on the Power System

5.3 InnoGrid 2023

In June 2023, ENTSO-E organised with E.DSO the 12th InnoGrid "Between urgency and energy transition: getting the balance right" jointly with E.DSO. The hybrid event brought together close to 600 participants on site and online from the industry, associations, EU institutions, regulators, the academic world and Member States. The 2023 edition of the event aimed to search for answers to the question: how to advance on the energy transition while dealing with the energy crisis?

InnoGrid focused on electrification, digitalisation and cooperation, highlighting the key role of the grids, and the innovative solutions developed by TSO- and HorizonEurope projects.

5.4 Projects and Cooperation

In 2023, ENTSO-E continued to collaborate with key external stakeholders on multiple levels. ENTSO-E has been part of a new Horizon Europe-funded project that was awarded funding in 2023: TwinEU. This is a flagship project for the implementation of the EU Action Plan: Digitalisation of the Energy System. Thus, through three years it will create a concept of a Pan-European digital twin of the electricity system based on the federation of local twins to enable a reliable, resilient and safe operation of the infrastructure while facilitating new business models that will accelerate the reaching of the European net-zero climate targets.

In addition, another ENTSO-E involved project, READY4DC, successfully concluded its two-year operation; it assessed and provided recommendations on the major technical and legal aspects of designing and building an interoperable multi-vendor DC grid. Similarly, the EU-funded project BD4NRG closed in 2023 with the participation of ENTSO-E, having developed and demonstrated an innovative energy-tailored Big Data Analytics Toolbox. In addition to these, ENTSO-E participated in 2023 in two other Horizon Europe projects: Int:Net and OneNet, ensuring the TSO perspective was considered on a European scale in the RDI scene.



The year 2023 has been a turning point, with grids moving front and centre of the EU agenda. Our members view the Grids Action Plan as the political recognition of the crucial importance of grids, and their efficient, resilient and secure operation in the European power system. It is also a turning point as we are moving beyond energy policy into the realm of industrial policy. The future competitiveness of Europe depends on the success of key net-zero industries. As technology providers, T&D Europe members are committed to supporting network operators in building, reinforcing and digitalising Europe's electricity networks to facilitate the energy transition. Together, network operators and technology providers are essential players in delivering on the Green Deal.

Diederik Peereboom, Secretary-General of T&D Europe

A woman with glasses and a dark blue top is pointing at a large monitor in a control room. The monitor displays a complex system diagram with various components and connections. A man is partially visible on the right, looking at the screen. The background shows a modern office environment with glass walls and overhead lights.

6

**Ensuring Efficient, Resilient
and Secure System Operation**

6.1 The System Operation Guideline

The Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing guidelines on electricity transmission system operation (SOGL) sets out harmonised rules on how to ensure system security through efficient grid operation in a variable renewables paradigm. The implementation of the SOGL and the related methodologies entails several challenging tasks for TSOs at the pan-European, synchronous area and regional levels. Work at the pan-European level is facilitated by ENTSO-E, whereas synchronous areas' activities are decided by TSOs in the respective regional groups.

The following SOGL implementation activities were carried out in 2023:

SOGL deliverables in 2023	Key documents and dates
Article 14.2 List of information to be delivered to ACER for monitoring purposes	21 December 2023 Revised list of information signed by ACER and ENTSO-E representatives.
Article 15 Annual report on operational security indicators	29 September 2023 Publication of the 2022 Annual Incident Classification Scale report
Article 16 Annual report on load-frequency control	30 June 2023 Publication of the 2022 Annual Load-Frequency Control report
Article 75.1 Methodology for coordinating operational security analysis	17 November 2023 Amendment proposal to CSAM submitted to ACER
Article 75.1 Methodology for coordinating operational security analysis	13 December 2023 Publication of the 2023 Biennial PRA report

Table 1 – SOGL implementation activities in 2023

The 2023 Annual Incident Classification Scale (ICS) report saw a trend of an increased number of reported voltage violations due to the increased amount of RES in the power generation mix. These remarks have already been noted by impacted TSOs, who have begun taking actions to prevent these voltage violations in the future. Furthermore, approximately 30 % of the incidents in CE that were due to contingencies from the contingency list were caused by unexpected discrepancies from load and generation forecasts. This indicates that improving the accuracy of load and generation forecasts in CE would significantly decrease the number of registered incidents.

In 2023, ENTSO-E also submitted the amendment proposals to CSAM following the recommendations of the system split event of January 2021 and a corrigendum issued by ACER that corrected a wrong reference in CSAM. To fulfil its monitoring purposes and reflect the progress made in RCC services, ENTSO-E revised the list of information to be collected for implementation monitoring. The revised list has been agreed and signed between ENTSO-E and ACER at end of 2023.

ENTSO-E provided regular updates to stakeholders on these topics and other system operation issues via the System Operation European Stakeholders Committee.

6.2 Implementation Monitoring

Between July and September 2023, ENTSO-E released three annual implementation monitoring reports: the “Annual Report on ICS 2022” (Article 15 SOGL), the “Annual Report on Load-Frequency

Control 2022” (Article 16 SOGL) and the “All TSOs” Scenario Definition and Scenario Description for the Year 2024” (Article 65 SOGL)

KEY DATES & DOCUMENTS

30 Jun 2023

Publication of
[Load-Frequency Control Annual Report 2022](#)

15 Jul 2023

Publication of
[All TSOs’ Scenario Definition And Scenario Description For The Year 2024](#)

6.3 The Emergency and Restoration Code

The Emergency and Restoration Network Code (NC ER) sets out harmonised rules on how to respond to emergency situations and restore the system as efficiently and as quickly as possible. It entered into force on 18 December 2017 and is primarily subject to implementation at a national or TSO level.

In 2023, NC ER Experts supported the work on the optimisation of regional restoration and the consistency assessment of TSOs defence plans and restoration plans, as outlined in Article 37 (1) Regulation 2019/943.

6.4 Frequency Stability

In 2023, no major grid incidents were recorded in the pan-European system. Moreover, the ongoing implementation of the recommendations provided by the Expert Panel of the 2021 ICS Scale 2 grid

incidents is bringing more support and the needed added value to improve the operational processes followed by the TSOs at pan-European level.

6.5 ENTSO-E Awareness System (EAS)

The EAS provides a real-time pan-European view of the state of transmission systems. All TSOs input several measurements indicators including frequency and cross-border exchange. These measurements are then merged to provide an overall European view of each TSO on the platform.

ENTSO-E has been monitoring the maintenance of the EAS to ensure its continuous operations within TSO business Service Level Agreements (SLAs).

On Friday 8 January 2021 at 14:05 CET, the CE SA was separated into two areas (the North-West area and the South-East area) due to cascading trips (i. e. sequential disconnections) of several transmission network elements. In the immediate aftermath of the system separation, European TSOs, in close collaboration through the ENTSO-E, decided to start a joint process to collect all relevant facts regarding the incident. Furthermore, a detailed technical analysis of the main causes of the incident has been completed.

The technical report of the incident revealed other necessary improvements to the EAS:

- › Integration of Wide Area Monitoring System (WAMS) measured data (voltage phase angles, voltage magnitude and frequency) – using such data and enhanced EAS functionality, additional alarms could be developed in EAS to warn operators in the event of significant deviations in voltage phase angles or of significant differences between physical and commercial flows; and
- › Configuration of additional alarms to warn operators in the event of significant deviations and/or unexpected system behaviour, such as “system split detection” and “phase angle deviations”.

The following implementation actions were delivered in 2023:

1. The WAMS development in EAS will include automatic detection and alarming of system separation events and measurements and alarms on voltage phase angles between specified corridors;
2.) Island alarms from Synchronous Area Monitor (SAM) Amprion and Swissgrid to be integrated into EAS (SAM is the role assigned to TSO(s) with dedicated frequency control responsibilities as stipulated in the Synchronous Area Framework Agreement (SAFA) for Continental Europe); and
3. Regular training sessions will guarantee that operators are aware of all functionalities of the EAS system.

WAMS protocol converter implementation, from detailed design until the final Site Acceptance Test, was executed and led to the go-live of the new functionalities in the EAS Production system from 15 January 2024.

In 2023, access to EAS by Regional Coordination Centres (RCCs) operators was approved by ENTSO-E System Operations Committee. Implementation is ongoing. As of 15 February 2024, three of the six RCCs are already connected to EAS.

The adherence of Ukrenergo to the EAS Data Exchange and Delivery Agreement was approved in 2023 by ENTSO-E System Operations Committee and an interim solution was deployed to allow Ukrenergo to send SCADA, including system state, and PMU measurements to EAS.

These data from Ukrenergo are visualised in EAS maps and available to other TSO operators.

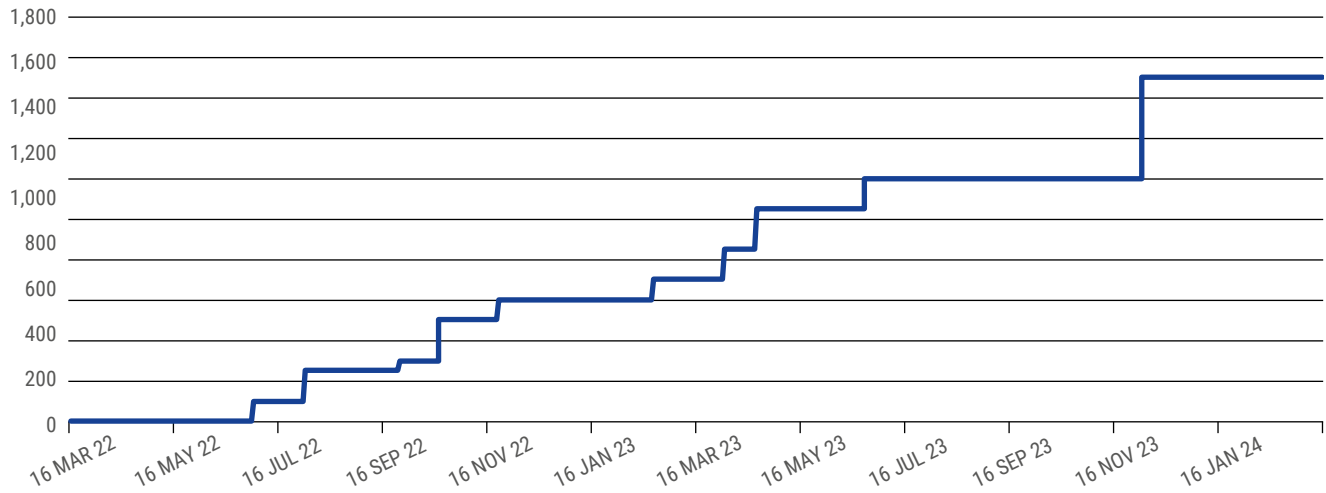
6.6 Permanent Synchronisation of Ukrenergo

On 16 March 2022, CE enabled the emergency trial synchronous operation of Ukrenergo and Moldelectrica. Since then, Ukrenergo has actively worked with hundreds of CE experts to ensure its compliance with its Catalogue of Measures, listing key requirements from the Operational Framework (SAFA + SO GL + NC ER + EB GL Article 50.3 and 51.1).

On 28 November 2023, CE confirmed the sufficient compliance of Ukrenergo, enabling them to be considered as permanently synchronised, to adhere to the Synchronous Area Framework Agreement (SAFA), and to become eligible for ENTSO-E membership.

Following the emergency trial synchronisation of March 2022, commercial exchanges were not allowed between Ukraine-Moldova and CE. Starting from 16 July 2022 commercial exchange was allowed and the capacities in both directions were gradually increased, as presented on the graphs below.

Import Capacity (MW)



Export Capacity (MW)

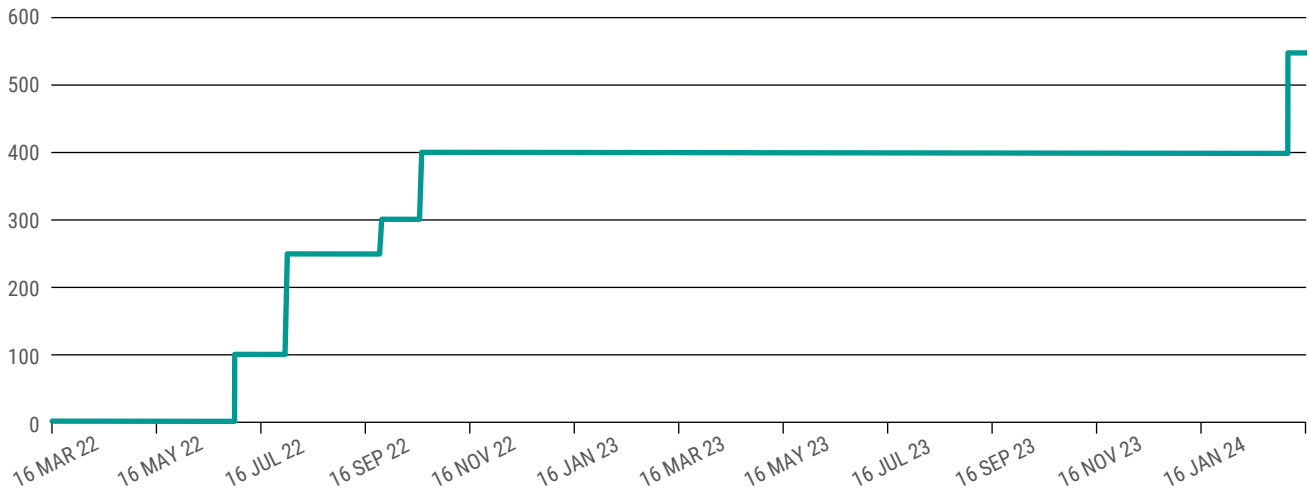


Figure 5 - Commercial exchanges between Ukraine/Moldova and Continental Europe

6.7 Tasks for synchronous areas

Depending on the specific arrangements within each Regional Group corresponding to SAs, ENTSO-E provides support on an ad-hoc basis or serves the SA on a continuous basis. ENTSO-E supports the Regional Group Continental Europe (RGCE) with implementation processes and supports the synchronisation project between the Baltic TSOs and CE and

the synchronisation project between Ukraine and Moldova and CE. In 2023, ENTSO-E enabled the permanent synchronisation of Ukrenergo, approved the membership of Ukrenergo, approved the observer membership of Moldelectrica and TEIAS, and defined an updated roadmap for Baltic TSOs synchronisation.

6.8 Risk Preparedness

The “Methodology for Identifying Regional Electricity Crisis Scenarios” (the RP Methodology) was first approved by ACER in 2020 pursuant to Article 5 of Regulation (EU) 2019/941 of the European Parliament and of the Council on risk-preparedness in the electricity sector (RPR, [link](#)). The methodology lays down a framework for how TSOs identify electricity crisis scenario candidates and how these should be assessed into regional electricity crisis scenarios.

Article 5 of the RPR mandates ENTSO-E to update and improve the RP Methodology “[...] where significant new information becomes available”. Therefore, based on engagements with ECG and before the next cycle of creating the regional electricity crisis scenarios, ENTSO-E decided to commence the update and improvement process of the RP Methodology.

ENTSO-E proposed to ACER an update to the Methodology for Identifying Regional Electricity Crisis Scenarios. The proposed updates to the methodology involve:

1. **Introducing a top-down process** based on the scenarios from the previous cycle (2020);
2. **Earlier engagement of member states, competent authorities and subgroups;** and
3. **Undertaking simulations** with existing ENTSO-E tools.

These proposed updates will provide an enhanced basis for Member States to develop national risk preparedness plans, based on regional scenarios with cross-border impact (beyond the normal TSO operational measures).





7

**Market Development
and Operation:** Completing the
Internal Energy Market

7.1 The Capacity Allocation and Congestion Management Regulation (CACM)

The rules set by the CACM Regulation provide the basis for the implementation of a single energy market across Europe. They set the methods for allocating capacity in the DA and ID time frames and outline how capacity will be calculated across the different zones. Implementing harmonised cross-border markets in all time frames will lead to a more efficient European market and benefit customers.

All the Terms and Conditions stemming from the CACM Regulation have been submitted, and the implementation of these Terms and Conditions is ongoing.

In 2023 all TSOs submitted amendment to the Capacity Calculation Region (CCR) determination according to Article 15 of the CACM Regulation. At the initiative of ACER, TSOs have developed a proposal to merge Italy North CCR and Core CCR for the DA timeframe. The newly created CCR is called Central Europe. The proposal also includes a new bidding zone border between the bidding zones of SEM (Single Electricity Market, in Ireland) and FR (France). The Celtic Interconnector is a planned subsea 700 MW link to allow the exchange of electricity between Ireland and France. The amendment proposal containing both the inclusion of Celtic cable interconnector in Core CCR and the merge of Core and Italy North for the DA timeframe was submitted to ACER for approval on 1 November 2023.

During 2023, ENTSO-E explored options for either maintaining the default CCR configurations, as defined by Annex I to the adapted CACM Guideline, or proposing alternative configurations. The EnC TF established three work streams: Italy–Montenegro (IT–ME), East Europe (EE) and South-East Europe (SEE), with the purpose of tackling the three default CCR configurations as proposed by the adopted CACM Guideline. The work continues in 2024.

All TSOs have developed a [Framework for assessing the configuration of the CCRs](#), with the purpose to apply this framework to any CCR assessments in the future, including assessments resulting from a legal requirement (e.g. Article 12 of Annex I ACER Decision 04/2021) in addition to any other CCR assessment TSOs wish to perform. The framework outlines the relevant parameters that require consideration to achieve a comprehensive analysis. The framework document is a “toolbox” to be used by all TSOs when performing any future assessments of CCR configurations.

KEY DELIVERABLES

30 Jun 2023

Congestion Income Distribution methodology

Sep 2023

2022 Report on costs of establishing, amending and operating the single day-ahead and intra-day coupling

30 Nov 2023

Determination of capacity calculation regions

18 Dec 2023

Framework for Assessing the Configuration of Capacity Calculation Regions

The assessment framework proposes a three-step approach to analysing CCRs:

- › **Step 1:** Identify alternative CCR configuration(s);
- › **Step 2:** Assess the alternative CCR configuration(s) against the status quo; and
- › **Step 3:** Either maintain the current status quo of CCRs in the event it is more efficient than the alternative CCR configuration(s) assessed or provide a recommendation to amend the CCRs' configuration in the event a different scenario is found to be more efficient than the status quo.

The adaptable stepwise structure of the framework and the flexibility proposed in the parameters are expected to simplify the CCR assessments over the coming years while giving a consistent structure, ensuring that TSOs consistently consider all relevant factors.

As required in the latest decision from ACER, all TSOs developed an amendment to the Congestion Income Distribution methodology in accordance with Article 73 CACM. In this amendment, TSOs have introduced specific formulas to deal with the non-intuitive flows, which are flows against price differences. These may occur to achieve the highest social welfare possible across CCRs. Two major situations are considered into the amended methodology, where the unintuitive flows impact first inside a CCR, and second across multiples CCRs. To alleviate the effect of unintuitive flows

with cross CCRs impacts, the virtual hub approach is introduced to better consider all the flows from cross-CCRs allocation mechanisms, to determine the congestion income distribution in a fair and efficient manner. The amended methodology was submitted on 5 July 2023 and approved by ACER on 22 December 2023.

After receiving the decision from ACER on the DA Scheduled Exchanges Methodology (SEC) Article 49 (7) for optimising the NEMO-Trading hub flows calculation, All TSOs worked in 2023 to further amend the methodology. This new amendment proposal for SEC was prepared and submitted for public consultation on 30 November.

The SEC is an optimisation problem build in to the DA Algorithm. This is a process that provides the so-called commercial flows on interconnectors as an output of the algorithm. With the transition to a 15 min Market Time Unit (MTU) for DA expected in Q1 2025, the algorithm required an improvement to cope with the increased computation pressure to deliver timely results. The back-up calculation of DA SEC described in the amendment will be activated if the Euphemia algorithm takes too long to find a solution, thereby preventing a decoupling. The amendment proposal containing a back-up calculation of SEC is expected to be submitted to all NRAs for approval in Q1 2024.

- › During 2023, a dedicated group of experts from ENTSO-E, TSOs and the Joint Allocation Office (JAO) worked on completing the daily harmonised allocation rules needed to establish the go-live of common daily auctions on the Slovakia–Ukraine, Hungary–Ukraine and Poland–Ukraine borders organised by the JAO, in addition to daily allocation rules for auctions on the Romania–Ukraine border. The common auctions went live as follows: Romania–Ukraine: 2 November 2023 – daily joint allocation run by UA party;
- › Poland–Ukraine: rules entered into force on 16 January 2024 for first bidding on 18 January 2024 – daily joint allocation by JAO;
- › Hungary–Ukraine: rules entered into force on 22 February 2024 for first bidding on 23 February 2024 – daily joint allocation by JAO; and
- › Slovakia–Ukraine: rules entered into force on 4 March 2024 for first bidding on 6 March 2024 – daily joint allocation by JAO.

The daily joint auctions on the Moldova–Romania border went live on 11 October 2022, and were continuous in 2023 and the first half of 2024.

7.1.1 Single Day-Ahead and Intraday Coupling

According to Article 10 CACM, TSOs cooperate with Nominated Electricity Market Operators (NEMOs) to organise the day-to-day management of the single DA and ID coupling. ENTSO-E facilitates the discussion. This work helps to jointly organise the further development of the market coupling in addition to defining the criteria for prioritising the functionalities to be developed. In 2023, NEMOs and TSOs focused their work on the implementation of two important features of the market coupling, namely the ID Auctions, which are planned to go-live mid-2024 and the 15-min in DA, which will provide the possibility to trade based on the 15 min MTU in the DA Timeframe across Europe.

Among its numerous tasks and the implementation of additional functionalities, in September 2023 NEMOs and TSOs developed and published the 2022 CACM cost report. This report presents an exhaustive view of the spending to develop the market coupling in Europe.

At ACER's request, NEMOs have also amended the Algorithm methodology pursuant to Article 37, to take into consideration the requirements submitted by the TSOs for the co-optimisation of the balancing energy. Further work will still be necessary as the concept is not defined and will require research and development work. The amendment proposal was submitted by the NEMOs to ACER on 24 November 2023.

7.1.2 Capacity Calculation Regions

	DA and ID CapCalc (Article 20.2)	RD and CT (Article 35.1)
Baltic	30 Oct – 30 Nov 2023: Public Consultation	
Core	IDCCM: 2nd and 3rd amendment were referred to ACER in April 2023 by NRAs. DACCM: 2nd RfA was approved by NRAs November 2023. 3rd RfA was put out for public consultation in Sept/Oct 2023. The RfA was submitted to NRAs in December 2023.	
Hansa	19 Jan – 19 Feb 2023: public consultation	
SEE		1 Jun – 1 Jul 2023: Public consultation

Table 2 – CACM Capacity Calculation methodologies in 2023

7.1.3 Implementation Monitoring

KEY DATES & DOCUMENTS

30 JUN 2023

Publication of
Publication of the
Annual Market
Report 2023

30 JUN 2023

Publication of the
Biennial Report on
Capacity Calcula-
tion and Alloca-
tion 2023

ENTSO-E monitors the progress of electricity markets and publishes an Annual Market Report in accordance with Article 82 of CACM Regulation, Article 63 of Forward Capacity Allocation (FCA) Regulation, and Article 59 of Electricity Balancing (EB) Regulation. The ENTSO-E Annual Market Report 2023 was published on 30 June 2023. The report outlines the progress made in the implementation of CACM, FCA, and EB Regulations during the reporting period from June 2022 to May 2023, and in bringing the internal European electricity market closer to full realisation.

On 30 June 2023, ENTSO-E also published the 2023 Biennial Report on Capacity Calculation and Allocation. The 2023 edition of the report covers the period from Q1 2022 to Q2 2022 and outlines the results of monitoring the implementation of the coordinated capacity calculation processes in each capacity CCR in ID, DA and long-term timeframes.

7.2 The Forward Capacity Allocation Regulation (FCA)

The FCA Regulation, which entered into force on 17 October 2016, sets out rules regarding the type of long-term transmission rights (LTTRs) that can be allocated via explicit auction, and how holders of transmission rights are compensated in the event their rights are curtailed. The overarching goal is to promote the coordinated development of liquid and competitive forward markets across Europe and to provide market participants with the ability to hedge their risk associated with cross-border electricity trading.

All the Terms and Conditions deriving from the FCA Regulation have been submitted, and their implementation is ongoing.

In 2023, ENTSO-E reviewed the Harmonised Allocation Rules (HAR) methodology according to Article 68 (5) of HAR and in line with ACER's request to update the necessary FCA methodologies to adapt to the Long-Term Flow-Based Allocation project. In addition to general updates and maintenance of HAR, the bulk of the submission was related to necessary changes due to the forthcoming introduction of Long-Term Flow-Based Allocation. ACER approved the updated HAR on 22 December 2023.

The TSOs and JAO have been working in parallel on the implementation of the Long-Term Flow Based Allocation project to prepare for the go-live in accordance with the regulatory deadlines set for Core and Nordic CCRs. Several workshops have been organised to share the progress of the project and the expected results of the implementation.

Participating in the broader discussion on the energy market reform, the TSOs have developed their initial ideas regarding the proposed long-term market design. Most of the proposals from the TSOs were taken on board in the adopted version of the text, such as the removal of Regional Virtual Hubs as the default model, or the introduction of an assessment of different market features. The final wording will allow the TSOs to participate in a comprehensive assessment of methods to further enhance the long-term market design to ensure that energy customers all over the EU are able to fully benefit from the advantages of integrated electricity markets and competition across the Union.

KEY DATES & DOCUMENTS

01 AUG 2023

[FCA Harmonised Allocation Rules](#)

Capacity Calculation Regions

Region	Splitting of the Long-Term cross-zonal capacity (Art 16)
Baltic	ACER in its opinion has stated that as there was no proper LT CCM, capacity splitting methodology could not be amended. New Splitting methodology shall consider the EE-FI border
Core	1 st amendment of Core CCR TSOs' methodology for splitting long-term cross-zonal capacity approved by NRAs in April 2023.
Italy North	19 Sep – 20 Oct 2023 – Public Consultation

7.3 The Electricity Balancing (EB) Regulation

Efficient balancing markets, in which all resources are empowered to participate on a level playing field, shall ensure operational security at the lowest cost and can deliver environmental benefits by reducing the need for back-up generation. The EB Regulation sets a framework for common European rules and European platforms for cross-border balancing markets.

Ongoing or planned implementation activities include the development of several methodologies by all TSOs, with ENTSO-E acting as the facilitator, in addition to the implementation of the European balancing platforms.

Key dates and documents in 2023:

Date	Event
17 MAR 2023	RCC's task facilitating the regional procurement of balancing capacity (RCC Procurement Proposal) submitted to ACER in accordance with Article 37 (1)(k) of the Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity.
24 MAY 2023	<p>Submission by each asynchronously connected TSO to its respective NRA of the:</p> <ol style="list-style-type: none"> 1. FSKar¹ between SA common settlement rules Review Report², in accordance with the methodologies pursuant to Article 50 (4) of EB Regulation and Article 51 (2) of EB Regulation; 2. All asynchronously connected TSOs' amended proposal for Common settlement rules for intended exchanges of energy between SAs as a result of the frequency containment process and of ramping restrictions in accordance with Article 50 (4) of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing; and 3. All asynchronously connected TSOs' amended proposal for Common settlement rules for all unintended exchanges of energy in accordance with Article 51 (2) of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing. <p>Submission by each continental European TSO to its respective NRA of the Continental Europe the Fskar within SA common settlement rules Review Report³, in accordance with Article 50 (3) of EB Regulation and Article 51 (1) of EB Regulation.</p>
25 MAY 2023	EB stakeholders group meeting
30 JUN 2023	EB Cost Report 2023 published and submitted to ACER
11 SEP 2023	All TSOs Proposal for updating the Common set of requirements for the price coupling algorithm submission to NEMOs
26 OCT 2023	EB stakeholders group meeting
30 NOV 2023	Annual Balancing platforms stakeholders' workshop
05 DEC 2023	Updated Balancing Performance Indicators submitted to ACER

1 FSKar stands for **F**inancial **S**ettlement of **K**f, **A**CE and **R**amping **P**eriod

2 Review Report of All asynchronously connected TSOs' proposal for Common settlement rules for intended exchanges of energy between SAs as a result of the frequency containment process and of ramping restrictions in accordance with Article 50 (4) and Review Report of All asynchronously connected TSOs' proposal for Common settlement rules for all unintended exchanges of energy in accordance with Article 51 (2) of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing

3 Review Report of All continental European TSOs' proposal for Common settlement rules for intended exchanges of energy as a result of the frequency containment process and ramping period in accordance with Article 50 (3) and of All continental European TSOs' proposal for Common settlement rules for all unintended exchanges of energy in accordance with Article 51 (1) of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing.

7.3.1 The European Balancing Platforms

IGCC: The 1 March 2023 marked the start of operational participation of the TSO from Bulgaria, ESO, in the International Grid Control Cooperation (IGCC). Thanks to this accession and all previous ones, a significant milestone has been reached by the IGCC project – All TSOs with the obligation to connect under the EB Regulation are now connected to IGCC. The IGCC was first established in 2011 to avoid counter-acting activations of automatic Frequency Restoration Reserve (aFRR) balancing energy through the process known as imbalance netting. The establishment of a common European platform for operating the imbalance netting process has been officially achieved by the legal deadline of 24 June 2021, following the successful completion of all requirements as defined in the guideline on electricity balancing (EB Regulation Article 22). The cooperation has grown and currently counts 27 members, of which 21 TSOs are already performing the imbalance netting process in a coordinated manner. In addition, Ukrenergo, the Ukrainian TSO became an observer in 2023.

PICASSO: The Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation (PICASSO), is the implementation project endorsed by all TSOs through the ENTSO-E Market Committee. The PICASSO project includes 26 TSO members and four TSO observers. The project's objective revolves around establishing a European platform for the exchange of balancing energy from frequency restoration reserves with automatic activation, known as the aFRR-Platform, pursuant to Article 21 of the Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing (EB Regulation). With the approval by ACER of the TSOs' proposal regarding the Implementation Framework for PICASSO on 24 January 2020, the legal deadline for implementation of the platform was set to 30 months later, on 24 July 2022, in accordance with article 22.6 of EB Regulation. Terna joined PICASSO on 19 July 2023 and further TSOs' accessions are planned for 2024 (see the latest accession roadmap from 25 October 2023 here).



MARI: The Platform for the Manually Activated Reserves Initiative (MARI) was successfully made operational on 5 October 2022 with the accession of five TSOs. The launch of the MARI platform marked the beginning of a European-wide coupling of national balancing markets for frequency restoration reserves with manual activation (mFRR) by the deployment of, for example, standard products, harmonised balancing energy gate closure times, a common merit order list, a central activation optimisation function, merit order activation and a harmonised pricing of balancing energy. With the first accessions in 2022, interchanges of balancing energy from mFRR also began. APG joined MARI on 20 June 2023 and further TSOs accessions are planned for 2024 (see the latest accession roadmap from 25 October, 2023 here).

TERRE: The European platform for replacement reserves – Trans-European Replacement Reserves Exchange (TERRE) – was made operational in January 2020. Currently, the TERRE project consists of eight TSOs, including operational and non-operational members and observers. In addition, three TSOs are designated as TERRE project members, distinct from TERRE members. The project members have joined the TERRE project specifically to participate in the development, operation and management of the IT solution (LIBRA software) and to obtain the intellectual property rights of the IT solution in order to make use of and continue to develop it as part of a regional project in the case of the Nordics TSO, or as part of the MARI project.

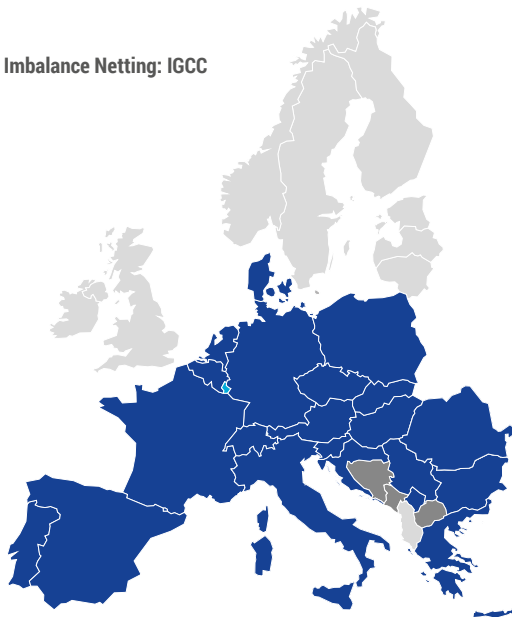
All TSOs via ENTSO-E aim to keep stakeholders informed of the evolution of the European platforms while gathering their feedback for future developments. Therefore, the balancing projects in collaboration with ENTSO-E organised a public online workshop on 30 November 2023. For more information, please refer to [this webpage](#).

In addition, 2023 marked the technical go-live of the Capacity Management IT Solution. The TSOs of the MARI, PICASSO, IGCC as well as the TERRE announced that on 10 October 2023.

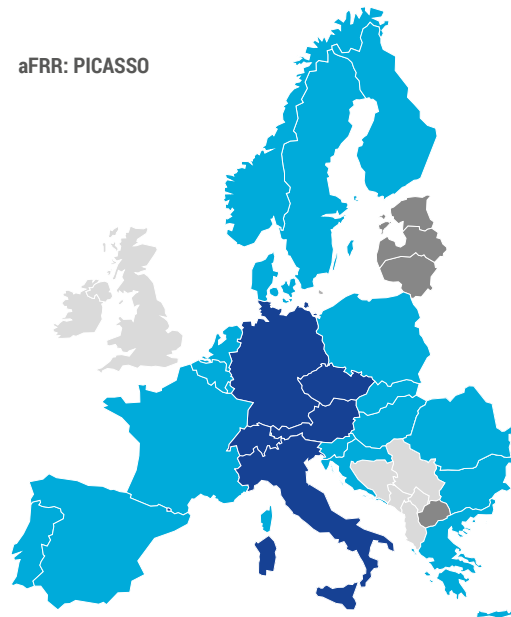


Balancing Implementation Projects Status

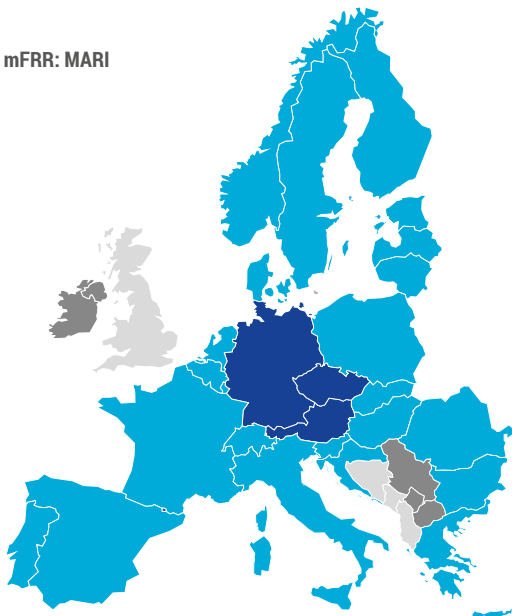
Imbalance Netting: IGCC



aFRR: PICASSO



mFRR: MARI



RR: TERRE

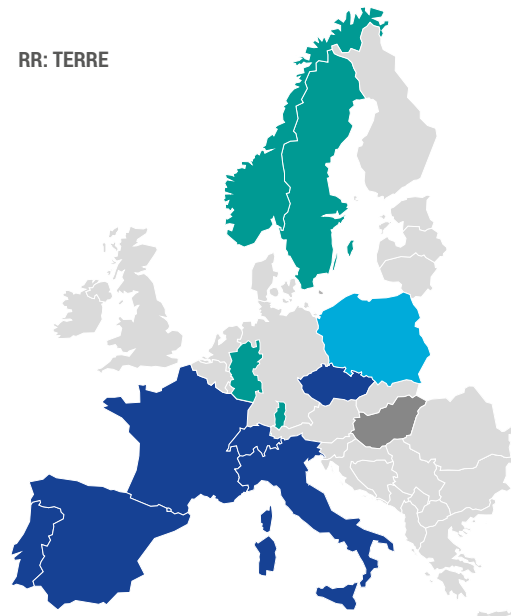


Figure 6 – Balancing Implementation Projects Status

■ Member operational

■ Member non operational

■ Observer

■ Project member

7.3.2 All TSOs and ENTSO-E Methodologies

On 17 March 2023, ENTSO-E's Proposal for the RCC task "Facilitating the regional procurement of balancing capacity" ("RCC Procurement Proposal") was submitted to ACER, in accordance with Article 37 (1)(k) of the Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity. With regards to the TSOs' task of procurement of balancing capacity, the facilitation by the RCC is only considered mandatory for TSOs accounting for volumes of non-contracted balancing energy bids, which are expected to be available within the European platforms (non-contracted platform bids) and/or allocating cross zonal capacity for the exchange of balancing capacity or sharing of reserves with neighbouring TSOs following Article 38 (3) of EB Regulation.

Following its finalisation and approval on 24 May 2023, the TSOs submitted to their corresponding National Regulatory Authorities (NRAs): the FSKar between SA Review Report (in accordance with the methodologies pursuant Article 50 (4) of EB Regulation and Article 51 (2) of EB Regulation), Proposal for Amendments of the Methodology pursuant to Article 50 (4) of EB Regulation, Proposal for Amendments of the Methodology pursuant to Article 51 (2) of EB Regulation, and the Fskar Within SA CE Review Report (in accordance with the methodologies pursuant Article 50 (3) of EB Regulation and Article 51 (1) of EB Regulation).

The Fskar Within SA CE Review Report includes the review of Fskar operations (i. e. history of Fskar amounts and values since the introduction of Fskar, and qualitative description of the evolution of Fskar, i.e. new areas and participants) and the review of Fskar methodology (i. e. the usage of balancing prices, and a justification why these are not appropriate yet). The Fskar Between SAs Review Report includes the review of Fskar operations (i. e. the historical development of FSKar between SAs, and FSKar between SAs operations) and the review of FSKar methodologies (i. e. the possibility of a harmonised pricing calculation method and the justification of why this is not yet possible). It also includes the improvements and changes, i. e. Nordlink to be added to the Annex and minor changes to Annex's (6–7).

In accordance [with Article 27\(7\) of ACER Decision No 11/2023 of 19 July 2023](#), the Cross-zonal Capacity Allocation (CZCA) Harmonised Methodology has been approved by ACER and several amendments have been requested for submission by end of July 2024. All TSOs are in the process of preparing the proposal for these amendments. The required amendments can be distinguished by two different types: 1) mandatory amendments on governance and forecasting to be performed by All TSOs; and 2) voluntary amendment on the maximum limits on CZC for the balancing capacity exchange, as included in the ACER decision text inviting All TSOs to submit such an amendment if considered necessary.

In accordance with **Article 27(7) of ACER Decision No 11/2023 of 19 July 2023**, on 11 September 2023, all TSOs submitted the “All TSOs Proposal

for updating the Common set of requirements for the price coupling algorithm” to NEMOs.

Further EB Reg. all TSOs and ENTSO-E deliverables in 2023	Key documents and dates
17 MAR 2023	<p>Submission to ACER of the ENTSO-E’s Proposal for the Regional Coordination Centres’ task Facilitating the regional procurement of balancing capacity (“RCC Procurement Proposal”).</p> <p>On 19 July 2023, ENTSO-E received ACER’s decision, which included mandatory request for amendments concerning annexing parameters per System Operation Region (SOR).</p>
After 24 MAY 2023	<p>TSOs submitted to their corresponding NRAs for approval the:</p> <ul style="list-style-type: none"> • FSKar between SA Review Report (in accordance with the methodologies pursuant Article 50 (4) of EB Regulation and Article 51 (2) of EB Regulation); • Proposal for Amendments of the Methodology pursuant to Article 50 (4) of EB Regulation; • Proposal for Amendments of the Methodology pursuant to Article 51 (2) of EB Regulation; and • FSKar Within SA CE Review Report (in accordance with the methodologies pursuant Article 50 (3) of EB Regulation and Article 51 (1) of EB Regulation).
19 JUL 2023	<p>ACER Decision No 11/2023 of 19 July 2023 on the CZCA Harmonised Methodology.</p>
11 SEP 2023	<p>Submission to NEMOs of the “All TSOs Proposal for updating the Common set of requirements for the price coupling algorithm”, in accordance with Article 27 (7) of ACER Decision No 11/2023 of 19 July 2023.</p>

Table 3 – Further EB Reg. all TSOs and ENTSO-E deliverables in 2023

7.3.3 Regional Methodologies

In 2022, regarding implementation at the regional level, CCRs delivered methodologies for CZC calculation within the balancing timeframe for

the exchange of balancing energy or for operating the imbalance netting process in accordance with Article 37.3 of the EB Regulation.

In 2023, the NRAs' decision status is as follows:

Hansa	Pending Hansa NRAs' approval following Hansa TSOs' submission of the original methodology proposal on 14 December 2022.
Core	On 11 June 2023, Core NRAs issued a Request for Amendments (RfA). On 13 November 2023, Core TSOs submitted to Core NRAs an amended methodology proposal. Currently, the amended methodology proposal is pending Core NRAs approval.
Greece-Italy	Approved by Greece-Italy NRAs on 27 June 2023.
Italy North	On 15 June 2023, Italy North NRAs issued an RfA . On 28 September 2023, Italy North TSOs submitted an amended methodology proposal . On 24 November 2023, Italy North NRAs approved the amended methodology proposal.
Nordic	On 16 August 2023, Nordic TSOs submitted an amended methodology proposal . On 16 October 2023, the amended methodology proposal was approved by Nordic NRAs.
SEE	On 23 October 2023, SEE NRAs issued an RfA. On 23 January 2024, the SEE TSOs submitted an amended methodology proposal (Methodology and Explanatory document) to the SEE NRAs. The SEE NRAs' decision is expected in June 2024.
SWE	Approved by SWE NRAs in June 2023.

Table 4 – EB GL Capacity Calculation Methodologies in 2023

KEY DATES & DOCUMENTS

30 JUN 2023

Publication of the **Electricity Balancing Cost Report**

30 JUN 2023

Publication of the **Market Report 2023**, including latest developments in European balancing

From 2023

Publication of **Quarterly Pricing Reports**

7.3.4 Implementation Monitoring

On 30 June 2023, all TSOs [published the Electricity Balancing Cost Report](#), in accordance with Article 23 (1) of the EB Regulation, which includes the detailed reporting on 2022 while keeping an overview of cumulative costs since the previous reports (i. e. 2018–2021).

On 30 June 2023, ENTSO-E published its annual Market Report 2023. [The Market Report 2023](#) includes the latest developments in European balancing that took place until May 2023 with minor exceptions. The performance indicators listed in this report are calculated considering the data available for the period from January to December 2022.

Furthermore, from 2023, to increase transparency and as an additional measure identified during discussions on high price mitigation measures, All TSOs started publishing the Quarterly Pricing Reports [on the ENTSO-E website](#) according to the methodology for pricing balancing energy and cross-zonal capacity used for the exchange of balancing energy or operating the imbalance netting process in accordance with Article 30 (1) of Commission Regulation (EU) 2017/2195 establishing a guideline on electricity balancing (“Balancing Pricing Methodology” hereafter).

7.4 Transparency of Capacity Calculation by TSOs

” The recent energy crisis has provided clear evidence for the robustness and effectiveness of the internal electricity market: electricity has been and continues being delivered to where and when it is most needed. ”

Oliver John, Vice-Chair of the ENTSO-E Market Committee

The Clean Energy Package introduced a new regulatory framework for CZC calculation. Specifically, Article 16.8 of the EU Electricity Regulation demands that at least 70 % of the interconnection capacity shall be made available for cross-zonal electricity trading (respecting the operational security limits of internal and cross-zonal critical network elements and considering contingencies). The remaining 30 % of the total capacity of each critical network element can be used for the reliability margins, loop flows and internal flows. ENTSO-E provides an overview of this target every year in the Market Report and fulfils the legal obligation set in the CEP every three years in the Technical Report (the next Technical Report is foreseen in 2024).

7.5 Bidding Zone Review

A major element in the design of the European electricity market is the delineation of bidding zones. As defined by Regulation (EU) 543/2013 (the “Transparency Regulation”), these are the largest geographical areas within which market participants can exchange energy without capacity allocation. The entry into force of Article 14 (3) of the Electricity Regulation triggered a bidding zone review (BZR) process.

Following [ACER’s decision on the alternative BZ configurations](#) adopted on 8 August 2022, the formal BZR process started. ENTSO-E and the TSOs are now assessing the BZ alternative configurations as proposed by ACER in its decision, based on a wide variety of indicators including overall economic efficiency and social welfare, market liquidity, transition costs and the ability to maintain the grid’s operational security.

As part of the current review, in 2023, the TSOs published information on the assumptions and input data and as foreseen in article 17 (3) of the BZR Methodology, ACER and NRAs have provided comments on the input data that have been duly considered by the TSOs

The BZ review study will continue in 2024⁴. The next step is the public consultation that will last for at least four weeks, and will include the publication of two Pan European Studies: the Transition Cost Study and the Liquidity study (1S 2024).

TSOs are instrumental in the progressive harmonisation of electricity market rules, which leads to a vast increase of electricity exchanges across countries, stimulates competition and increases liquidity in wholesale markets. This delivers benefits to society and enables the entry of an increasing number of market participants, including producers of renewable energy, thus contributing to a more sustainable energy system.

7.6 Capacity Mechanisms

Regulation (EU) 2019/943 on the internal market for electricity introduced in Article 26 an obligation for Capacity Mechanisms (other than strategic reserves) to include open, direct, cross-border participation of capacity providers located in Member States with direct network connections to the Member State applying the mechanism.

Article 26 also required ENTSO-E to develop common rules, methodologies and an EU-wide register of capacity providers to facilitate the implementation of cross-border participation in Capacity Mechanisms.

4 The BZ Technical Report will be published in Q4 2024.

In 2023, ENTSO-E managed the operations and maintenance of capacity registry tools used by TSOs, Capacity Market Operators and Capacity Providers.

Based on registry data and according to the technical specification, ENTSO-E shall report yearly information to ACER on eligible capacity

providers and furnish an overview of relevant Capacity Mechanisms rules. In 2023, ENTSO-E collected relevant data and information from TSOs' operating Capacity Mechanisms and from TSOs where eligible capacity providers are located. This information is included in the yearly report published in May 2024.

7.7 Inter-Transmission System Operator Compensation

KEY DATES & DOCUMENTS

Feb 2023

Approval of the Case(ii) methodology and Guidance on the Audit

15 Nov 2023

Publication of the ITC Transit Losses Data Report 2022

The Inter-Transmission System Operator Compensation (ITC) Agreement is a multiparty agreement concluded between ENTSO-E and its member TSOs in addition to KOSTT and National Grid ESO, also referred to in this context as "ITC Parties". It offers a single framework wherein European TSOs compensate one another for costs associated with hosting transit flows (i.e. facilitating the transfer of electricity between two countries). This mechanism aims to incentivise the hosting of cross-border flows and thereby facilitate an effectively competitive pan-European electricity market.

The ITC mechanism is governed by Article 49 of the Electricity Regulation. The ITC mechanism is further specified by the Regulation (EU) 838/2010 on establishing guidelines relating to the inter-transmission system operator compensation mechanism and a common regulatory approach to transmission charging.

The ITC Agreement provides for an annual process in which the parties are required to provide and check the values for the calculation of the annual perimeter fee. Based on the preliminary data, the

transit flows, including the perimeter flows, are calculated (i.e. imports and exports of electricity to and from third countries).

According to the ITC Agreement, ENTSO-E is mandated to ensure the smooth operation of the mechanism in accordance with Regulation (EU) 828/2010 and ensure that all the Data Administrator tasks necessary for a smooth operation are performed. The data administrator tasks concern calculating the losses caused by transits incurred on national transmission systems by calculating the difference between (1) the amount of losses incurred on the transmission system during the relevant period; and (2) the estimated amount of losses on the transmission system which would have been incurred on the system during the relevant period if no transit of electricity had occurred. Finally, under the Regulation, ENTSO-E shall perform certain ancillary Data Administration tasks (i.e. the publication of data).

In April 2023, ACER published its recommendation on the treatment of losses in the ITC mechanism.

7.8 Transparency Regulation

ENTSO-E's [Transparency Platform](#) (TP) (Article 3, Regulation 543/2013) centralises data regarding the generation, transmission and consumption of electricity at the European level. The data are collected from data providers, including TSOs and other qualified third parties. Depending on the users' needs, these data serve various purposes, such as market analysis, research or trading. The TP is also instrumental in monitoring and regulating power markets. Start-ups and new players increasingly use the TP's wealth of data to deliver more value to customers, for example by highlighting life-CO₂ emissions by country, wind generation and more.

During 2023, the main guiding document for the Transparency Platform (TP) – Manual of Procedures (MoP) was in the development phase for a new release v3.4, which incorporates both improvements of the existing data publications and the inclusion of new data publications. The amended MoP package went through internal approvals, reviews by ACER, a Public Consultation and incorporation of additional amendments based on the received feedback from regulators and market participants. Three meetings were organised during the year with ENTSO-E Transparency User Group (ETUG) to communicate and consult on the MoP changes as well as other developments. MoP v3r. is set to be finalised during 2024.

TP implementation, to comply with the latest MoP v3r3 and other change requests, was also successfully addressed in 2023. The designs for new data item implementations were concluded and signed off, which includes Netted and Exchange Volumes per border data point and Continuous allocations.

For "TP as Inside Information Platform" project, which will enable the publishing of Other Market Information, the design document, development and integration were signed off.

TP Redesign project activities also continued in 2023, which aimed to upgrade the existing architecture of the TP targeting improvement of performance and quality data publications to meet transparency requirements from various guidelines. Batch 1 and 2a were released during the year in line with the project timeline. Several data items were migrated as part of the TP Redesign scope. Other important deliverables include keylock migration, the audit log service and other technological enhancements.

Moreover, to deliver one of ENTSO-E's main objectives to improve current GUI and Navigation, the year 2023 saw the implementation of new screens (Batch 1 and 2) for the new TP as part of the TP Vision project.

KEY DATES & DOCUMENTS

Jun – Aug 23

[MoP v3r4 – Public Consultations](#)

2 Oct 2023

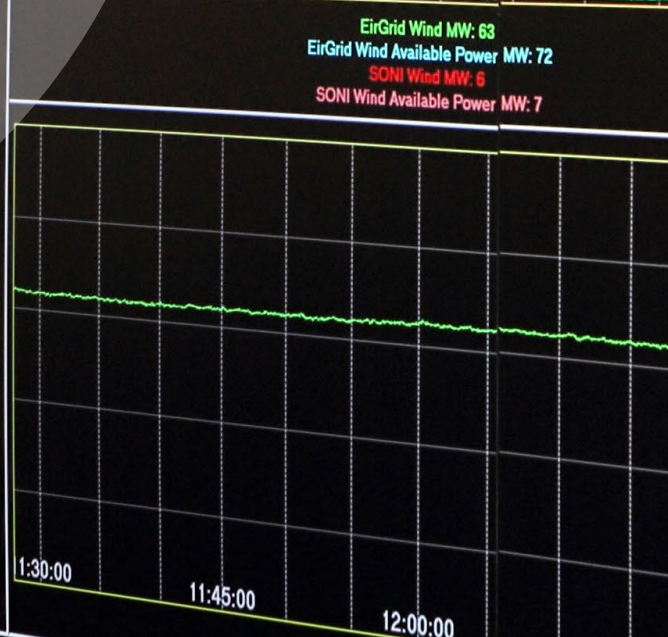
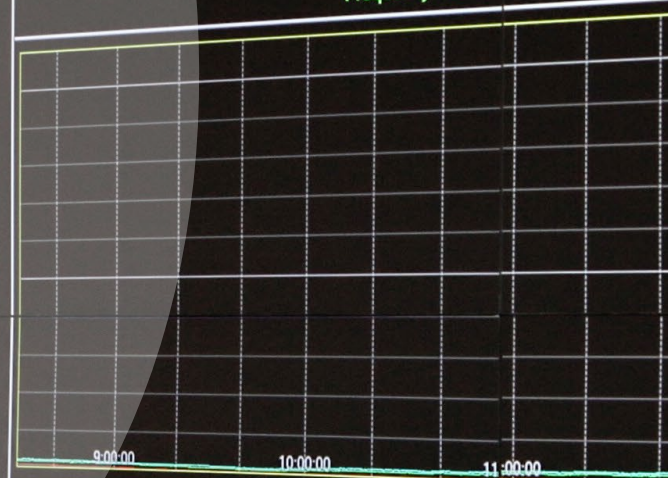
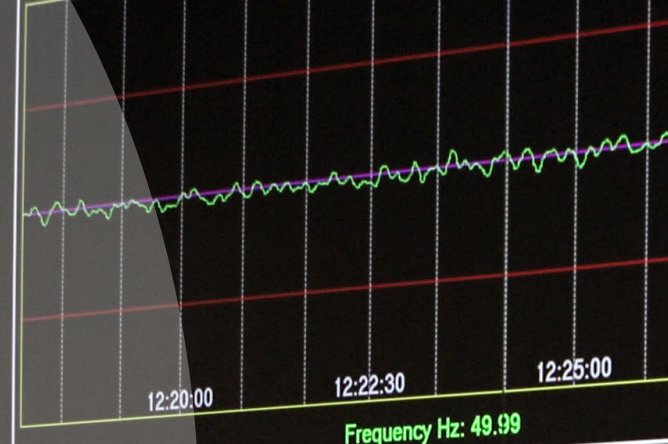
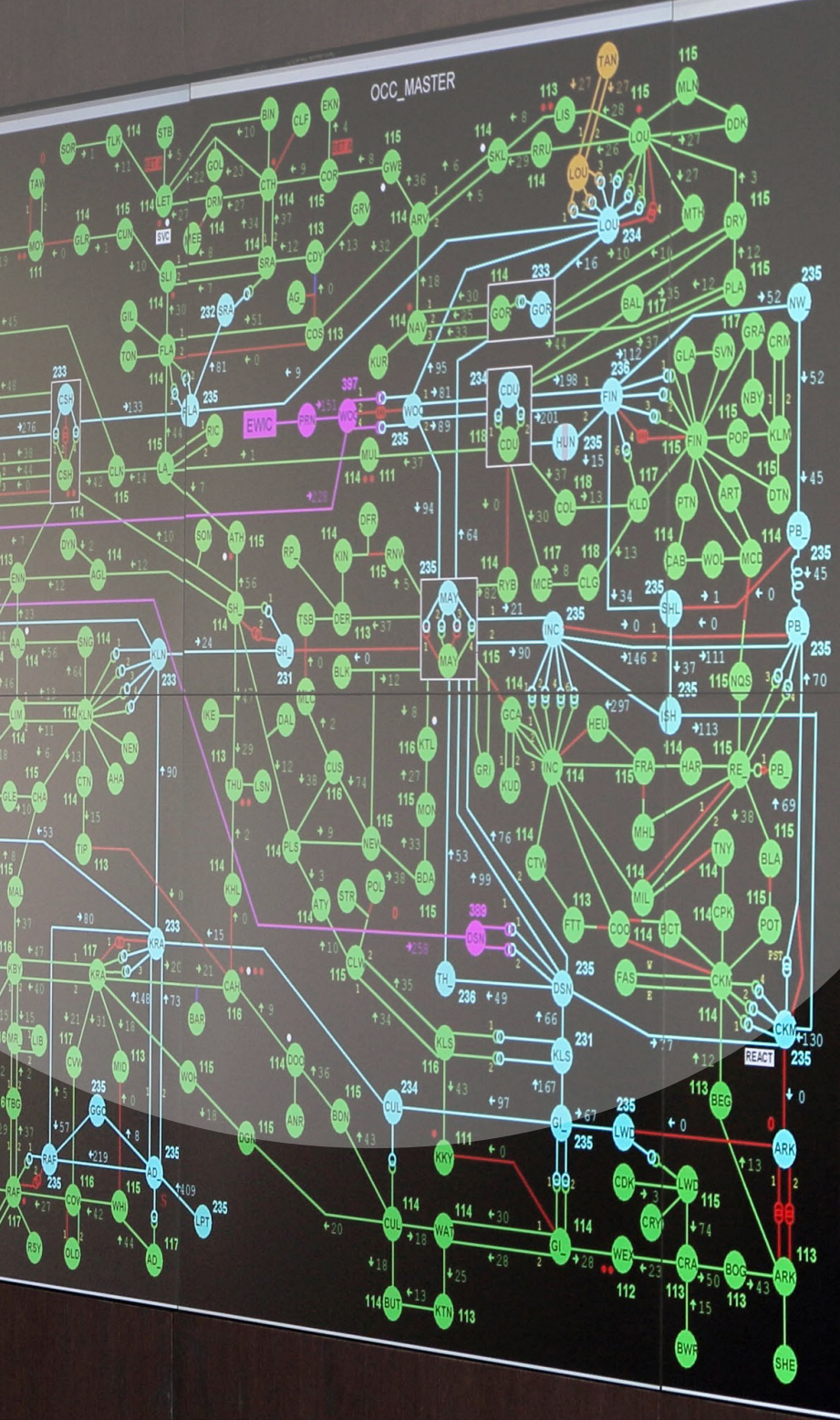
[Data Provider General Requirements monitoring report go-live](#)

As part of measures to improve data quality and user satisfaction in TP, some obligations were introduced on Data Providers in 2023 related to the requests by the users. Monitoring via two KPIs which measured the response times to users by the Data Providers was developed in-house by ENTSO-E. Hence, the go-live of the Data Provider General Requirements in October 2023 was a step forward to address operational quality issues and improve the current operational performance of TP by resolving user tickets in a reasonable time. It also adds to the current automated reports and monitoring tools ENTSO-E already has in place to address data quality issues.

Finally, in 2023 the revived Statistical Data Portal solution was used to publish the statistical reports and factsheet for 2021 and 2022. In addition, high-level requirements were prepared and approved for the enduring Statistical Data Portal solution.

The datasets provide an easy opportunity to transparently follow the share of generation technologies in the different geographical areas.







8

Regional Coordination

Cooperation at the regional level is a key building block to ensure the security of supply while maximising cross-border capacity as a result from the coordinate security analysis and coordinated capacity calculation. The development of intermittent generation and increased interconnections render regional coordination among TSOs more important than ever.

ENTSO-E provides a platform to coordinate deliverables to support regional cooperation across neighbouring regions and where addressing the matter at the pan-European level is more efficient than doing so bilaterally.

The “Annual Report on Regional Coordination Assessment 2022” was published by ENTSO-E on 4 October 2023.

The implementation of the RCC services from SOGL is still ongoing:

- › Short-Term Adequacy Assessment Process (STA) and OPC are in operation but will continue to be updated;
- › Common Grid Models (CGM) are live, and Individual Grid Models (IGMs) are provided by TSOs over the Operational Platform for Data Exchange (OPDE) for the creation of pan-European CGMs;
- › The implementation of CSA and CCC in the regions according to regional methodologies will be pursued; and
- › The consistency assessment of system defence plans and restoration plans (Article 6 of NC ER) is already established.

ENTSO-E is actively involved in various aspects of the STA (Article 81 SO GL), OPC (Article 80 SO GL) and CGM services, while the CC (Article 25 CACM Regulation) and CSA (Article 75 SO GL) services are mainly implemented in the regions. IEM The Electricity Regulation (Recital 59, Article 30 (1)(e) and Article 30 (2)) stipulates that ENTSO-E will have a more active role in monitoring and coordinating the implementation of regional services.

In addition to the original services defined in the network codes and guidelines, new RCC tasks are defined in Article 37 (1) of Electricity Regulation. ENTSO-E shall prepare proposals for the new tasks, which are not already covered in the Network Codes or Guidelines.

KEY DATES & DOCUMENTS

4 Oct 2023

[Publication of the ‘Regional Coordination Assessment Annual Reporting’](#)

- › Article 37 (1)(g): Training and Certification: execution phase is expected to last until 2026.
- › Article 37 (1)(h): Supporting restoration: methodology proposal planned to be delivered in September 2024 after which implementation will be initiated.
- › Article 37 (1)(j) and Article 37 (1)(k): Sizing and procurement of balancing capacities: implementation by SORs together with RCCs is expected in the coming years.
- › Article 37 (1)(l): Inter-TSO settlement: implementation will be done where applicable, if requested by TSOs.
- › Article 37 (1)(o): Maximum Entry Capacity: task go-live and first delivery in 2024, ENTSO-E will continue to actively support continued process development.
- › Article 37 (1)(p): The need for new infrastructures, which is related to system development, is currently on hold pending full implementation of CGM and CSA/CC processes.



“ Regional Coordination Centres such as Coreso play a crucial role by coordinating cross-zonal exchanges and grid security for TSOs and market players in Europe. Based on our grid knowledge and expertise, we propose solutions and actions to TSOs to ensure a secure, sustainable and efficient management of the European transmission system. In 2023, significant milestones have been achieved to further develop and implement the regulated coordination tasks aiming to strengthen TSO regional coordination. This was possible thanks to the intensive collaboration between TSOs, ENTSO-E and RCCs. ”

*Jan Van Roost,
Chief Executive Officer, Coreso*

Tasks of Regional Coordination Centres (RCCs)		
Methodology development	DA and ID CapCalc (Article 20.2)	RD and CT (Article 35.1)
a) Coordinated capacity calculation	CCMs completed	Partially done
b) Coordinated security analysis	Regional Operational Security Coordination (ROSCs) completed; CSAm completed; Regional Cost sharing methodologies completed; Regional Re-dispatching and Countertrading methodologies completed	On track
c) CGM	ROSCs completed, CGMm update in progress	Partially completed, technical service is live but continuous improvement is ongoing to ensure CGMs created meet the requirements from other regional services
d) Support assessment of defence and restoration plans	N/A	Completed
e) Short-term adequacy	ROSCs completed; Short-term and Seasonal Adequacy methodology completed	Partially completed; Continuous improvements ongoing for methodology compliance
f) Regional outage planning coordination	ROSCs completed; RCOP investigation ongoing; WA CGMm completed	Pan-EU level completed; Regional almost completed, improvements ongoing
g) Training and certification	Completed	On track
h) Supporting regional restoration	On track	-
i) Post-operation and post-disturbance analysis and reporting	Completed	Completed
j) Regional sizing of reserve capacity	Approved, Amendments needed	SORs are organising groups including RCCs for implementing the task
k) Facilitating procurement of balancing capacity	Approved, Amendments needed	SORs are organising groups including RCCs for implementing the task
l) Support optimisation Inter TSO settlement	Completed	If requested by CCR TSOs
m) Crisis scenarios	On track	Completed
n) Seasonal adequacy	N/A	N/A
o) Maximum entry capacity for CMs	Completed	On track
p) Supporting needs for new infrastructures	Ongoing	-

8.1 Other regional developments

ENTSO-E supports the IT operations and evolutions of Outage Planning Coordination (OPC) and the Short-Term Adequacy Assessment Process (STA) for the pan-European IT Tool. The OPC pan-European IT Tool, operational since the end of March 2020, allows all RCCs and TSOs to coordinate weekly outage planning on the regional level. Based on generation and demand forecasts provided by all ENTSO-E Member TSOs, the STA pan-European IT Tool, launched in May 2020, enables RCCs and TSOs to perform daily calculations that identify adequacy levels for the week ahead.

ENTSO-E supports RCCs with the further developments of the OPC and STA IT tools to improve the service delivery according to TSO and RCC requirements. ENTSO-E also supports TSOs and RCCs in further improving the CGM operational performances and has initiated the development project for the Maximum Entry Capacity calculation tool, which will go live with the first delivery in 2024.

8.2 Common Grid Model (CGM)

The CGM and Operational Planning Data Environment (OPDE) are critical enablers of the operational coordination and the security of supply on a European level. Ensuring greater visibility and insight into pan-European interconnection flows is a critical step in the broader effort to strengthen grid security, ensure cost-efficient operation, and increase cooperation and collaboration amongst the European TSOs and RCCs.

The legal basis for CGM and OPDE is found in The legal basis for CGM and OPDE is found in three of the Network Codes: the SOGL (Article 64), the CACM Regulation (Article 17) and the FCA Regulation (Article 18).

The CGM is a prerequisite for several services harmonised in the Network Codes, including coordinated capacity calculation (CCC), Coordinated security analysis (CSA), OPC and Short-term adequacy analysis.

A CGM compiles with the IGM of each TSO, covering timeframes from one year before real-time to one hour before real-time. After a quality assessment and pan-European alignment process, TSOs' IGMs are picked up by RSCs, which merge them into a pan-European CGM and feed the merged CGM back into the system.

8.3 Achievements and Challenges

In July 2023 ACER approved the methodology proposals for RCC Sizing and Procurement of reserve capacity. Implementation has been initiated by the SORs.

Prototype tool for the Maximum Entry Capacity calculation was developed and tender for development of industrialised tool was completed in 2023.

Following the go-live of the CGM Programme at the end of 2021 and the completion of a sub-stability phase in 2022, for 2023 Board targets were identified to ensure close to 100 percent participation of the TSOs and RCCs to the CGM service for ID and DA timeframes. To achieve the set targets, SOC decided to stabilise the CGMES standard for use for the CGM service to enable higher criteria for achieving full operations.

There was continuous effort from the RCCs, who started to merge IGMs provided by TSOs into CGMs for ID, DA, two-days-ahead and year-ahead time frames with frequent debugging sessions. The CGM merge is performed by two RCCs in the role of merging agents to ensure redundancy, and the rotation is ensured on a regular basis between five RCCs participating in the merge process. The CGM merge success rate of the RCCs has been close to 100 percent in 2023. Several initiatives were also undertaken in 2023 to support the TSOs to increase the levels of submission and publication of IGMs and their inclusion in CGMs through channels such as Model improvement, bi-monthly interoperability testing, fixing OPDE connectivity issues, etc. To facilitate full participation, a survey was conducted in Q3 2023 for all the TSOs and RCCs to identify key issues blocking participation to the CGM building process. The challenges and risks were communicated, and mitigation actions will be taken in 2024. Three TSOs were unblocked from connecting to OPDE after the successful completion of the security audits and meeting the MVS criteria for connection.

TSOs, RCCs and ENTSO-E coordinate at regional level to anticipate and prepare for future operational challenges. Regional coordination between these actors is essential to address the complexity of operating the future European grid and to constantly evolve Regional Coordination Processes.

*Carla Wolf and Andrea Mannocchi,
Convenors of Steering Group Regional
Coordination.*



A woman with blonde hair in a ponytail, wearing large white over-ear headphones, is shown in profile, smiling and looking out a window. The scene is bathed in warm, golden sunlight, creating a bright and pleasant atmosphere. A large, semi-transparent white circle is overlaid on the left side of the image, containing the number '9'.

9

Information and Communication Technology: Ensuring Optimisation and Security of the Electricity System

9.1 Cybersecurity, Interoperability and Data

In 2017, the ENTSO-E Board approved a framework for digital activities, which clearly identified interoperability and cybersecurity as the two

foundations for ENTSO-E's information systems. This led to the approval of the ENTSO-E cybersecurity strategy in 2019.

9.2 Cyber-security

Protecting TSO systems and networks against cyber-attack is of paramount importance. For several years, ENTSO-E has been acting as a platform for sharing best practices between TSOs. The entry into force of the CEP tasked ENTSO-E with the mandate to promote cybersecurity and data protection in cooperation with relevant authorities and regulated entities (Article 30.1.n Reg. 943/2019). Within the framework of the cybersecurity improvement implementation plan⁵, in 2023, the newly established Information and Communication Technology Committee (ICTC) has actively promoted cybersecurity activities and contributed to enhanced security across the cyber domain, in particular the setting up of a dedicated Steering Group on Security and a Cybersecurity Working Group. These workstreams have prepared the very first incident and information sharing strategy that includes the voluntary communication among TSOs and lays down the preparations for the upcoming Network Code on Cybersecurity (and is expanding to the already existing ENTSO-E Secretariat procedures), in addition to risk assessments of the connections of Ukrenergog and Moldelectrica while helping to improve their cybersecurity posture.

In 2023, ENTSO-E and the DSO Entity have continued discussions on technical aspects of the key processes and deliverables for the implementation phase of the Network Code Cybersecurity (henceforth NCCS). The implementation phase is expected to start after the entry into force of the NCCS. ENTSO-E, in collaboration with the DSO Entity, has proposed feedback to the review rounds organised by ACER and the European Commission (the EC) to the revised NCCS versions. This collaboration has resulted in an edited and final version of the NCCS that has been sent by the EC to the translation and is expected to be published in Q2 2024.

On 21 September 2023 ENTSO-E, E.DSO, ENCS and ENISA together hosted a well-attended public conference on power grids cybersecurity in Athens, with keynotes and panel contributions from DG ENER and DG CONNECT. The event was also held in partnership with the European Energy – Information Sharing & Analysis Centre (EE-ISAC) and was organised as part of the cybersecurity week of ENISA. As cybersecurity becomes more dominant in all sectors, the conference explored the latest developments for the electricity grids to remain prepared for new cyber risks.

KEY DATES & DOCUMENTS

21 SEP 2023

[6th Event on Cybersecurity co-organised by E.DSO-ENCS-ENISA-ENTSO-E European energy grids' security in a changed landscape - closing the skills gap and getting prepared.](#)

⁵ The ENTSO-E Board approved the plan in 2022.



Information and communication technologies (ICT) are integral parts of our lives, much more than ever before. We perceive them as very important, value-added assets. At the same time, vulnerability and sensitivity considerations drive us to focus on resilience and cyber security. This is also the way we follow in ENTSO-E, aiming to provide the right ICT solutions to all our business activities. We strongly believe this is the right approach to successfully reach our energy transition goals.

Radek Hartman, Chair of the ENTSO-E Information & Communication Technologies Committee Chair

9.3 Data Exchange Standards: Ensuring pan-European Interoperability

Standards facilitate cross-border exchange and allow for the efficient and reliable identification of different objects and parties relating to the internal energy market and its operations. Standards also support the implementation of network codes, and several of ENTSO-E's IT tools and data environments, such as the OPDE, rely on standards. In accordance with Article 30.1.k of the Electricity Regulation (943/2019), ENTSO-E should contribute to the establishment of interoperability requirements and non-discriminatory and transparent procedures for accessing data. ENTSO-E develops and maintains an Electronic Data Interchange library to enable interoperability between actors in the electrical industry in Europe.

In 2023, the main standardisation activities included developing the Common Information Model (CIM) and implementation guides to support data exchanges required from the Network Codes; working on international standards; updating the data exchange profiles required for the RCC services; maintaining the harmonised role model; contributing to the editorial team's drafts of supporting documents related to the implementation acts on data and interoperability on consumption and metering data and general interoperability requirements; implementing Article 55 (2) (a, b, c) of the Internal Electricity Market (IEM) Regulation and Article 24 of the IEM Directive; setting up the Joint Working Group with EU DSO entity; and training activities for the TSO-RCC community.

The transition towards a more interoperable society implies the need to develop high-level use cases for data exchanges in energy that are key to delivering on the objectives of the Green Deal and the Digital Decade. Data exchange initiatives between TSOs and DSOs are the first step toward this transition, which will require trust for all stakeholders to embrace this evolution.

In 2023, the European Commission continued to make major steps to improve Europe's cybersecurity by finalizing the Cyber Resilience Act and the Network Code on Cybersecurity (NCCS). ENTSO-E has played a key role in developing the NCCS, and it will keep the role in its implementation. Only by working together as a TSO community can we involve the right experts to understand cybersecurity risks to the electricity system, and determine the right measures to mitigate these.

*Anjos Nijk, Managing Director
of the European Network
for Cyber Security*





10

ENTSO-E Strategic Roadmap 2023 – 2025

In the course of 2023, ENTSO-E decided to follow-up on its Vision by elaborating and agreeing a Strategic Roadmap for the association and its member TSOs.

This new ENTSO-E Strategic Roadmap provides a framework to address the challenges of the European electricity system via all our key tasks and deliverables. It builds on activities necessary to ensure a secure and efficient power system for Europe and on the recently published ENTSO-E Vision “A Power System for a Carbon-neutral Europe”. It reflects the shared priorities of TSOs in Europe and serves as a compass for the work of ENTSO-E today and for the future.

The Strategic Roadmap is built around two interconnected pillars, which reflect the shared twofold mission of TSOs in Europe: preparing a future Power System fit for a Carbon-Neutral Europe, all the while managing a Secure and Efficient Power System for the whole of Europe.

ENTSO-E Strategic Roadmap 2023–2025 and beyond



Figure 7 – Two Pillars contributing to the ENTSO-E strategic dual objective

Pillar 1: a power system fit for a carbon-neutral Europe will require significant changes in five key areas:

- › The development of significant Energy System Flexibilities to balance the increased weather-dependency and complexity of the energy system;
- › The adaptation of the Operation of Future Grids, to deliver a secure and efficient operation of what will have become a “system of systems”;
- › A strong drive on Infrastructure & Investments, to accelerate the development and delivery of the grids needed for the transition; An updated Electricity Market Design to give value to what will be needed for the energy transition and empower energy consumers; and
- › A coordinated and targeted Innovation effort, to enable the necessary technology developments, grid equipment and uptake of solutions.

Pillar 2: a secure and efficient power system for Europe requires:

- › Operational Excellence, to support TSOs for an efficient, secure and resilient system operation;
- › Market Development and Operation, to support and implement market mechanisms for efficiently operating the system and optimising social welfare;
- › Regional Coordination between national and regional actors at the scale of European regions; and
- › Information and Communication Technologies and the tools to manage the power system.
- ›

With this new ENTSO-E Strategic Roadmap, our association now has a clear framework to address the ambition and the challenges of the European electricity system. This powerful tool reflects the shared priorities of TSOs in Europe and serves as a compass for the work of ENTSO-E on its journey to reach our goal, our vision “A Power System for a Carbon-neutral Europe” while, at the same time, continuing to ensure a secure and efficient power system for Europe, navigating through our daily challenges.

Damian Cortinas, Chair of the ENTSO-E Board





11

**Policy, Communication and
Stakeholder Management**

TSOs for electricity ensure the efficiency and security of the pan-European interconnected power system across all time frames while simultaneously enabling the conditions for a carbon-neutral future. The energy transition goes with increased electrification of the economy to increase the share of Renewable Energy Sources (RES) while simultaneously securing access to sustainable, secure and affordable electricity. In this context, ENTSO-E is keen to provide a substantive voice for the sector of electricity grids to the EU policy developments supporting the energy transition and leverage its communication tools (website, publications, newsletters, events and social media) and stakeholder engagement activities (dedicated stakeholder groups, public consultations, specific meetings and individual contacts) in this regard.

The following paragraphs describe our main external outreach initiatives implemented in 2023.

11.1 Main events

11.1.1 Joint ENTSO-E & RGI Conference on Adaptation & Resilience – Ensuring the energy transition is built on resilient infrastructure

ENTSO-E co-hosted with Renewables Grid Initiative on 13 March 2023 an online conference “Adaptation and Resilience: Ensuring the energy transition is built on resilient infrastructure”. On this occasion, experts on climate change, energy infrastructure

and policies discussed the key elements to be considered when planning a robust and resilient renewable energy system, while adapting it to the impacts of climate change.

KEY DATES & DOCUMENTS

13 MAR 2023

[Video recording](#) of the Joint ENTSO-E & RGI event “Adaptation and Resilience: Ensuring the energy transition is built on resilient infrastructure”.

KEY DATES & DOCUMENTS

07 SEP 2023

[EU Grid Forum](#)

11.1.2 EU Grid Forum

Over 200 European industry leaders met on 7 September 2023 at the ENTSO-E “High Level Forum on Future of Our Grids – Accelerating Europe’s energy transition” in Brussels to exchange on opportunities and challenges for accelerating the development of electricity grids to support Europe’s energy transition. The Forum was organised under the patronage of the EU Commissioner for Energy Kadri Simson. The EU Spanish Presidency with the presence of Vice-President and Minister for Ecological Transition Teresa Ribera, highlighted the importance of electricity grids as a key enabler for meeting the European Green Deal targets.

The Forum provided policy input on the following topics:

- › Secure and mobilise the necessary financial capabilities; ([conclusions here](#))
- › How policy and regulation can facilitate and speed-up the grid investments; ([conclusions here](#))
- › The challenges of manufacturing capacities and skills to supply all the necessary grid components; ([conclusions here](#))
- › How to better include local communities and the public at large to increase support for grid infrastructure; ([conclusions here](#)).



Figure 8 - The EU Grid Forum was held in Brussels on 7 September 2023

11.1.3 ENTSO-E Conference 2023

The ENTSO-E Conference, “ENTSO-E Vision for the Future of the Energy System: One Year On”, was held on 4 October 2023.

One year on from the launch of our forward-looking ENTSO-E Vision: A Power System for a Carbon-Neutral Europe, the event provided a platform to take stock of the progress of the ENTSO-E Vision and discuss the present and the future of the European power system. Based on the ENTSO-E Vision, four elements have been identified as key to ensuring a successful transition and thus formed the basis of discussions at the Vision Conference: market design, flexibility, technology solutions and investments of the grid

infrastructure, as well as how other pivotal files such as the Net Zero Industry Act and the Critical Raw Materials Act will impact Europe’s ambitions for the transition.

This online conference brought together leading contributors from across the energy sector, including the European Commission, EU stakeholders and key members of ENTSO-E with an online audience of over 400 people. The event highlighted once more the need to accelerate the Energy Transition and the role of TSOs in facilitating this transition whilst maintaining system security.

KEY DATES & DOCUMENTS

04 OCT 2023

[Video recording of the ENTSO-E Conference “ENTSO-E Vision for the Future of the Energy System: One Year On”](#)

11.2 EU Policy Developments⁶

11.2.1 EU Grid Action Plan

On 28 November 2023, the European Commission adopted its EU Action Plan for Grids, building on the forum ENTSO-E organized on ‘Future of our Grids’ on 7 September 2023. This plan recognises the essential role of grids to achieve the decarbonisation of the European energy system. It consists in a set of 14 actions to be implemented by the end of 2025.

Those actions strongly resonate with ENTSO-E’s position on the future of the grids. On the topic of planning and delivering Europe’s future electricity

system, the plan incentivises coordinated onshore and offshore planning and a stronger cooperation with DSOs. It also acknowledges the vital role of transmission and cross-border interconnections and has concrete proposals to speed up permitting procedures.

When it comes to financing grid projects and ramping-up investments, the plan suggests providing stability and predictability for investors through the appropriate legal and regulatory framework, to adequately support the necessary grid expansions.

⁶ The reader can find ENTSO-E’s contribution to the EU Electricity Market Design Reform in Chapter 4 of the present Annual Report.

The plan also proposes to ensure adequate and sustainable manufacturing capacity, as first steps to address the current supply chain bottlenecks and manufacturing challenges including skills shortages. This is also recognised by ENTSO-E as a key priority to fulfil the needs for upgraded grids for a low-carbon power system. ENTSO-E has already started engaging with the stakeholders of the value-chain to systematically address this challenge (see chapter on EU Grid Forum).

Finally, the Plan acknowledges the need for forward-looking regulations, including guidelines for anticipatory investments that should align regulatory frameworks with energy policies.

ENTSO-E is committed to fulfilling its responsibilities under this Plan and to further cooperating with industry leaders and key stakeholders on its implementation. The EU Action Plan for Grids will contribute to accelerating the transition to a decarbonised, reliable and affordable energy system for Europe by unlocking the potential that grids can bring to meet the European decarbonisation targets.

11.2.2 European Wind Action Plan

ENTSO-E also detailed its position on the Wind Power Action Plan presented by the European Commission on 24 October 2023.

ENTSO-E is supportive of the emphasis placed on the efficient and effective permitting for renewables. This same emphasis is equally important for grid infrastructure. ENTSO-E therefore sees a strong link between the permitting of new wind power installations and related grid infrastructure, as this will ultimately facilitate the growing demand for wind power. For these reasons, consistency between the EU Wind Action Plan and the upcoming EU Grid Action Plan must be ensured.

Actions related to increased predictability through faster permitting will yield substantially higher acceptance by local communities in addition to

bringing forward the transposition and implementation of the revised Renewables Energy Directive (RED) provisions on permitting.

On the facilitation of access to EU funding, as highlighted in the EU Grid Forum conclusions, ENTSO-E is glad to see that facilitation measures have been included to support wind energy manufacturing. However, a holistic approach is needed to include access to funding, ensuring stability and predictability for investors through an appropriate legal and regulatory framework to adequately support the necessary grid expansions.

ENTSO-E also recognises the need to ensure a high-level of cyber and physical resilience in the electricity system is a must, in line with relevant EU legislation and the upcoming Network Code on Cybersecurity of cross-border electricity flows.

KEY DATES & DOCUMENTS

28 JUL 2023

[Publication](#) of the Net-Zero Industry Act position paper

11.2.3 Net-Zero Industry Act

On 16 March 2023, as an operational implementation of the “Green Deal Industrial Plan” and the “European Industrial Strategy”, the EC published a Net-Zero Industry Act (NZIA). ENTSO-E welcomed the inclusion of grid technologies as part of the Strategic Net-Zero Technologies list. In the context of increasing international competition, the EC’s proposals are a first step to ensuring that the EU will not suffer from a lack of manufacturing capacities, specialised skills, or critical and strategic raw materials.

In this context, ENTSO-E issued four recommendations in a position paper published in July 2023:

- › Ensure that industry stakeholders are properly included in the value chain dialogues;
- › Streamline permitting procedures to ensure the timely emergence of European manufacturing capacities;
- › Clarify public procurement provisions for a consistent purchasing policy compatible with EU climate objectives; and
- › Provide a clear and coherent regulatory framework to incentivise innovation in grid technologies.

11.2.4 Cyber Resilience Act

On 15 September 2022, the EC published a Proposal for a regulation of the European Parliament and of the Council on horizontal cybersecurity requirements for products with digital elements and amending Regulation (EU) 2019/1020, known also as the “Cyber Resilience Act” (CRA). Among the different legal provisions, the CRA seeks to improve the security of critical infrastructures by setting stricter conformity assessment requirements for critical products. For TSOs, as operators of critical infrastructure, it is therefore crucial that the CRA is designed in a way that optimally supports TSOs to mitigate cybersecurity risks and is coherent with other relevant EU legislations which aim to ensure cybersecurity of critical infrastructure.

From a regulatory perspective, the CRA is already well aligned with the Directive 2022/2555 on measures for a high common level of cybersecurity across the Union (the “NIS2 Directive”). Nevertheless, ENTSO-E believes that the alignment with the Network Code on sector-specific rules for cybersecurity aspects of cross-border electricity flows, also known as the NCSS, can be improved based on the following proposals:

KEY DATES & DOCUMENTS

27 JUN 2023

[Publication](#) of the position paper on the European Commission’s proposal for a Cyber Resilience Act

- › Adopting requirements developed under the NCCS as sectoral rules under the CRA;
- › Using the results from the NCCS regional cybersecurity risk assessment for the electricity sector to determine which products are critical; and
- › Requiring manufacturers to consider the results from the NCCS regional risk assessment in the risk assessments they need to perform under the CRA.

In addition, for the CRA to support cybersecurity risk mitigation for TSOs, more transparency should be provided to users regarding which risks a product can mitigate.

ENTSO-E's recommendations related to the Cyber Resilience Act include more transparency to users of critical products by:

- › Requiring manufacturers to describe the threats mitigated in the user documentation;
- › Requiring manufacturers to describe the assurance level in the user documentation; and
- › Defining clear criteria for when a reassessment needs to be performed for a product.

11.2.5 F-Gas

On 5 April 2022⁷, the EC proposed a revision of the Fluorinated Gas (F-Gas) Regulation. With a statement published on 17 March 2023, ENTSO-E gave its contribution to the debate on this legislative file. While embracing the overarching objective to reduce F-Gas emissions, European TSOs called for a realistic implementation approach.

TSOs for electricity use sulphur hexafluoride (SF6) in several applications, such as switchgear, transformers, gas insulated substations and gas-insulated transmission lines. Any barrier to the procurement process or any delay in the expansion or repair of such equipment pose critical risks to

the stability of the grid to ensure secure electricity supply and risks jeopardising decarbonisation targets.

For this reason, ENTSO-E and all European TSOs called for the inclusion of specific exemptions in the Regulation for spare parts and for the extension of existing assets, to be allowed until the end of the technical life span of the equipment. While supporting the development of SF6-free technological alternatives, it is of paramount importance that TSOs can continue to rely on multiple independent suppliers and suitable and mature technological solutions.

KEY DATES & DOCUMENTS

17 MAR 2023

Publication of the ENTSO-E's position on the F-Gas Regulation Revision

⁷ The F-Gas Regulation was published on 20 February 2024 in the Official Journal of the European Union: [Regulation - EU - 2024/573 - EN - EUR-Lex \(europa.eu\)](#)

11.3 Stakeholder Engagement

ENTSO-E engages with stakeholders via dedicated stakeholder groups, public consultations, specific meetings and individual contacts. Dedicated stakeholder groups include: the five Network Codes European Stakeholder Committees: the Market Stakeholder Committee, the Balancing Stakeholders Group, the Grid Connection Stakeholder Committee, the System Operations Stakeholder Committee and the Network Code Implementation and Monitoring Group. ENTSO-E is legally required to consult with stakeholders and citizens on its methodologies, guidelines, network development scenarios and its most strategic deliverables.

Stakeholder input is integrated into these documents before submission to NRAs and/or ACER. ENTSO-E uses the [Consultation Hub](#) as a platform to conduct public consultations and collect stakeholder input on the documents mentioned above. In 2023, ENTSO-E conducted 52 public consultations.



Enabling the energy transition is a global goal that requires a lot of technical expertise from all actors involved. It is essential for us that European citizens, decision-makers and policymakers understand the complexity behind this effort. In line with this objective, and with the Strategic Roadmap as a main reference, ENTSO-E is taking steps to enhance its external outreach capabilities.

*Timothée Decroix,
Convenor of the ENTSO-E Policy
and Communication Group*

A young boy in a bright yellow raincoat is shown from the side, holding a small white model wind turbine up to his eye as if looking through it. The background is a dramatic sky at sunset or sunrise, with soft orange and yellow light near the horizon and a clear blue sky above. The overall mood is one of hope and innovation.

12

Association Governance

12.1 NPC Ukrenergo and SA Moldelectrica as a New Member and New Observer of ENTSO-E Respectively

Following a vote by the ENTSO-E Assembly held on 14 December 2023, NPC Ukrenergo, the TSO in Ukraine, became the 40th Member of the Association as of 1 January 2024. ENTSO-E and NPC Ukrenergo have been working together since 2017 to achieve such an integration. A notable milestone was reached on 16 March 2022 with the emergency synchronisation of Ukraine and Moldova with the CE power system. In November 2023, ENTSO-E announced the successful completion of the synchronisation project with Ukraine after the compliance by NPC Ukrenergo with the key technical requirements necessary to enable a permanent interconnection between the power systems of CE and Ukraine.

Following a successful emergency synchronisation of the CE Power System with the Moldovan and Ukrainian grids in March 2022, the signing of the Observer Membership Agreement that took place on 22 November 2023 marks a meaningful moment in the evolution of the partnership between SA Moldelectrica and the European electricity TSO members of ENTSO-E.

These two developments reflect the dedication of the European TSOs to bolster the stability, efficiency and security of the European interconnected power network.

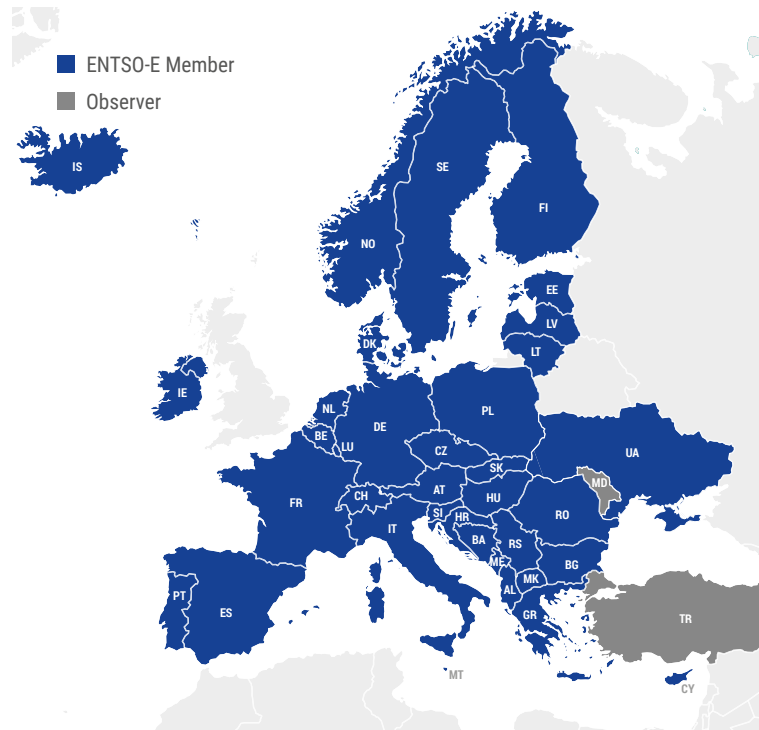


Figure 9 – ENTSO-E Membership as of 1 January 2024.

12.2 A new governance team

In 2023, ENTSO-E elected their new governance team, effective from 28 June 2023.

The new leadership is led by the President Mr Zbyněk Boldiš, (ČEPS, Czech transmission system operator), Vice-President Ms Asta Sihvonen-Punkka (Fingrid, the Finnish transmission system operator), Chair of the Board, Mr Damian Cortinas (RTE, the French transmission system operator) and Vice-Chair of the Board Mr Tahir Kapetanovic (APG, the Austrian transmission system operator). Mr Kapetanovic was elected Vice-Chair of the Board on 5 October 2023.

The Chairs of the ENTSO-E Committees, of the Legal and Regulatory Group and the Members of the ENTSO-E Board were appointed by the Assembly and assumed their role on 28 June 2023.

In 2023, ENTSO-E was governed by an Assembly representing the 40 TSOs and by a Board consisting of 12 elected members.

Assembly



Zbyněk Boldiš
President of the Assembly
ČEPS a. s.



Asta Sihvonen-Punkka
Vice-President of the Assembly
Fingrid

Board



Damian Cortinas
Chair of the Board
RTE



Tahir Kapetanovic
Vice-Chair of the Board
Austrian Power Grid



Anne Elisabeth Wedum
Member of the Board
Statnett



Dirk Biermann
Member of the Board
50Hertz Transmission



Eleni Charpantidou
Member of the Board
IPTO



Enrico Carlini
Member of the Board
Terna



Johannes Bruun
Member of the Board
Energinet



Liam Ryan
Member of the Board
EirGrid



Miguel De La Torre
Member of the Board
REE



Nell Reimann
Member of the Board
Swissgrid



Remigiusz Warzywoda
Member of the Board
PSE



Susana De Almeida De Graaff
Member of the Board
TenneT

Committees



Fokke Elskamp
Legal and Regulatory Group Chair
TenneT TSO B.V.



Gerald Kaendler
System Development
Committee Chair, Amprion



Kjell A. Barmsnes
Market Committee Chair
Statnett SF



Olivier Arrivé
System Operations
Committee Chair, RTE



Radek Hartman
Information & Communication
Technologies Committee Chair
ČEPS a.s.



Uroš Salobir
Research, Development &
Innovation Committee Chair
Eles

Appendix 1 – Network Codes and Clean Energy Package: Focus on Implementation

The Network Codes and Guidelines and the CEP represent a large part of the legislative framework under which ENTSO-E operates. The implementation of the Network Codes and Guidelines and the CEP represents a substantial effort which ENTSO-E is prioritising.

All codes and guidelines have entered into force, and ENTSO-E is now focused on their implementation and monitoring.

What is ENTSO-E's role in the implementation?

The implementation of European legislation occurs on national, regional and pan-European levels, frequently in combination. TSOs, DSOs, market participants and regulators at the EU, regional and national levels are also involved in various ways. In some cases, Network Codes or primary legislation define clear and detailed roles for specific bodies or entities; while in others, legal provisions are less detailed and require an additional layer of text to define roles and processes.

Implementation Responsibility in Network Codes and Guidelines

Task attributed to ...	Responsibility	Approval ⁸
ENTSO-E	ENTSO-E tasks	ACER
Pan-European "All TSOs"	All TSOs	ACER
Regional "All TSOs"	TSOs in the region	NRAs in the region. ACER makes the final decision if NRAs cannot agree ⁹
National	Depending on national legislation (TSO, DSO ...) (ENTSO-E may provide supporting documents and guidance)	National NRAs

Table 5 – Entities responsible for pan-European, regional and national tasks

⁸ In accordance with the CEP provisions of Electricity Regulation 2019/943.

⁹ In accordance with Article 5(3) of ACER Regulation 2019/942.

“All TSOs” refer to the TSOs of all EU countries (pan-European “All TSOs”), or the TSOs of a specific EU region (regional “All TSOs”).

Monitoring the Implementation

ENTSO-E is responsible for monitoring the implementation of Network Codes and Guidelines as defined by the legal provisions of the latter. To fulfil this obligation, ENTSO-E adds to monitoring plans and publishes reports. It also collects data (termed “lists of information”) and designs and implements interfaces for data collection. Based on new provisions under Regulation (EU) 2019/943, ENTSO-E will further cooperate with the future EU DSO Entity to monitor the implementation of possible new Network Codes and Guidelines. These will be adopted pursuant to this Regulation and are relevant to the operation and planning of distribution grids and the coordinated operation of the transmission and distribution networks.

ENTSO-E and ACER have signed an agreement on data collection and provision to ACER. This agreement is currently being used to monitor the Capacity Allocation and Congestion Management (CACM) and should then be extended to other Network Codes and Guidelines.



Appendix 2 – Staff

The ENTSO-E Secretariat Management Team



Sonya Twohig
Secretary-General



Ervis Bregu
Head of ICT Solutions
Section



Norela Constantinescu
Head of Innovation
Section



Evelyne Driane
Head of People,
Talent & Culture Section



Bruno Gouverneur
Head of Operations Section



Zoltan Gyulay
Head of Market Section



Edwin Haesen
Head of System Development
Section



Bertrand Macabeo
Head of Corporate Services
Section



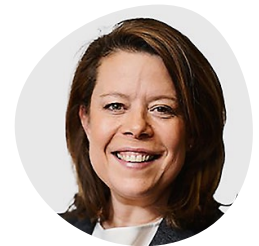
Florence Melchior
Head of Corporate Govern-
ance Section & General
Counsel



Nicolas Richet
Head of ICT Governance &
Architectures Section



Ivan Taleski
Head of Legal Section



Christelle Verstraeten
Head of Policy, Communications
and Stakeholder Management
Section

Appendix 3 – Cooperation with UK TSOs

On 31 December 2020, the United Kingdom (UK) officially left the European Union (EU) with a Trade and Cooperation Agreement (TCA) signed on the same date.

The TCA foresees that:

- › ENTSO-E and the UK TSOs shall prepare under the guidance of the Specialised Committee on Energy a framework for cooperation not involving, or conferring a status comparable to, membership in ENTSO-E by UK TSOs; and
- › EU and UK TSOs shall prepare technical procedures once requested by the Specialised Committee on Energy.

On 10 February 2023, the UK TSO's and ENTSO-E were tasked with providing a joint answer to a set of technical questions to the European Commission and the Department for Energy, Security and Net Zero (UK) on the proposed trading solution Multi-Region Loose Volume Coupling (MRLVC), which has

been agreed in the Trade and Cooperation Agreement between the European Union and The United Kingdom of Great Britain and Northern Ireland, in order to reintegrate GB electricity market into the EU electricity market.

The answers to the set of technical questions are a joint work of the group of relevant TSOs (UK TSOs and the EU TSOs directly connected to the UK). The involved parties have engaged with an external consultant, who has conducted quantitative analysis, interviews with relevant NEMOs, market participants, and facilitated workshops with EU experts to provide detailed insight on the technical questions. The work builds upon the CBA carried out in the spring of 2021 and seeks to further investigate and provide insights into the possible MRLVC design options which were proposed and assessed in the CBA.

The result of the work was sent to the European Commission and the Department for Energy, Security and Net Zero (UK) on 10 July 2023.

Appendix 4 – Resources

Budget

ENTSO-E AISBL¹⁰ is a not-for-profit organisation under Belgian law.

ENTSO-E's budget is covered by membership fees as well as other revenues and incomes. For 2023, the budget of ENTSO-E totalled EUR 61.2 million, funded by TSO member fees of EUR 42.4 million and other revenues of EUR 18.8 million (H2020 grants and additional TSO funding).

Staff

Our human resources include permanent staff and secondment from TSOs as well as outsourced “on site” services (such as IT support services). This is in addition to the numerous TSO staff members who bring their expertise to the Association via its numerous bodies (Assembly, Board, Committees and subgroups).

On 31 December 2023, ENTSO-E counted 145 employees.

¹⁰ International not-for-profit association (Association internationale sans but lucratif)

Abbreviations

Abbreviation	Definition
ACER	Agency for the Cooperation of Energy Regulators
aFRR	Automatic Frequency Restoration Reserves
AISBL	Association Internationale Sans But Lucratif (International Not-For-Profit Association)
CACM	Capacity Allocation and Congestion Management
CBA	Cost-Benefit Analysis
CCR	Capacity Calculation Region
CE	Continental Europe
CEF	Connecting Europe Facility
CENELEC	European Committee for Electrotechnical Standardisation
CEP	Clean Energy Package
CfDs	Contracts for Difference
CGM	Common Grid Model
CGMES	Common Grid Model Exchange Standard
CIDM	Congestion Income Distribution Methodology
CIM	Common Information Model
CNC	Connection Network Code
CNEC	Critical Network Element
CoNE	Cost of New Entry
CRMs	Capacity Remuneration Mechanisms
CSAM	Methodology for Coordinating Operational Security Analysis
CZC	Cross-Zonal Capacity
DA	Day Ahead

Abbreviation	Definition
DCC	Demand Connection Code
DERs	Distributed Energy Resources
DSO	Distribution System Operator
EAS	ENTSO-E Awareness System
EB Reg.	Electricity Balancing Regulation
EC	European Commission
ENTSOG	European Network of Transmission System Operators for Gas
ERAA	European Resource Adequacy Assessment
ETIP SNET	European Technology and Innovation Platform Smart on Networks for Energy Transition
EU	European Union
FCA	Forward Capacity Allocation
FCR	Frequency Containment Reserve
FSKAR	Financial Settlement of KΔf, ACE and ramping
GHG	Greenhouse Gases
GL	Guideline
GRIT	Greece-Italy
GUI	Graphical User Interface
HAR	Harmonised Allocation Rules
HVDC	High Voltage Direct Current
iAC	Independent Advisory Council
ICS	Incident Classification Scale
ICTC	Information and Communication Technology Committee
ID	Intraday

Abbreviation	Definition
IEC	International Electrotechnical Commission
IEM	Internal Energy Market
IGCC	International Grid Control Cooperation
IGDs	Implementation Guidance Documents
IGM	Individual Grid Model
IN	Imbalance Netting
ITC	Inter Transmission System Operator Compensation
JAO	Joint Allocation Office
KORR	Key Organisational Roles and Responsibilities
LTTR	Long-Term Transmission Rights
PMU	Phasor Measurement Unit
PRA	Probabilistic Risk Assessment
Prosumers	Neologism that designates producers and consumers
RCC	Regional Coordination Centre
RES	Renewable Energy Source
RfG	Requirements for Generators
RGCE	Regional Group Continental Europe
RDI	Research, Development and Innovation
RoCoF	Rate of Change of Frequency
ROSC	Regional Operational Security Coordination
RR	Replacement Reserves
RSC	Regional Security Coordinator
SA	Synchronous Area
SAT	Site Acceptance Test

Abbreviation	Definition
SAFA	Synchronous Area Framework Agreement
SCC	Security Coordination Centre
SDAC	Single Day-Ahead Coupling
SEC	Scheduled Exchanges Calculation
SET	Strategic Energy Technology
SEE	South-East Europe
SEW	Social Economic Welfare
SIDC	Single Intraday Coupling
SLA	Service-Level Agreement
SO	System Operation
SOC	System Operation Committee
SOGL	System Operation Guideline
SOR	System Operation Region
SSDLC	Secure Software Development Lifecycle
TCA	Trade and Cooperation Agreement
TERRE	Trans-European Replacement Reserves Exchange
TP	Transparency Platform
TRL	Technology Readiness Level
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
UK	United Kingdom
VoLL	Value of Lost Load
WA	Working Arrangement
WAMS	Wide Area Monitoring System

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