2025

ANNUAL REPORT

entsoe

Contents

Foreword 2
Highlights of 2025 6
Strategic Roadmap 2023-2025 10
Our Mission, our Vision 12
Governance 13

CHAPTER 1 Operational Excellence 15
CHAPTER 2 Securing System Operations 20
CHAPTER 3 Managing Complexity: Energy System Flexibility 22
CHAPTER 4 Operating the grids of the future 24
CHAPTER 5 Infrastructure & Investments 26
CHAPTER 6 Innovative solutions 30
CHAPTER 7 Market Development and Operation 34
CHAPTER 8 Regional Coordination 43
CHAPTER 9 Information and Communication Technologies 46
CHAPTER 10 Facilitating the Energy Transition A Fit for Purpose Market Design 49

APPENDIX 1 Staff 52
APPENDIX 2 Resources 53
APPENDIX 3 Collaboration with UK TSOs 54
APPENDIX 4 Network Codes and Clean Energy Package: Focus on implementation 55

Foreword

Zbyněk Boldiš
President

Damian Cortinas
Chair of the Board

In 2025, Europe's power system stands at the crossroads of a profound transformation. Electrification is accelerating, renewables are re-shaping the energy mix, and the electricity mix is increasingly expected to not only deliver security and efficiency, but also enable a low-carbon, competitive and resilient economy. This is a challenge of historic scale and comes with significant responsibility. In this defining moment, ENTSO-E's role as a system-wide coordinator and trusted technical authority is more critical than ever.

Building on more than fifteen years of cooperation and technical excellence, ENTSO-E continues to translate a shared vision of the future into coordinated action. Guided by our Strategic Roadmap, we continue to work tirelessly to prepare the European power system for a carbon-neutral future, while safeguarding security of supply, system efficiency and market integration in every step of the way.

To achieve Europe's energy transition, we need ambition to match infrastructure. In 2025, ENTSO-E's system-wide planning and analytical work provides a clear, evidence-based view of investment needs and system benefits, supporting informed national and cross-border decisions. Since the first TYNDP in 2010, over 16,000 km of new transmission infrastructure have been built. In addition, since 2010, 23 EU Member States have established at least one new interconnection, further strengthening the interconnection of Europe's electricity grid. At the same time, ENTSO-E is contributing to practical conditions that enable delivery, recognising that grids must not only be planned, but continue to be built, financed and connected in time to meet Europe's electrification goals.

As the power system becomes more decentralised, digitalised and interconnected, operational excellence remains paramount. ENTSO-E continues to enhance adequacy assessments (European Resource Adequacy Assessments and two Seasonal Outlook reports were released in 2025), flexibility analysis and market integration tools to ensure that reliability keeps pace with transformation. ENTSO-E is actively engaging with stakeholders, promoting harmonisation of the regulatory frameworks and cross-sector collaboration on energy security and risk preparedness to strengthen the European risk preparedness. Recent system incidents serve as a powerful reminder that resilience is not static but needs to match the pace of the overall transformation of the electricity system. In this regard, continued vigilance, transparency, and coordination across all levels is essential.

Cooperation remains a core enabler, a key component of our progress. 2025 saw deepened cooperation with all stakeholders: from European institutions, national regulators and DSOs to market participants to neighboring regions. ENTSO-E continued its efforts to ensure that developments across borders and sectors accelerate at the pace needed to match our shared challenges. Joint initiatives on flexibility, digitalisation and energy system planning reflect our shared commitment to maintaining European interdependence as a strength and the fuel our success.

These achievements are driven by the expertise and dedication of ENTSO-E's members and Secretariat. Their collective knowledge and long-term perspective ensure that Europe's power system evolves with purpose and coherence.

Looking ahead, ENTSO-E remains united by a clear purpose: to enable a secure, efficient and integrated European power system that supports decarbonisation, strengthens resilience, and delivers lasting value for citizens and society.

Zbyněk Boldiš, President of the Assembly
Damian Cortinas, Chair of the Board

Introductory Statement

This Annual Report covers the period from January 2025 to December 2025. It presents ENTSO-E's key achievements in supporting the secure and coordinated operation of Europe's power system, while contributing to the implementation of European energy and climate policy objectives. The report highlights ENTSO-E's central role in facilitating the energy transition, in fulfilling its legal mandates under EU legislation, and in coordinating pan-European "All TSOs" tasks across system operation, market design, infrastructure planning, innovation, and digitalisation.

The activities described in this report were carried out with the expertise and support of the 40 Transmission System Operators (TSOs) that were ENTSO-E members in 2025. The successful delivery of these tasks also reflects the valued input of stakeholders through structured consultations, collaborative processes, and dedicated engagement forums.

A core framing element of ENTSO-E's work in 2025 is the Strategic Roadmap 2023–2025, which sets the vision and priorities for Europe's TSOs. The Roadmap defines a common direction based on two interconnected pillars: **Pillar 1** – *Preparing a power system fit for a carbon-neutral Europe,* and **Pillar 2** – *Operating a secure and efficient power system today*.

The 2025 report also reflects ENTSO-E's expanding responsibilities in the context of digitalisation, cybersecurity, and the integration of new system actors, including developments related to the Network Code on Demand Response and the Network Code on Cybersecurity.

In an increasingly complex and fast-changing energy landscape, ENTSO-E continues to act as a technical leader and trusted partner, contributing to the success of the EU's energy and competitiveness priorities and ensuring the power system remains secure, efficient, and future-ready.

PILLAR 1

A POWER SYSTEM FOR A CARBON-NEUTRAL EUROPE

PREPARE
THE FUTURE

PILLAR 2

A SECURE AND EFFICIENT POWER SYSTEM FOR EUROPE

MANAGE
THE PRESENT

Highlights of 2025

January 2025

ENTSO-E publishes its 2024 edition of the Ten-Year Network Development Plan (TYNDP), highlighting the need for large-scale, cost-efficient investments in cross-border and national electricity grids, while flagging permitting and supply-chain constraints as key risks to timely delivery of infrastructure essential for Europe's secure, competitive and decarbonised energy system.

9 February 2025

Estonia, Latvia and Lithuania successfully synchronise with the Continental Europe Synchronous Area (CESA), marking a significant step forward for regional security and European grid integration.

5 March 2025

Lithuanian electricity transmission system operator Litgrid successfully accesses the pan-European Platform for the International Coordination of Automatic Frequency Restoration Reserves and Stable System Operation (PICASSO), becoming the 13th electricity Transmission System Operator (TSO) to join the platform.

Litgrid

JANUARY | FEBRUARY | MARCH

9 April 2025

ENTSO-E submits the draft 2024 TYNDP to ACER.

7 April 2025

Marking continued efforts to ensure system adequacy, ENTSO-E publishes key findings from its European Resource Adequacy Assessment (ERAA) 2025. The ERAA provides an integrated, pan-European perspective on the challenges of European countries face in maintaining the reliability of their power system for the years 2028 and 2030 in longer term 2033 and 2035.

16 April 2025

ENTSO-E and the EU DSO Entity jointly submit proposal for Flexibility Needs Assessment (FNA) methodology to ACER.

28 April 2025

ENTSO-E releases the report on the Bidding Zone (BZ) Study. In this report the TSOs within the electricity markets of the Central Europe and Nordic regions evaluated 14 alternative bidding zone configurations specified by ACER (1,3).

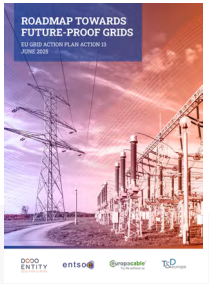
May 2025

ENTSO-E releases its Summer Outlook Report 2025, confirming that most European regions faced no systemic adequacy risks in the summer period. Limited risks are identified in the island systems of Ireland, Malta and Cyprus due to planned outrages, limited imports and lack of back-up resources.

ENTSO-E sets up an independent Expert Panels to investigate the causes behind the blackout in Spain and Portugal of 28 April and the partial blackout in North Macedonia of 18 May.

2 June 2025

Exemplifying the electricity sector's commitment to developing future-proof infrastructure, ENTSO-E, Europacable, DSO Entity and T&D Europe publish a "Joint Roadmap for Future Proof Grids".



25 June 2025

ENTSO-E appoints its new governance team, which will be in place for a two-year mandate until the June 2027 ENTSO-E General Assembly.

APRIL | MAY | JUNE

4 July 2025

ENTSO-E sets up an Expert Panel to investigate the causes of the grid incident in Czech Republic.

7 July 2025

ENTSO-E and EU DSO Entity launch Joint Working Group (JWG) Data Interoperability Repository to support transparent and harmonised data access across Europe.

17 July 2025

ENTSO-E successfully concludes new Working Arrangements with UK TSOs, ensuring continued technical cooperation on system security and offshore grid development following the UK's exit from the European Union.

11 September 2025

ENTSO-E publishes its Recommendations for the European Grids Package, highlighting the need for streamlined planning and strengthened regional coordination, faster permitting, creating a more favourable environment for investments and strengthening supply chains.

JULY | AUGUST | SEPTEMBER

3 October 2025

The Expert Panel on the 28 April Blackout in Spain and Portugal publishes the Factual Report, providing a minute-by-minute overview of the event, system conditions and restoration process.

3 November 2025

ENTSO-E publishes the draft list of electricity infrastructure projects to be assessed in the next edition of the Ten-Year Network Development Plan (TYNDP), consisting of 178 transmission projects and 49 storage projects.

6 November 2025

ENTSO-E submits to ACER its proposal for the repurposing of the ERAA Methodology, as required by ACER's request dated 6 April 2025.

10 November 2025

The Expert Panel on the 18 May blackout in North Macedonia releases its comprehensive factual report on the event.

20 November 2025

ENTSO-E publishes its Winter Outlook 2025-2026, confirming that Europe is adequately prepared for the coming winter.

10 December 2025

ENTSO-E reacts to the publication of the European Grids Package, highlighting the need for greater simplification and cautioning against governance changes that could weaken the link between European-level planning and national specificities.

16 December 2025

FNA methodology submission to ACER Methodology

19 December 2025

- The Expert Panel on the 4 July power system incident in the Czech Republic releases its comprehensive factual report on the event.
- ENTSO-E and the EU DSO Entity jointly submit draft proposal for an "Implementing Regulation on demand on interoperability requirements and non-discriminatory and transparent procedures for access to and exchange of data for demand response" to the European Commission.
- ENTSO-E and the EU DSO Entity publish joint progress report on Capacitypedia.

22 December 2025

Annual Work Programme 2026 published.

OCTOBER | NOVEMBER | DECEMBER

Strategic Roadmap 2023–2025

Guided by the Strategic Roadmap 2023–2025, ENTSO-E's 2025 activities followed a clear, collective direction for Europe's Transmission System Operators. The Roadmap recognises their dual role: safeguarding system reliability in the present and enabling the transformation to a decarbonised and digitalised future. It is organised around two complementary pillars that define the association's strategic focus.

PILLAR 1

A power system fit for a carbon-neutral Europe will need significant changes in five key areas.

Europe's climate targets demand a structural transformation of the electricity system. TSOs are leading this shift by:

- **Enhancing system flexibility** to manage greater variability from renewables and enable demand-side participation
- **Adapting operational practices** to cope with more decentralised and digitally integrated grids
- **Scaling up infrastructure and investment** to support electrification, offshore integration and cross-border capacity
- **Modernising market design** to send the right price signals, unlock flexibility, and empower consumers
- **Driving innovation** to develop and deploy the tools, technologies and standards of the future

PILLAR 2

Securing system operations today.

As transformation accelerates, TSOs remain responsible for delivering secure and efficient system operation. This requires:

- **Operational excellence**, with robust planning, coordination and real-time oversight
- **Market development**, ensuring cross border efficiency and system balance
- **Regional coordination**, aligning national and regional actions across Europe
- **Advanced ICT systems**, supporting digitalisation, data exchange and cybersecurity

Together, these two pillars define ENTSO-E's strategic response to a fast-changing energy landscape, and structured the work delivered throughout 2025.

Our Mission, our Vision

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the association of the European transmission system operators (TSOs). The 40 member TSOs, representing 36 countries, are responsible for the secure and coordinated operation of Europe's 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 creation of electrical synchronous areas and interconnections which were established in the 1950s.

In its present form, ENTSO-E was founded to fulfil the common mission of the European TSO community: to power our society. At its core, European consumers rely upon a secure and efficient electricity system. Our electricity transmission grid, and its secure operation, is the backbone of the power system, thereby supporting the vitality of our society. ENTSO-E was created to ensure the efficiency and security of the pan-European interconnected power system across all time frames within the internal energy market and its extension to the interconnected countries.

ENTSO-E is working to secure a carbon-neutral future. The transition is a shared political objective throughout 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.

In its Strategic Roadmap presented in 2024, ENTSO-E has organised its activities around two interlinked pillars, reflecting this dual role:

"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 of Net Zero, the challenges of today and those of the future for the benefit of consumers, by working together with all stakeholders and policymakers.

Governance

In 2025, ENTSO-E elected their new governance team, effective from 26 June 2025. The new leadership is led by the President Mr Zbyněk Boldiš, Vice-President Ms Susana de Almeida de Graaff, Chair of the Board Mr Damian Cortinas and Vice-Chair of the Board Mr Tahir Kapetanovic.

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 roles on 25 June 2025.

In 2024, ENTSO-E was governed by an Assembly representing the 40 TSOs and by a Board consisting of 11 elected members.

Assembly:

Zbyněk Boldiš
President of the Assembly

Susana de Almeida de Graaff
Vice-President of the Assembly

Board:

Damian Cortinas
Chair of the Board

Tahir Kapetanovic
Vice-Chair of the Board

Marie Budtz
Member of the Board

Enrico Carlini
Member of the Board

Eleni Charpantidou
Member of the Board

Miguel De La Torre
Member of the Board

Pascale Fonck
Member of the Board

Frank-Peter Hansen
Member of the Board

Michael Kelly
Member of the Board

Kristin Lucie Munthe
Member of the Board

Nell Reimann
Member of the Board

Remigiusz Warzywoda
Member of the Board

Committees:

Grzegorz Bojar
Information and Communication Technologies Committee Chair

Olivier Arrivé
System Operations Committee Chair

Oliver John
Market Committee Chair

Patricia Labra
System Development Committee Chair

Maximilian Falbrede
Legal and Regulatory Group Chair

Uroš Salobir
Research, Development and Innovation Committee Chair

1 Operational Excellence

ENTSO-E is built on the commonly shared primary interests of its Members to ensure the stability of the pan-European interconnected power system. Under this umbrella, work in 2025 focused on the Regulation (EU) 2017/1485 establishing the System Operation Guideline (SO GL), identifying key areas requiring amendments following developments in the energy landscape in Europe and delivering reports as requested by the Regulation. ENTSO-E also finalised and adopted the updated Incident Classification Scale (ICS) Methodology to be applied as of 2026.

ENTSO-E pursued further collaboration with national TSOs. Ukrainian TSO Ukrenergo's adherence to the ENTSO-E Awareness System (EAS) Data Exchange and Delivery Agreement was approved. Following synchronisation of Ukrenergo and Moldovan TSO Moldelectrica with the Continental Europe Synchronous Area (CESA) in 2022, efforts in 2025 focused on helping Moldelectrica meet the requirements defined in its Catalogue of Measures. The Baltic TSOs successfully initiated synchronisation of their grids with CESA on 9 February 2025. On 25 November 2025, Continental Europe confirmed the successful synchronisation of Estonia, Latvia and Lithuania with the Continental Europe Synchronous Area.

I The System Operation Guideline

The SO GL sets out harmonised rules on how to ensure security of supply through efficient grid operation in a variable renewables paradigm. The implementation of the SO GL and the methodologies that stem from it entails several tasks for ENTSO-E and TSOs at the pan-European, synchronous area, and regional levels. Work at pan-European level is facilitated by ENTSO-E, whereas synchronous areas' activities are organised by TSOs in their respective regional groups. In preparation for a coming revision, in 2025 ENTSO-E worked on identifying key areas in which the SO GL requires amendments following developments in the European energy landscape.

Under Article 14 of the SO GL, ENTSO-E monitors the implementation of the Regulation across key operational areas. This includes oversight of operational security indicators under Article 15, load-frequency control under Article 16, and regional coordination under Article 17. It also covers the identification of divergences in national implementation of the terms, conditions and methodologies listed in Article 6(3), as well as potential improvements to tools and services pursuant to Article 55. In addition, ENTSO-E assesses the need for enhancements to the incident classification scale to support long-term operational security and identifies any difficulties in cooperation with third-country TSOs on secure system operation.

ENTSO-E regularly reports to stakeholders on developments regarding the implementation of the SO GL via the System Operations European Stakeholder Committee.

ENTSO-E supported TSOs in implementing Article 44 of the Methodology for Coordinating Operational Security Analysis, which requires the development of a probabilistic risk assessment methodology. Further details are provided in the 2025 Biennial Progress Report on Probabilistic Risk Assessment published in December 2025, as explained on page 22.

ENTSO-E has finalised and adopted the updated ICS Methodology to be applied by TSOs as of 1 January 2026. Developed under Article 8(3) of Regulation (EC) No 714/2009 and now governed by Article 30 of Regulation (EU) 2019/943 (Electricity Regulation), the ICS Methodology is a key framework for classifying and investigating incidents across Europe's power systems. The updated methodology aims to clarify and refine reporting procedures, the ICS Expert Panel process, and its timings. The previous ICS Methodology was approved by the ENTSO-E System Operations Committee on 4 December 2019. The revision of the ICS Methodology included a public consultation in the autumn of 2025.

The Annual Load Frequency Control (ALFC) report presents the results of the frequency quality evaluation criteria for each synchronous area and LFC block, and the initial Frequency Containment Reserves (FCR) obligations of each TSO for each month of the preceding two years, in accordance with Article 16 of the SO GL. Additional details include a description and the date of implementation of any mitigation measures and ramping requirements to alleviate deterministic frequency deviations in which TSOs were involved during the preceding year.

The following deliverables were published on ENTSO-E's website in 2025:

SO GL deliverables in 2025	Key documents
Article 15 Annual report on operational security indicators.	**29 September 2025** ICS 2024 Annual report
Article 16 Annual report on load-frequency control.	**30 September 2025** Publication of the ALFC report
Article 17 Annual report on regional coordination assessment	**30 September 2025** Publication of the Regional Coordination Assessment annual report 2024
Article 65 Year-ahead scenarios	**15 July 2025** Publication of all TSOs' scenarios definition and scenario description for the year 2026 CGM creation
Article 75 – CSAM article 44.1 Methodology for coordinating operational security analysis.	**12 December 2025** Biennial Progress Report on Operational Probabilistic Coordinated Security Assessment and Risk Management

The Emergency and Restoration Network Code

Regulation (EU) 2017/2196 establishing the Network Code on Electricity Emergency and Restoration (NC ER), in force since December 2017, governs how TSOs prepare for and respond to system emergencies. ENTSO-E continues to monitor the implementation of NC ER and since 2024 performs a voluntary campaign which aims to understand whether the Low Frequency Demand Disconnection related requirements are fit for purpose given the new energy landscape with higher penetration of energy from photovoltaics (PV).

Frequency Stability

The three grid incidents recorded in 2025 are being investigated. The potential relevance of frequency stability to their root causes will be addressed in the final reports prepared by the Expert Panels published in the first half of 2026.

Throughout 2025 ENTSO-E continued implementing recommendations from the final reports of ICS Expert Panel investigations concluded in past years in order to strengthen operational procedures across TSOs.

For more information, see the chapter on Securing System Operations on page 18.

ENTSO-E Awareness System (EAS)

The ENTSO-E Awareness System (EAS) provides a real-time, pan-European view of the state of transmission systems. All TSOs input measurement indicators, such as frequency and cross-border exchanges, are combined to give each TSO a comprehensive overview through the platform. In 2025, ENTSO-E monitored the system to ensure continuous operation within agreed Service Level Agreements (SLAs).

The EAS aggregates automatic real-time measurements (including SCADA-based indicators and, since 2023, selected Wide Area Monitoring System (WAMS) / PMU streams via a concentrator) together with manual operational indications used during stressed situations and disturbances (e.g., system states, predefined messages and short free-text messages). Given the continental scale of the system, EAS is designed to prioritise a limited set of high-value information to ease interpretation and speed up decision-making. In practice, this enables TSOs to better assess the nature and magnitude of disturbances, coordinate cross-border measures (including during restoration), and avoid actions that could aggravate system conditions.

Due to the approaching end of vendor support for the current Siemens Spectrum Power 4 platform in April 2027, ENTSO-E is implementing EAS NextGen to ensure continuity of Europe's real-time situational awareness capability. The NextGen programme replaces the legacy SCADA component with a future-ready real-time platform delivered by Hitachi Energy, with a planned operational transition in Q1 2027 and decommissioning of the legacy solution thereafter. The NextGen solution is planned to be hosted by Amprion and Swissgrid, with a programme focus on data migration, hosting readiness and end-to-end TSO connectivity (including ICCP readiness) ahead of system testing and go-live

Synchronisation of the Baltic State Power System with the Continental Europe Synchronous Area (CESA)

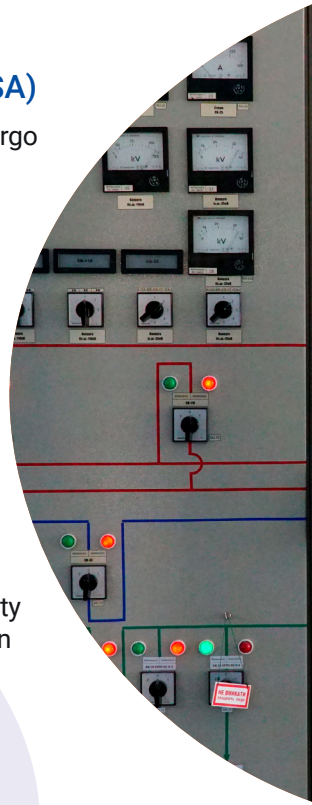
Estonia, Latvia, and Lithuania successfully initiated trial synchronisation of their grids with CESA on 9 February 2025 – a major technical and geopolitical milestone. ENTSO-E extended its efforts in ensuring the cross-border exchange between Lithuania and Poland, facilitating smooth transfer of affected operational regional and pan-European tasks.

On 25 November 2025, Continental Europe TSOs confirmed the completion of all technical requirements requested of the Baltic TSOs, decided on their permanent synchronisation with Continental Europe, and approved their adherence to the main Continental Europe Operational Agreement, the Synchronous Area Framework Agreement (SAFA). These decisions were the last success of the Baltic Synchronisation Project, which is now closed after a decade of preparation.

Integration of Ukrenergo and Moldelectrica into Continental Europe Synchronous Area (CESA)

The emergency synchronisation of Ukrenergo and Moldelectrica with the Continental Europe Synchronous Area was initiated in March 2022. Efforts in 2025 focused on helping Moldelectrica meet its Catalogue of Measures – a set of requirements based on the SO GL, NC ER, Electricity Balancing Guideline (EB GL), and SAFA.

Commercial electricity exchanges between Ukraine-Moldova and CESA began in July 2022 and have since expanded, with increasing capacity in both directions. As of July 2025, the Eastern Europe Capacity Calculation Region (EE CCR) took over the responsibility of deciding on this capacity, in consultation with ENTSO-E dynamic experts.



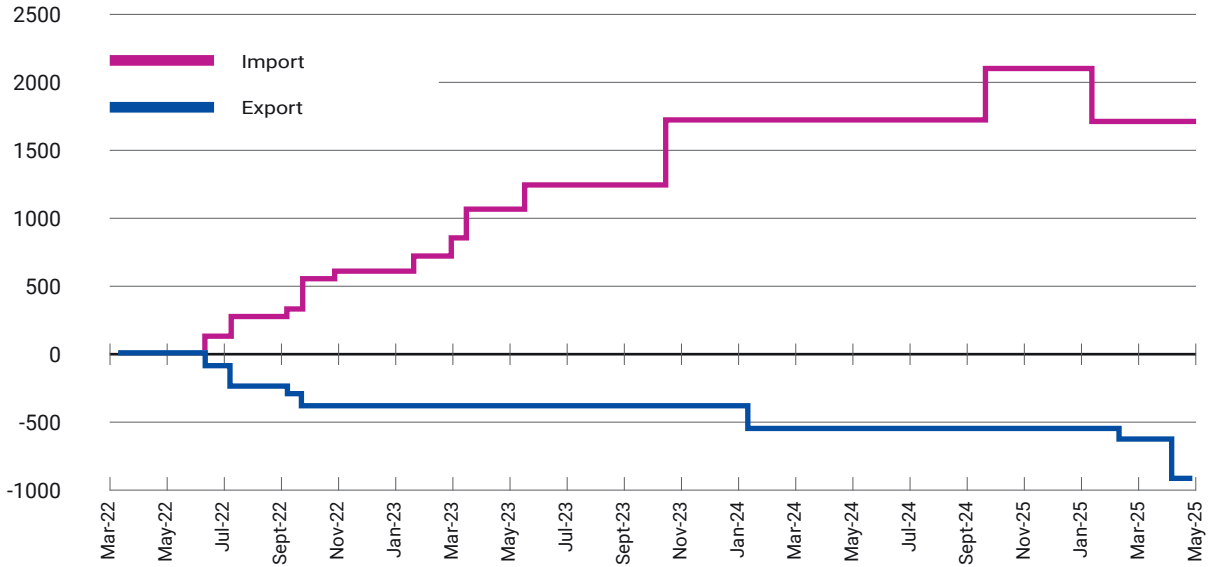


Figure 1 - Commercial exchanges between Ukraine/Moldova and Continental Europe

ENTSO-E also supported the inclusion of Moldelectrica in Continental Europe Operational Processes, coordinating Operational, Legal, and IT dimensions of the process. This inclusion should be finalised in 2026.

Tasks for Synchronous Areas

Depending on the specific arrangements within each Regional Group corresponding to Synchronous Areas (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 ongoing integration of third country TSOs.

Risk preparedness

Under the Risk Preparedness in the Electricity Sector Regulation (Regulation (EU) 2019/941), ENTSO-E is mandated to support EU-wide risk preparedness by assessing risks to electricity security (Article 4), developing the common methodology for regional electricity crisis scenarios (Article 5), and identifying regional electricity crisis scenarios (Article 6). These regional scenarios were subsequently reassessed in 2024.

In 2025, preparations for the next cycle in 2028 continued by engaging key stakeholders via workshops and sessions on the identified regional electricity crisis scenarios and planning and implementing improvements to increase European energy resilience. Key recommendations to improve European energy security have also been provided to the European Commission via the Call for Evidence on the revision of the EU's energy security framework (see ENTSO-E's response).

In March 2025, the ENTSO-E Assembly approved the creation of the Task Force Security of Critical Infrastructures. Its mandate is to assess system-wide security risks, analyse the impact of new and existing legislation, and support advocacy positions on energy security, with an end goal to increase the cooperation between TSOs on the security topic. It also provides the opportunity to identify the need for a structured cooperation with external actors.

Conclusion

In 2025, ENTSO-E continued to translate its legal mandate on supporting TSOs' contributions to security of supply into tangible operational delivery across Europe. Through the implementation and refinement of the System Operation Guideline and the Emergency and Restoration Network Code, the approval of the updated Incident Classification Scale Methodology, and the publication of key monitoring reports, ENTSO-E strengthened harmonised system operation in an increasingly complex and renewables-based electricity landscape.

At the same time, the successful synchronisation of the Baltic States with the Continental Europe Synchronous Area, the continued integration of Ukrenergo and Moldelectrica, and the steady operation and future renewal of the ENTSO-E Awareness System demonstrated Europe's capacity to enhance resilience, coordination and geopolitical cohesion through technical excellence.

Together, these achievements reflect ENTSO-E's commitment to operational excellence as the foundation of a secure, interconnected and future-proof European power system.

> The successful Baltic Synchronisation in 2025 marked a historic step for Europe's power system — built on shared infrastructure, operational trust and harmonisation, and the continued integration of new countries in the European electrical system, after Ukraine and Moldova in 2022.

Olivier Arrive
System Operations Committee Chair

> ENTSO-E and the European TSOs responded effectively to the 2025 incidents, leveraging the EU's existing legal framework for system operation and regional coordination to enable close cooperation, rapid information exchange, and strong cross border support. Collaboration under this framework proved essential to managing the crises TSOs faced in 2025 and the lessons learned will further strengthen the resilience of Europe's electricity system.

Maximilian Falbrede
Legal and Regulatory Group Chair

2 Securing System Operations

In 2025, three incidents occurred on the European Grid. These took place in Spain, Portugal (and a small area in Southwest France close to the Spanish border), North Macedonia, and Czechia. ENTSO-E is facilitating and supporting its TSO members in the investigation process, with each case overseen by a dedicated Expert Panel that brings together TSOs and regulatory authorities.

The three Expert Panels published the Factual Reports of their investigations presenting the minute-by-minute sequence of events. Analysis has been performed using the Incident Classification Scale (ICS) Methodology.

28 April Blackout in Spain and Portugal Factual Report Release

On 28 April 2025, at 12:33 Central European Summer Time (CEST), the power systems of Spain and Portugal experienced a blackout. A small area in France near the Spanish border also experienced disruptions for a limited duration. The remainder of the Continental European power system did not experience any significant disturbance. Following the incident, each affected TSO – REN (Portugal), RE (Spain), and RTE (France) – immediately activated their respective system restoration plans, as well as all other relevant procedures and protocols for restoring the voltage of the electricity system. The system restoration was completed by 00:22 on 29 April 2025 in Portugal. By 04:00 on the same day, the transmission system was restored in Spain. This blackout was the most serious incident to occur in the European power system in over 20 years, with a major impact on citizens and society in Spain and Portugal.

The incident has been classified as a scale 3 event – the highest level in severity – following Article 15(5) of the System Operation Guideline (SO GL) and the ICS Methodology. Consequently, pursuant to the same legal framework, an Expert Panel was set up, which began investigating the incident on 12 May 2025 with the aim of delivering a factual and final report.

The factual report on the incident was published on 3 October 2025 and the final report was published on 20 March 2026.

North Macedonia Blackout Factual Report

On 18 May 2025, at 04:59 CEST, the power system of North Macedonia experienced a separation of the 400kV and 110 kV voltage levels, which led to a loss of stability, supply, and load in the 110 kV transmission network. The 400 kV transmission network remained operational. This incident was classified as a blackout due to 100% loss of load in the 110 kV transmission network, therefore also classifying as a Scale 3 incident in accordance with the ICS Methodology.

Following the incident, North Macedonia's TSO (MEPSO), immediately activated their system restoration plan, as well as other relevant national operational procedures. The system restoration was completed by 07:47 CEST on 18 May 2025.

The final report of the incident concludes that the main reason for the incident was caused by high voltages (in 420 kV) in the 400kV network, i.e. activation of the overvoltage protection of all 400/110kV power transformers. The event caused a loss of load and generation, with a total generation loss of 313MW and a load loss of approximately 485MW in the 110kV network. The incident affected only the neighbouring Bulgarian TSO (ESO), leaving other neighbouring TSOs unaffected.

The factual report on the incident was published on 10 November 2025 and the final report was published on 20 April 2026.

Czech Republic Grid Incident Factual Report

On 4 July 2025, an incident occurred in the Czech power system which led to significant outages, affecting grid elements and power units in the eastern and northern part of Czechia, including the Prague area. Part of the transmission network went into island operation, disconnecting from the larger national system, and almost immediately collapsed. The sequence of events lasted for about 8 minutes, starting with the tripping of the V411 Hradec–Výškov 400kV line at 11:51:08 CEST and followed by the loss of transmission and distribution-connected generation. The operation of the interconnected European grid continued as usual, and no other country was affected by the incident.

The Czech TSO (ČEPS) immediately activated its system restoration plan. By 14:09 CEST, all the affected transmission system substations were put back into operation. By 17:35 CEST, the supply of all the load lost in the incident was also restored.

The highest-priority ICS criterion violated during this event was a Scale 2 incident on load (L2). This criterion is met if the load loss is between 10% and 50%. In this incident, 2,300MW of load was lost, which is 28% of the demand before the incident (8,200MW) in the ČEPS control area.

The investigation showed that the unsuccessful auto-reclosure of V411 in phase L2 was the result of a cable break; while the loss of the transmission-connected generation was due to a boiler outage caused by a defective relay. The reason for the distribution-connected generation loss is under investigation.

The factual report on the incident was published on 19 December 2025 and the final report's publication is planned for the second quarter of 2026.

> The events of 2025 demonstrated that operational resilience depends on collaboration. United action by Europe's TSOs ensured system security and improved joint resilience.

Klaus Kaschnitz
Co-chair of the Expert Panel

3 Managing Complexity: Energy System Flexibility

The European electricity system is undergoing a profound structural transformation. Rising shares of variable renewable generation, the accelerating electrification of transport, heating and industry, and growing interdependence between electricity and other energy and non-energy sectors are fundamentally reshaping system operation. Power flows are becoming more dynamic and less predictable, demand patterns are evolving, and the system is increasingly exposed to external influences such as digitalisation and cross-sector coupling. In this context of heightened complexity, flexibility has emerged as a defining operational and strategic challenge for system operators, requiring enhanced coordination, advanced forecasting capabilities, and new market and technical solutions to ensure security of supply and system stability.

Operationalising Non-Fossil Flexibility Across Europe

In 2025, ENTSO-E and its members made significant progress in addressing this challenge through the integration and deployment of non-fossil flexibility resources (e.g. demand-side response, storage, and renewable energy source (RES) flexibility). These capabilities are essential for system stability and efficient operation amid higher variability and uncertainty, as renewables accounted for an ever-greater share of generation across Europe.

Work in 2025 spanned both operational readiness and regulatory-market frameworks. A cornerstone achievement was the joint submission of the Flexibility Needs Assessment Methodology (FNA methodology) to the EU Agency for the Cooperation of Energy Regulators (ACER), developed with the EU DSO Entity under a new legal mandate introduced by Article 19e of Regulation (EU) 2019/943, as revised by Regulation (EU) 2024/1747 (EMD Regulation) within of the Electricity Market Design Reform. This methodology establishes harmonised data formats and analytical approaches for TSOs and DSOs, paving the way for comparable national flexibility needs assessments and the definition of non-fossil flexibility targets by Member States, where required.

ACER approved the FNA methodology under Article 19e of Regulation (EU) 2019/943 on 25 July 2025, while highlighting the need for continued coordination and consistent implementation during its rollout.

Following approval of the FNA methodology, ENTSO-E supported TSOs' implementation of the FNA methodology by coordinating TSOs as regards the provision of data and analyses necessary for the adoption of FNA reports, in coordination with the DSO Entity where required, in accordance with Articles 19e(4) and (5) of Regulation (EU) 2019/943.

This work included coordination meetings on data and analysis provision, as well as the development of a Q&A document regarding the main or recurring implementation challenges raised by TSOs. In support of operational planning and adequacy, ENTSO-E's 2025 Summer Outlook Report highlighted the doubling of battery storage capacity compared to the previous year and the critical role of interconnection and active demand tools in managing excess renewable generation or system stress.

ENTSO-E also published its "Report and Position Paper on Flexibility from Renewable Energy Sources (RES)", outlining technical and market recommendations to unlock the full flexibility potential of RES. These include enhanced observability and controllability of RES assets, standardised interfaces and data exchange, and targeted market incentives to reward dynamic RES participation in balancing and ancillary services.

Collaboration with the EU DSO Entity continued to deliver increased transparency and system insight, exemplified by the joint progress report on Capacitypedia, developed within the scope of Action 6 of the EU Action Plan for Grids and jointly published on the 19 December 2025, which aggregates hosting capacity information to support developers and planners in accelerating the deployment of flexibility-enabling technologies.

The main deliverable of this initiative, an online portal that provides an overview of grid hosting capacities across Europe, is expected to be launched in Q2 2026.

Conclusion

These collective efforts reflect ENTSO-E's commitment to equip Europe's power system with the tools and frameworks necessary to manage growing complexity and flexibility needs, contributing to the secure and efficient integration of renewable and distributed resources across the continent in line with the 2023-2025 strategic priorities.

> Flexibility is essential to managing system complexity. Together, ENTSO-E and DSO Entity are ensuring Europe's power system remains stable, adaptable, and future-ready.
>
> ***Vincenzo Ranieri***
> ***DSO Entity President***

4 Operating the grids of the future

To accommodate the evolving electricity landscape, TSOs must always ensure that their operational approaches are still fit for purpose or adapt them if necessary. The new challenges faced by TSOs in grid stability, modelling, and system behaviour require to go beyond traditional approaches and creatively prepare for the future. Therefore, ENTSO-E is supporting its member TSOs in developing a common Probabilistic Risk Assessment (PRA) methodology and published the third biennial progress report on this topic in Q4 2025.

Additionally, through Project Inertia, ENTSO-E assessed the evolution of inertia levels in the long-term horizons in the Continental Europe Synchronous Area (CESA), and the challenges emerging from their decrease. ENTSO-E proposes a step-by-step approach, aiming at future-proof and realistically achievable steps to gradually and sustainably recover system resilience while continuously reassessing system needs and suitable solutions.

I Probabilistic risk assessment methodology

The System Operation Guideline (SO GL) mandates, via the Methodology for Coordinating Operational Security Analysis (CSAM) adopted pursuant to Article 75(1), all TSOs to jointly propose a Probabilistic Risk Assessment (PRA) methodology by 31 December 2027.

While the deterministic N-1 approach remains a cornerstone of grid operation – ensuring resilience to the failure of any single system component – it does not account for the variable likelihood of contingencies. A probabilistic framework would enable TSOs to assess not just what could go wrong, but how likely such an event is to occur and what the impact might be. By estimating both the probability and impact of potential contingencies, the PRA methodology will support more efficient and targeted security measures based on a risk assessment. It will also help TSOs optimise

maintenance planning, determine the timing and scope of outages, and identify where remedial actions are most valuable. In doing so, it will offer a more flexible and resource-efficient approach to maintaining operational security.

ENTSO-E supported TSOs in this complex task and published the latest biennial progress report in December 2025 (previous reports were published in 2021 and 2023). The report outlines the progress made in the collection of relevant data necessary for the development of the PRA methodology and towards the development of a proof-of-concept to assess how the methodology's theoretical concepts apply in practice to power systems. The outcome of the proof-of-concept will help TSOs determine how the PRA can support their decision-making process in the operation of the transmission power system.

Project Inertia Phase II – Solutions for a future-ready decarbonised system

Through its studies and analysis, ENTSO-E triggers discussions on various power system stability issues, aiming to engage with stakeholders and establish a common understanding of the challenges and solutions for secure and stable operation of the present and future power system. As part of this commitment, a project was developed to assess and enhance the resilience of the Continental European interconnected transmission system to withstand system splits under hypothetical future scenarios, given the challenge of reduced total system inertia and increased power transfers. For the avoidance of doubt, please note that the results of the project inertia do not constitute the common study by all TSOs of the Continental Europe Synchronous Area to identify whether a minimum level of inertia needs to be established, in accordance with Article 39(3)(a) of the SOGL.

While in the first report ENTSO-E identified the relevant trends and created awareness of the challenge of decreased system resilience in the case of system splits, follow-up work points to a risk of a progressive decline of system resilience against hypothetical system splits in the Continental Europe Synchronous Area (CESA). Using TYNDP 2022 long-term market studies, the project analysed numerous combination of system split events. The results indicate that if nothing is done by 2030 and 2040, the number of theoretical splits that exceed the critical Rate of Change of Frequency (RoCoF) threshold of 1 Hz/s will rise significantly. In many cases, both islands created by a split would breach that limit – indicating a systemic decline in frequency resilience. Since system split events cannot be anticipated, kinetic energy should always be well distributed throughout the system.

In its January 2025 position paper and supporting technical report, ENTSO-E outlined the operational measures available to maintain possible system stability as inertia levels decline. Historically, inertia was inherently provided by rotating masses of synchronous generators, ensuring resilience against frequency deviations and system splits without additional intervention. As conventional generation is progressively replaced by power-electronics-based resources, this inherent resilience decreases. Maintaining frequency stability could in the future require targeted investments in network solutions or the activation of technical capabilities from third-party assets, implemented in a proportionate and system-efficient manner.

The most efficient and appropriate way to ensure system security should be the focus of an open debate, considering all technical solutions along with costs, efficiency, and other key factors. ENTSO-E believes this discussion should involve all stakeholders, as the final resilience of the system depends on the contributions of all participants connected to the grid and their agreement on various solutions and targets. ENTSO-E will proactively support this discussion with updated assessments of the technical parameters and contribute to the discussion concerning the solution of the challenges related to the stability of the future energy system.

Conclusion

ENTSO-E continued advancing the tools and methodologies needed to operate a rapidly evolving, decarbonised power system. Through progress on the Probabilistic Risk Assessment methodology and the findings of Project Inertia, TSOs strengthened their ability to anticipate risks, further the debate on potential solutions to declining system inertia, and safeguard frequency stability. These efforts reinforce ENTSO-E's commitment to ensuring that Europe's grids remain secure, resilient and fit for the future.

5

Infrastructure & Investments

In 2025, ENTSO-E continued to drive Europe's transition towards a low-carbon and more electrified energy system via diligent technical assessments and recommendations in infrastructure planning and investment needs. Central to this effort is the 2024 Ten-Year Network Development Plan (TYNDP), which outlines policy-driven scenarios to 2050, identifies pan-European transmission system needs, and assesses the costs and benefits of grid and storage projects required to meet these objectives.

ENTSO-E also delivered Seasonal Adequacy Assessments and the European Resource Adequacy Assessment (ERAA), providing forward-looking insights into security of supply. In 2025, a key milestone was the launch of the joint roadmap Towards Future-Proof Grids, developed with Europacable, the DSO Entity and T&D Europe to address growing infrastructure and supply-chain constraints. It outlined coordinated actions on technical harmonisation, procurement, investment visibility, industrial capacity and skills to support timely grid expansion.

ENTSO-E has initiated targeted work to address growing grid connection queues, assessing more flexible connection approaches and operational solutions to accelerate system integration while safeguarding security of supply. It is also advancing preparations for future offshore grid development, mapping the integration of large-scale offshore renewables and hybrid interconnectors. Together, these efforts demonstrate ENTSO-E's commitment to enhancing system flexibility, strengthening cross-border coordination, and addressing implementation barriers to Europe's energy transition.

Ten-Year Network Development Plan (TYNDP) 2024

Published in January 2025, the Ten-Year Network Development Plan (TYNDP) provides a pan-European view of the grid and storage investments needed to meet EU 2030 and 2050 climate targets. It stresses that Europe must urgently expand and modernise electricity infrastructure – especially cross-border transmission – to integrate renewables and allow for a shift to electricity demand. TYNDP 2024 shows that around 108 GW of extra cross-border capacity would be economically beneficial by 2040 and

evaluates 176 transmission and 33 storage projects that could meet those capacity needs. The conclusion is clear: coordinated investment, accelerated permitting, and coherent planning are critical to avoid congestion, support financing decisions, and maintain momentum in the energy transition.

Proposed Amendments for a revised ERAA methodology

ENTSO-E's proposed amendments to the European Resource Adequacy Assessment (ERAA) methodology aim to ensure that the ERAA remains robust, transparent and fit-for-purpose in supporting secure and efficient electricity supply across Europe. The update process was initiated after the European Commission's March 2025 report on streamlining capacity mechanisms, which led ACER to formally request ENTSO-E to revise the methodology under Regulation (EU) 2019/943 (Electricity Regulation). The proposed amendments focus on reinforcing methodological soundness, facilitating implementation, and balancing the assessment at both pan-European and national levels.

Seasonal Adequacy Assessments

ENTSO-E's Seasonal Adequacy Assessments evaluate Europe's ability to meet electricity demand under expected and extreme conditions. The Winter Outlook 2025–2026 was broadly favourable: most European systems showed no adequacy risks under normal market conditions. However, Cyprus, Ireland, and Malta – small or weakly interconnected systems – remained exposed to supply risks during periods of low renewable output and high demand. Finland, Estonia, and Lithuania faced smaller risks under severe cold spells or unexpected outages. Adequacy is assessed using probabilistic indicators such as Loss of Load Expectation (LOLE) and Expected Energy Not Served (EENS).

While the continental grid remains robust, isolated systems require targeted measures such as non-market resources, enhanced interconnection, and demand-side response.

European Resource Adequacy Assessment (ERAA) 2024 and 2025

The ERAA provides a pan-European view of power system adequacy up to 10 years ahead, using probabilistic modelling and state-of-the-art methods. It supports decision-makers on topics such as capacity mechanisms and other market incentives based on a diligent probabilistic pan-European risk assessment. With fossil capacity retiring, renewables expanding, and demand rising, renewed attention is needed on the economic viability of all resources and on how Member States can preserve resource adequacy.

Both ERAA 2024 and 2025 reports concluded that several countries might face tightening supply margins by 2028–2030 unless additional investments or policy measures are implemented.

ERAA uses pan-European modelling of generation, storage, interconnections, and demand, quantifying risk mainly in terms of Loss of Load Expectation (LOLE). The findings highlight the need to accelerate investment in flexibility – storage, grid reinforcements, demand response – and, where appropriate, maintain some thermal capacity. Market tools such as capacity mechanisms may be required to ensure security of supply.

Supply Chains and Public Procurement

ENTSO-E identified major challenges in scaling Europe's energy supply chains and industrial capacity at the pace required for the energy transition. More than 150,000 km of additional transmission lines are needed by 2030, alongside significant volumes of critical equipment – over 14,000

circuit breakers, around 4,800 Gas-Insulated Switchgears (GIS), 1,900 transformers, 800 shunt reactors, and 71 phase-shifting transformers. By 2050, cumulative grid investment needs are expected to exceed €800 billion. TSOs reported widespread supply-chain bottlenecks, including workforce shortages, long permitting timelines, limited manufacturing capacity, and rising global equipment costs. The previously mentioned Roadmap Towards Future-Proof Grids developed with Europacable, the DSO Entity and T&D Europe, sets out coordinated actions to strengthen supply-chain resilience through earlier demand visibility, industrial partnerships, skills development, and the scaling-up of European manufacturing. It calls for more flexible and innovation-friendly public procurement practices, including longer-term contracting, risk-sharing mechanisms, and sustainability-oriented award criteria. Without reforms in these areas Europe risks delays in renewables deployment, higher system costs, increased congestion, and reduced system security.

Preparing for Future Offshore Grid Development

ENTSO-E's Offshore Network Development Plans (ONDPs), part of the TYNDP, map the infrastructure needed to integrate massive offshore renewable expansion. With European countries targeting up to 496 GW of offshore renewables by 2050 (including EU states, Norway, and the UK), Europe will require around 54,000 km of offshore transmission routes and roughly €400 billion in investment. Part of this build-out will rely on "hybrid" assets that both collect offshore wind and interconnect national grids, especially in the Northern Seas and Baltic regions. Delivering offshore ambitions demands rapid investment, cross-border coordination, and regulatory adjustments. Without timely action, Europe risks major bottlenecks that could limit access to abundant offshore wind, undermining decarbonisation, energy security, and cost-efficient system integration. ENTSO-E's integrated offshore and onshore planning via the TYNDP processes is pivotal to identify future needs. ENTSO-E informed the European Commission and Member States on possible technical options for offshore sea basin cost-sharing. In May, ENTSO-E published its Offshore Roadmap, which identified several of the most pressing regulatory and technical issues to be addressed by TSOs: offshore geographical zones, offshore balancing, frequency control, ramping, governance, and market frameworks.

> Europe's system development efforts and coordination unite TSOs around a shared vision, contributing to identify and deliver the grid capacity and resilience needed to meet our shared security, affordability and carbon neutral goals.

Patricia Labra
System Development Committee

Conclusion

ENTSO-E's recent analyses underscore that Europe's energy transition hinges on rapid coordinated action. Achieving 2030 and 2050 energy and climate goals requires unprecedented investment in transmission, storage, and offshore infrastructure, alongside regulatory and supply-chain reforms. While overall system adequacy remains strong, without flexibility measures and capacity mechanisms, isolated regions and future scenarios reveal growing risks. In short, Europe must accelerate planning, financing, and innovation to avoid bottlenecks, ensure security of supply, and deliver a resilient, low-carbon power system.

> The energy transition requires connected planning across electricity, hydrogen and gas sectors, and the continued close collaboration between ENTSO-E and ENTSOG with involvement of all stakeholders is key to delivering it.

Sonya Twohig
ENTSO-E Secretary-General

and Piotr M Kuś
ENTSOG General Director

6 Innovative solutions

Innovation remains a cornerstone of ENTSO-E's contribution to a secure, resilient, and future-proof European electricity system. In 2025, the Research, Development, and Innovation Committee (RDIC) played a central role in translating long-term strategic objectives into concrete actions, strengthening cooperation across TSOs and DSOs, and supporting the implementation of key EU policy initiatives.

In 2025, ENTSO-E advanced the implementation of its Research Development and Innovation (RDI) Roadmap 2024–2034. This included contributions to key EU initiatives, such as the Digitalisation and Grids Action Plans, the Electricity Market Design reform, and emerging areas including space resilience for energy infrastructure. ENTSO-E continued its cooperation with the DSO Entity, stakeholder engagement, and participation in EU-funded research projects.

Together, these activities demonstrate how ENTSO-E is aligning innovation efforts across Europe to accelerate system modernisation, enhance system resilience, and ensure that research and innovation deliver tangible value for the electricity system over the coming decade.

I RDI Roadmap 2024–2034

In 2025, the Research, Development, and Innovation Committee (RDIC) continued to advance the objectives established in the RDI Roadmap 2024–2034. This legally mandated roadmap outlines priority innovation areas to support the modernisation and resilience of the European power grid over the next decade. Building on this, the RDIC drafted the Implementation Plan, which is planned for release in 2026, translating roadmap clusters into a portfolio of tangible project ideas to accelerate innovation across TSOs.

Work also began on an Innovation Database to map TSO projects against the RDI Roadmap priorities, improving visibility of progress and helping identify gaps and synergies.

Support for the EU Action Plan on Digitalisation

The European Commission's 2022 Action Plan on Digitalising the Energy System aims to develop a sustainable, secure, and competitive market for digital energy services by fostering an interoperable ecosystem. To support this, ENTSO-E and the DSO Entity collaborate through a Joint Task Force to define business requirements and a strategic framework for a European grid Digital Twin. In 2025, the project moved from identifying common challenges to defining concrete Digital Twin use cases and integration requirements. This work provides a foundation for the upcoming 2026 Digital Twin roadmap.

In May 2025, ENTSO-E and the DSO Entity hosted a public webinar titled "TSO-DSO Challenges & Opportunities for Digital Twins" to present the Joint Task Forces' strategic vision and progress made to industry participants. Building on the technical groundwork and aiming to bridge the gap between policy and practice, ENTSO-E submitted a formal response to the European Commission's consultation on the Strategic Roadmap for Digitalisation and AI in the Energy Sector in November 2025. In its response, ENTSO-E advocated for "safety-by-design" AI frameworks and a Common European Energy Data Space.

Supporting the EU Grids Action Plan for Grids – Technopedia

In line with Action 7 of the EU Grids Action Plan, in 2025 ENTSO-E continued its close cooperation with the DSO Entity on the development of a common TSO/DSO Technopedia. Following extensive preparatory work and structured exchanges with key stakeholders, the Technopedia was officially launched at the 6th PCI Energy Days. It serves as a collaborative knowledge-sharing tool on grid technologies and use cases for transmission and distribution system operators. It has been developed with engagement from the European Commission, vendors, and industry associations. Building on this first implementation phase, preparations were initiated in 2025 for a new development cycle which will be launched in April 2026. In line with Action 6 of the European Grid Action Plan, in 2025 ENTSO-E and the DSO Entity established a joint task force to deliver a TSO/DSO platform on hosting capacity information. The platform is expected to act as a single portal linking various national hosting capacity pages and providing contextual information to help users understand national practices.

Following extensive exchanges with industry and institutional stakeholders, the Joint Task Force conducted structured and comprehensive data collection to inform its work. The first set of information collected from TSOs and DSOs was published as an interim report on 19 December 2025 (Joint Progress Report on Capacitypedia). The contents of this report increase the visibility of grid hosting capacity information, improve comparability between different countries and system operators, and enhance the clarity of existing information. The main deliverable of this work, the IT platform, will be launched by mid-2026.

Supporting the EU Space Act: ensuring resilient space services for critical energy infrastructure

The European energy system is increasingly relying on space-based services to ensure secure, efficient, and resilient grid operations. Satellite communications, navigation, and Earth observation now play a critical role in system monitoring, forecasting, crisis management, and cross-border coordination. Against this backdrop, ENTSO-E submitted feedback to the EU Space Act proposed by the European Commission, which seeks to strengthen the safety, resilience, and sustainability of space activities within the EU. This work aligns with the RDI Roadmap pillars on system resilience, digitalisation, and security of supply.

Collaboration and Strategic Engagement

Inter-TSO collaboration on innovation topics has been further strengthened through a webinar series showcasing TSO innovation projects, enhancing knowledge-sharing, and triggering new collaborations. In total, six events have been organised with speakers presenting their innovation projects across multiple topics spanning from offshore wind simulation and forecasting, to innovation strategies for system resilience and security of supply under extreme conditions. Together, six TSOs presented to an audience ranging from 50 to 500 participants.

The RDIC led preparatory actions for the implementation of the Interoperability Workstream for Multi-Vendor, Multi-Terminal HVDC (MV-MT HVDC) solutions. This work, aligned with T&D Europe and WindEurope, produced two internal documents and supported two workshops to plan the next phase of work in 2026 and beyond.

In November 2025, RDIC organised its yearly Strategy Workshop to shape the Committee's Work Plan for 2026 and 2027. Part of this workplan is the implementation of a stakeholder engagement plan, to further strengthen the structured collaboration with key stakeholders in the energy innovation landscape.

Participation in EU-funded projects

In 2025, ENTSO-E participated in two EU-funded projects: IntNet and TwinEU. The IntNet Project finished in autumn 2025 with communication and dissemination activities. The TwinEU project continues beyond 2025, with completion planned for 2027.

The ENTSO-E RDI strategy continues to support involvement in future funded research projects. The RDIC works to coordinate TSOs' responses to open Horizon Europe calls. In 2025, coordination efforts resulted in TSOs' applications to four Europe Horizon calls (results pending). Coordination efforts for a further seven calls are currently ongoing.

Conclusion

In 2025 the RDIC accelerated the implementation of the RDI Roadmap 2024–2034 by translating strategic priorities into concrete initiatives and advancing key innovation activities. ENTSO-E strengthened its contribution to EU policy initiatives, including the Digitalisation and Grid Action Plans, deepened cooperation with the DSO Entity. ENTSO-E remained actively engaged in EU-funded research through the IntNet and TwinEU projects, and coordinating TSO participation in Horizon Europe calls.

> By working together on innovation, Europe's TSOs are turning ideas into solutions – from HVDC readiness to system resilience.

Uros Salobir
Research, Development and Innovation Committee Chair

> Through Technopedia, ENTSO-E and DSO Entity are building a shared knowledge base that accelerates innovation across Europe's power system.

Peter Vermaat
Secretary-General of DSO Entity

7 Market Development and Operation

ENTSO-E and TSOs have delivered major achievements in electricity market integration in 2025, strengthening efficiency, flexibility, and harmonisation across Europe. The key milestone was a successful implementation of the 15-minute Market Time Unit (MTU) in the Day-Ahead Market, aligning market products with system needs and supporting the integration of renewable generation. TSOs jointly completed and submitted the Bidding Zone Review, providing an evidence-based assessment of bidding zone configurations to support Member States in their decision making. Significant progress was also made with the submission and approval of the Capacity Calculation Region (CCR) methodologies, enhancing coordinated capacity calculation and cross-border exchanges. Finally, following the 2024 revision of the Electricity Regulation by the EMD Regulation, TSOs submitted the updated Intraday Cross-Zonal Gate Closure Time methodology, ensuring consistency with the updated regulatory framework and enabling more effective intraday trading closer to real-time operation.

Forward Capacity Allocation (FCA) Regulation

The Forward Capacity Allocation (FCA) Regulation, in force since 17 October 2016, sets out rules for allocating long-term transmission rights (LTTRs) via explicit auctions. The regulation's objective is to promote the development of liquid and competitive forward markets, giving market participants the ability to hedge cross-border trading risks. All the Terms, Conditions, and Methodologies (TCMs) under the FCA Regulation have been submitted and are currently being implemented. As the electricity market is continuously evolving, some TCMs need to be amended.

Harmonised Allocation Rules (HAR)

In 2025, All TSOs reviewed the Harmonised Allocation Rules (HAR) methodology, as required by Article 68(5) of the HAR. The review involved the Single Allocation Platform (SAP), relevant TSOs, and Registered Participants, and is conducted at least every two years. The main amendments to the HAR in 2025 were related to the Market Time Unit; market participants' registration, suspension, and termination; and rules regarding the publication of the price cap.

Long-Term Flow-Based Allocation (LTFBA) project

TSOs and the Joint Allocation Office (JAO) continued working on the implementation of the Long-Term Flow-Based Allocation (LTFBA) project in the Core and Nordic Capacity Calculation Regions (CCRs), for a go-live in November 2026. A workshop was organised in December 2025 with stakeholders to share information on progress made so far and present expected outcomes. This project aims to facilitate the implementation of the new LTFBA mechanism in line with existing requirements. LTFBA will require the long-term transmission rights (LTTRs) for all bidding zone borders in a flow-based Capacity Calculation Region (CCR) to be allocated in a single auction.

Forward Market development

In 2025, ENTSO-E published a position paper outlining TSO views on collateral requirements, highlighting concerns about the potential costs associated with collateral obligations when TSOs trade financial derivatives. The paper stresses that these costs must be carefully considered in any proposal involving TSO participation in the design of forward markets.

ENTSO-E also addressed the issue of volume determination, noting its significant implications for hedging needs, TSO revenue adequacy and collateral requirements. Given its cross-cutting impact, the volume determination process requires careful design to ensure market efficiency and financial stability.

FCA interpretation of financial transmission rights curtailment and force majeure

In October 2025, ENTSO-E published a position paper presenting the views of TSOs relating to the curtailment of financial transmission rights (FTRs) and interpretation of force majeure. TSOs firmly assert that curtailing FTRs is both legally justified and operationally necessary under the current FCA Regulation.

The European Balancing Regulation

The Electricity Balancing (EB) Regulation establishes a common framework for cross-border balancing in Europe. Its goal is to ensure system security at the lowest possible cost, while promoting equal market access for all balancing resources and delivering environmental benefits by reducing the need for backup generation. Several important developments took place in 2025.

Balancing Platforms

All TSOs continued their work on the implementation of the European balancing platforms, with a growing number of TSOs acceding to the International Grid Control Cooperation project (IGCC), the Platform for the International Coordination of Automated Frequency Restoration and Stable System Operation (PICASSO), and the Manually Activated Reserves Initiative (MARI). In contrast, the Trans European Replacement Reserves Exchange (TERRE) platform was decommissioned on 31 December 2025 due to compatibility issues with the timing introduced by the EMD Regulation. Specifically, the Replacement Reserves (RR) process could not align with the newly established Cross-Zonal Intraday Gate Closure Time, which is set to occur 30 minutes before real-time operations.

Balancing Market improvements

ENTSO-E and all TSOs continued their work on the development of methodologies aiming to improve the balancing markets.

In January 2025, ACER adopted its decision on the Harmonised Cross-Zonal Capacity Allocation Methodology (HCZCAM), while all TSOs proceeded with the Common Optimization of Balancing Reserves and Cross Zonal Capacity Allocation (COBRA) project to develop the Market-Based Cross-Zonal-Capacity Allocation Function (MB CZCAOF), following the HCZCAM which will be used by TSOs applying the market-based allocation process.

The R0 report on Co-optimisation was submitted to ACER in April 2025. Following a public consultation and modifications, it has been published as the R1 report of the Research and Development (R&D) phase required by the ACER Decision 11/2024 on the Algorithm Methodology. The report covers bidding products, bidding formats, and pricing.

ENTSO-E together with System Operation Regions (SORs) and Regional Coordination Centres (RCCs) developed an amendment to the RCC Procurement Methodology in accordance with Article 27 of the Electricity Regulation (Regulation (EU) 2019/943), proposing the reliability parameters to be used by RCCs to assess the availability of voluntary balancing bids and cross-zonal capacity. The amendment was submitted to ACER at the end of September and approved in December.

In December 2025, all TSOs submitted to ACER proposed amendments to the Implementation Frameworks (IF) for automatic Frequency Restoration Reserve (aFFR) and manual Frequency Restoration Reserve (mFRR), together with a Common Harmonisation Proposal (CHP) (Implementation Frameworks (IF) amendments and Common Harmonisation Proposal (CHP)), aiming to harmonise FRR prequalification across TSOs and further align TSO terms and conditions. ACER's decision is expected by June 2026.

The Capacity Allocation and Congestion Management (CACM) Regulation

The Capacity Allocation and Congestion Management (CACM) Regulation defines the framework for implementing a single energy market across Europe. It sets out rules for allocating transmission capacity in the day-ahead (DA) and intraday (ID) timeframes, as well as for calculating capacity across bidding zones. All TCMs under the CACM Regulation have been submitted and are currently implemented. As the electricity market is continuously evolving, some TCMs need to be amended. TSOs also continued preparing for the upcoming amendment of the Regulation, providing technical input to the European Commission, National Regulatory Authorities (NRAs), and Member States.

Congestion Income Distribution Methodology (Art. 73 of the CACM Regulation)

In 2025, TSOs continued the implementation of the Congestion Income Distribution (CID) methodology by developing the ENTSO-E-supported Cross-CCR CID project. This project aims to implement a tool to automatically distribute the congestion income arising from commercial flows within and between CCRs and deal with unintuitive flows. The Joint Allocation Office (JAO) is the service provider. The project is scheduled to go live by the end Q1 2026.

Determination of CCRs Methodology (Article 15(1) of the CACM Regulation)

The CACM Regulation defines CCRs as geographic areas in which coordinated capacity calculation is applied. Article 15(1) of the CACM Regulation requires all TSOs to jointly develop a common proposal regarding the determination of CCRs.

On 2 July 2025, all TSOs submitted a proposal to ACER to amend the determination of CCRs to consider and amend the CCRs determined for the Energy Community (EnC), covering the bidding zone borders among the EnC Contracting Parties (EnC CPs), as well among the EnC CPs and adjacent EU Member States. The EU TSOs had consulted with the TSOs of the EnC CPs regarding this proposal. In addition, the proposal by the TSOs included the further merger of the CCR Core and the CCR Italy North – a CCR known as Central Europe (CCR CE) – into the intraday market time frame.

The 'All TSOs' proposal was approved by ACER on 16 December 2025. The approval of the 'All TSOs' proposal is the culmination of intense negotiations and consensus-building among the Energy Community TSOs and their EU neighbours, facilitated by ENTSO-E over several years.

The amended CCR configuration will enable stronger integration of the power systems of Ukraine and Moldova with their EU neighbours, as well as linking the West Balkan TSOs with already organised electricity market areas of Central and South-East Europe.

The amended CCR configuration will also contribute to the optimisation of coordinated capacity calculation in the single largest CCR on the European continent by extending the scope of the Central Europe CCR into the intraday market timeframe.

Intraday Cross-Zonal Gate Opening and Gate Closure Times (IDCZGTs) methodology (Article 59 of the CACM Regulation)

Article 59 of the CACM Regulation, concerning the operation of the single intraday coupling, sets out the rules on the Intraday Cross-Zonal Gate Opening and Gate Closure Times (IDCZGTs).

On 2 July 2025, all TSOs submitted a proposal to ACER to amend the IDCZGTs methodology. The proposed amendments introduce provisions concerning the implementation timeline for the 30-minute Intraday Cross-Zonal Gate Opening and Gate Closure Time (IDCZGCT), in accordance with Article 8(1) of the Electricity Regulation (Regulation (EU) 2019/943) and subject to possible derogations in accordance with Articles 8(1a) and 8(1b) of the same Regulation, as amended by the EMD Regulation. The TSOs' proposal was approved by ACER on 19 December 2025.

The TSO-and border-based derogation overview for 30-minute IDCZGCT, dating December 2025, is available. The file is regularly updated on the ENTSO-E website, following the go-live of each border.

Single Day-Ahead and Intraday Coupling

In accordance with Article 10 of the CACM Regulation, TSOs cooperate with Nominated Electricity Market Operators (NEMOs) to manage the operation and development of Single Day-Ahead Coupling (SDAC) and Single Intraday Coupling (SIDC).

A major development took place on 30 September 2025 when the 15-minute MTU in SDAC successfully went live for delivery on 1 October 2025, enabling more granular trading and improved alignment with physical system needs.

Transparency Platform (TP)

New TP go-live

A major milestone was reached in 2025 with the launch of the new Transparency Platform (TP), introducing the new Graphical User Interface (GUI) and upgrading the back-end architecture, with enhanced scalability, performance, and system management. Work on further improvements will continue throughout 2026.

Manual of Procedures (MoP v3.5)

In line with the implementation of the Transparency Regulation, a new version of the TP's Manual of Procedures (MoP v3.5) was approved and adopted during 2025. Most necessary changes have been introduced in the platform accordingly. In parallel, drafting for the subsequent release of the MoP (v3.6) continued, aiming for improvements to existing publications and editorial changes.

Inside Information Platform (IIP) registration

TP was officially registered as an IIP by ACER, in line with REMIT requirements. Seven member TSOs currently use the platform as their IIP for relevant reporting obligations.

TP Vision 2030

In line ENTSO-E's Market Committee TP Vision 2030 for the platform's future development, several new initiatives and projects were launched. It resulted in new monitoring measures and KPIs, as well as increased cooperation with Data Providers aimed at improving data quality. The year also saw closer collaboration and information exchange with the public aimed at enhancing the user engagement.

ACER Lists of Data implementation

Requirements development and technical implementations took place throughout the year for dedicated data delivery to ACER as part of FCA, SO GL and EB GL provisions. The data is planned to be delivered to ACER via the restricted part of the platform starting 2026.

Trade Development with Ukraine and Moldova_

In 2025, further progress was made on enhancing electricity trade between the EU and its eastern neighbours, particularly Ukraine and Moldova. This work builds on the joint allocation framework developed in 2023 by ENTSO-E, TSOs, and the JAO.

Long-term auctions go-live

In 2025, the expert group continued work on establishing explicit monthly long-term capacity auctions on the Slovakia–Ukraine, Hungary–Ukraine, and Romania–Ukraine borders. The relevant TSOs updated the Harmonised Allocation Rules (HAR) for non-EU borders. These updates introduced Border Specific Annexes for the above-mentioned borders, enabling the allocation of available capacity through explicit monthly long-term auctions.

On 15 December 2025, the TSOs of Slovakia, Hungary, Ukraine, and Romania successfully launched explicit monthly long-term capacity auctions on their borders with Ukraine for the January 2026 market period, implemented by the JAO.

This milestone enhances market efficiency and transparency, contributing to closer integration of Ukraine with the European electricity market and supporting regional energy security.

Daily joint auctions developments

Following the go-live of the daily auctions in 2024, organised by the JAO, for the Slovakia–Ukraine, Hungary–Ukraine and Poland–Ukraine borders, and with the launch of the monthly auctions, the expert team worked on introducing a change in the daily auction regime on the Slovakia–Ukraine border in 2025. Since the trading day of 1 January 2026 for this profile, daily auctions were shifted on D-1 instead of the previous D-2, where D is the day of delivery.

The transition to the new regime was done according to this schedule:

- 29 December 2025 – daily auction held for the delivery day 31 December 2025
- 30 December 2025 – no daily auction
- 31 December 2025 – daily auction held for the delivery day 1 January 2026

Intraday auctions development

In 2025, the expert group continued its work on developing explicit intraday auctions for the Slovakia-Ukraine and Hungary–Ukraine borders, to be implemented by JAO, and for the Romania–Ukraine border, to be implemented via a bilateral auction platform.

The auction rules for the Slovakia-Ukraine and Hungary–Ukraine borders were finalised under the title Rules for intraday capacity allocation on Ukrainian borders, while the Romania–Ukraine border will apply bilateral rules developed by Ukrenergo and Transelectrica.

The implementation of intraday auctions is to be continued in 2026.

Bidding Zone Review (BZR)

A Bidding Zone (BZ) is a geographical area within the electricity market where electricity can be bought and sold without considering physical grid limitations. The BZ review aims to establish optimal BZ configurations in Europe to maximise economic efficiency and cross-zonal trading opportunities while maintaining security of supply.

On 28 April 2025, TSOs released a report on the Bidding Zone Study (BZ Study), in which the TSOs within the electricity markets of the Central Europe and Nordic regions evaluated 14 alternative Bidding Zone configurations specified by ACER. The report contains two proposals - one for the Central Europe and one for the Nordic region - to help Member States decide whether to amend or maintain current BZ configurations. This study was conducted in accordance with EU regulations and a bidding zone review (BZR) methodology defined by ACER.

According to the BZR methodology, TSOs were requested to assess 14 alternative configurations based on 22 criteria grouped into four categories: network security, market efficiency, BZ stability and robustness, and the energy transition. According to this methodology, the BZ configurations were ranked using the economic efficiency criterion.

The results of the economic efficiency assessment of alternative bidding zone (BZ) configurations show that, in the Nordic region, none of the studied alternatives improve economic efficiency. For the 2025 target year, all analysed configurations result in a negative change compared to the status quo, ranging from €2 million to €35 million.

In the Central Europe region, the simulation results indicate higher economic efficiency for all German–Luxembourgish split configurations, with gains ranging from €251 million to €339 million for 2025. Among the analysed alternatives, the split of Germany–Luxembourg into five bidding zones would deliver the highest economic efficiency. The Dutch split configuration would result in a modest positive impact (€9 million), while the French and Italian alternatives would lead to a reduction in economic efficiency.

The report presents two TSO proposals on the future configuration of bidding zones (BZs) in Europe, one from the Nordic TSOs and one from the Central Europe TSOs. The Nordic TSOs propose maintaining the current bidding zone configuration in Sweden, as all analysed alternatives show a negative monetised benefit compared to the status quo.

For Central Europe, the simulation results indicate that, under criterion four (economic efficiency), the configuration with the highest positive monetised benefit would be the split of Germany-Luxembourg into five bidding zones. However, the Central Europe TSOs underline that this outcome reflects the BZR methodology defined by ACER and does not account for additional relevant considerations. They stress that the result should therefore be assessed in a broader context before any final decision by the Member State(s) concerned, as these additional factors could significantly affect the interpretation of the study's findings.

Stakeholder Engagement on the BZ review

Stakeholder expertise is essential for any discussion of a fundamental market design element, such as the adaptation of BZ configurations. ENTSO-E and the TSOs engaged with a broad range of stakeholders from the outset of the BZ study, including the Bidding Zone Review Consultative Group (BZR CG) and the Market European Stakeholder Committee (MESC), as well as relevant stakeholders through a public workshop in 2025.

Reporting

ENTSO-E supports ACER's monitoring obligation on the implementation of EU Network Codes and Guidelines by developing monitoring plans, publishing reports, and collecting and providing data to ACER dedicated interfaces.

Market Report

On 30 June 2025, ENTSO-E published its annual Market Report 2025, covering implementation progress under the CACM, FCA and EB Regulations and tracking how these frameworks continue to advance the realisation of the internal electricity market. The report was prepared in accordance with Article 82 of the CACM Regulation, Article 63 of the FCA Regulation and Article 59 of the EB Regulation.

Cost reports

In 2025, ENTSO-E also coordinated the publication of the CACM Cost Report, developed jointly with relevant NEMOs and TSOs, detailing costs related to the operation and evolution of the SDAC and SIDC in accordance with Article 80 of the CACM Regulation. In addition, it published the EB Cost Report 2025, covering costs associated with balancing platforms pursuant to Article 23(1) of the EB Regulation.

Quarterly pricing balancing energy and cross-zonal capacity reports

All TSOs continued publishing Quarterly Pricing Reports on the ENTSO-E website. These reports support transparency and are mandated under the pricing methodology for balancing energy and cross-zonal capacity in accordance with Article 30(1) of the EB Regulation.

Data Collection and Provision to ACER

ENTSO-E is responsible for compiling and transmitting data to ACER to support regulatory monitoring under several guidelines, including Article 82(4) of the CACM Regulation, Article 63(3) of the FCA Regulation, Article 63(3) of the EB Regulation, and Article 14 of the SO GL.

To meet these obligations, ENTSO-E maintains a comprehensive, standardised digital data archive to facilitate timely information exchange with ACER. In 2025, this included updating the EB Regulation list of information, setting up the FCA list of information, and progressing the implementation of the SO GL and CACM list of information.

Inter-Transmission System Operator Compensation (ITC)

The ENTSO-E ITC Transit Losses Data Report 2024 was published on 5 November 2025 and provides an overview of transit losses data reported by TSOs under the Inter-TSO Compensation (ITC) mechanism.

Market Stakeholders engagement

ENTSO-E and ACER organised the Market European Stakeholder Committees (MESC). This committee aims to complement the legal obligations of stakeholder consultation and information included in the Network Codes (NCs) during the implementation period. Over 30 stakeholder organisations are meeting on a quarterly basis to exchange with ENTSO-E, TSOs, and regulatory bodies. The committee's dedicated subgroups have been established for the implementation of the EB GL and of the Network Code on Demand Response (NCDR).

Conclusion

ENTSO-E and TSOs further deepened Europe's electricity market integration, delivering greater harmonisation, transparency and operational alignment with system needs. From the successful go-live of the 15-minute Market Time Unit and progress on balancing and capacity calculation methodologies, to the completion of the Bidding Zone Review and enhanced trade with Ukraine and Moldova, key milestones strengthened both market efficiency and cross-border cooperation. Together, these achievements reinforce the foundations of a resilient, integrated and future-ready European electricity market.

> The 15-minute MTU rollout in the European Day Ahead market marks one of the most significant changes in the European electricity market's history.

Oliver John
Market Commitee Chair

8 Regional Coordination

Regional coordination is a cornerstone of secure and efficient electricity system operation in an increasingly interconnected and interdependent European grid. In 2025, ENTSO-E and TSOs supported in advancing the implementation of Regional Coordination Centre (RCC) tasks, as well as achieved major technical and geopolitical milestones such as Baltic synchronisation with Continental Europe and updating the determination of Capacity Calculation Regions (CCRs) in South-East and East Europe.

Steering Group Regional Coordination

On 30 September 2025, ENTSO-E published the Annual Report on Regional Coordination Assessment 2024, which reviewed progress and performance of key regional coordination tasks in line with the SO GL (Article 17).

RCC tasks related to methodologies include ongoing work on the implementation of the tasks on 'Sizing and Procurement of reserve capacity' mandated under Art. 37(1)(j)&(k) of the Electricity Regulation (Regulation (EU) 2019/943), with a particular focus on the definition of regional parameters for TSOs and relevant RCC(s), to be submitted by ENTSO-E, in a coordinated manner.

ENTSO-E further supports the operation and development of key regional coordination tools. In 2025, Release 8 of the Pan-European Short-Term Adequacy (STA) Assessment Tool was delivered, introducing modelling improvements and operational enhancements, including the consideration of must-run units in line with Article 37(1)(e) of the Electricity Regulation (Regulation (EU) 2019/943). Release 6 of the Outage Planning Coordination tool was also achieved, further advancing the Outage Coordination Framework. In addition, the Maximum Entry Capacity (MEC) IT tool went live in 2025.

Common Grid Model (CGM)

The Common Grid Model (CGM) and the supporting Operational Planning Data Environment (OPDE) are critical enablers of operational coordination and security of supply at European level. The CGM serves as the key input for various (cross-)regional services performed by RCCs, such as but not limited to Coordinated Security Analysis (CSA) and Coordinated Capacity Calculation (CCC). Enhancing visibility on pan-European

interconnection flows is a key step toward strengthening grid security, enabling cost-efficient operation, and fostering closer cooperation between TSOs and RCCs. In line with the SO GL, ENTSO-E operates and maintains the OPDE.

Since the Go-live of the OPDE supporting the CGM in 2021, significant issues were observed in the full delivery of the CGM TSOs due to various technical, operational and governance issues identified by the TSOs and RCCs.

In 2025, a new CGM organisational structure was established and implemented, to address the various concerns hindering the progress of delivering pan-EU CGMs, while RCCs advanced the harmonisation of European Merging Function (EMF) tools, including publishing merging results for RCCs not in rotation. An Individual Grid Model (IGM)/Common Grid Model (CGM) quality issue tracker went live to systematically improve data quality, and initial steps towards OPDE 2.0 were taken with the approval of the target architecture and Business Requirements Specification. Further progress included a detailed assessment of the transition to a new Common Grid Model Exchange Specifications (CGMES) standard, as well as strengthened communication flows and the launch of a dedicated information exchange page for the community. It is estimated that the first services to use a Pan-EU CGM for Regional Operational Security Analysis will go live in 2027, which will represent a significant milestone towards enhanced regional coordination and operational security across Europe.

South-East and East Europe Capacity Calculation Regions (CCR) Determination

All TSOs proposed new Capacity Calculation Regions (CCRs) in south-east Europe, deepening cooperation with Western Balkan TSOs, and strengthening market integration, security, and alignment with EU and Energy Community legislation as well as linking the West Balkan TSOs with already organised electricity market areas of Central and South-East Europe.

The amended CCR configuration will also enable stronger integration of the power systems of Ukraine and Moldova with their EU neighbours.

Regional Coordination Centres

In 2025, RCCs pursued implementation of tasks stemming from the Clean Energy Package and, in particular, Regulation (EU) 2019/943.

Short Term Adequacy (STA) and Outage Planning Coordination (OPC) continued to be updated according to the continuous improvement ofprocesses.

The Common Grid Model (CGM) is live and IGMs are provided by TSOs over OPDE and merged by the RCCs into pan-European CGMs. Focus was set on improvement of CGM quality and alignment between models merged by the RCCs.

The implementation of Coordinated Security Analysis (CSA) and Coordinated Capacity Calculation (CCC) in the regions according to regional methodologies was continued.

Conclusion

In 2025, ENTSO-E and TSOs further strengthened regional coordination as a key pillar of secure and efficient system operation. Progress on RCC task implementation, enhancements to the Common Grid Model and coordination tools, and the updated determination of Capacity Calculation Regions reinforced alignment across regions and improved operational visibility.

Together with major milestones such as Baltic synchronisation and deeper integration in South-East and East Europe, these achievements demonstrate how regional cooperation continues to enhance system security, market integration and pan-European resilience.

> Coordination at regional level between TSOs, strongly supported and facilitated by RCCs, is essential in System Operation today and will further increase in the future. The implementation, operation, and constant evolution of all Regional Coordination processes is crucial to manage the complexity of operating the European Grid. ENTSO-E, and in particular Steering Group Regional Coordination, promotes cooperation between all TSOs and RCCs across Europe.

Carla Wolf
Steering Group Regional Coordination co-convenor

9

Information and Communication Technologies

In 2025, ENTSO-E continued to reinforce the digital foundation that enables secure and coordinated grid operations in an increasingly interconnected and cyber-sensitive environment. Key achievements included deploying advanced security tools and policies, enhancing software assurance processes, active participation in EU-wide cybersecurity initiatives, and supporting the Network Code on Cybersecurity (NC CS), in line with the Strategic Roadmap's pillar 2 objective of advancing information and communication technology (ICT) systems for digitalisation, secure data exchange, and system resilience.

In parallel, ENTSO-E prioritised interoperability and standardisation, which are essential for facilitating cross-border data exchange and ensuring reliable identification of entities within the internal energy market.

Cybersecurity

ENTSO-E's Internal Security Controls environment remained effective, with no Critical- or High-rated security incidents reported over the year. Follow-up external auditing continues to identify areas for improvement but confirmed that ENTSO-E's Information Security Management System (ISMS) continues to mature and remains fit for purpose for a pan-European system operator association. Significant effort was dedicated to cybersecurity awareness training, delivered across teams and staff levels to highlight new cyber risks, threats, and the potential impact of cyber-attacks. The ENTSO-E Security Incident Event Monitoring (SIEM) tool continues to identify, block, and manage cyber-attacks in real-time.

As ENTSO-E increases its use of public cloud to host applications, the IT Security Team continues to invest in new tools and internal training to ensure a high level of in-house security expertise.

Secure Software Development and Testing

The Secure Software Development Life Cycle (SSDLC) programme remained active in 2025, monitoring the security and code quality of over 30 ENTSO-E-developed applications. External experts conducted testing throughout the year, identifying vulnerabilities and coding issues, which were remediated by development teams as part of a structured feedback loop.

All ENTSO-E applications continue to undergo cybersecurity penetration testing, threat modelling and security review prior to release. These steps ensure that all software made available to the TSO community meets rigorous cybersecurity standards.

Network Code on Cybersecurity

The Network Code on Cybersecurity (NC CS) entered into force on 13 June 2024. It establishes sector-specific rules to enhance the cybersecurity of cross-border electricity flows across the EU. In 2025, ENTSO-E, in coordination with TSOs and key stakeholders, delivered core documentation as required by the Network Code schedule, including the Provisional list of European and International Standards and Controls.

Stakeholder engagement with the European Commission, ENISA, ACER, DSO Entity, and others continued throughout the year. In 2025, work focused on delivering:

- Proposal for Cybersecurity Risk Assessment Methodologies
- Proposal for Cyber-Attack Classification Scale Methodology
- Establishment of NC CS European Stakeholder Committee (ESC)

These deliverables form the first legally binding cybersecurity methodologies under NC CS.

Data Interoperability

Standards underpin the implementation of network codes and support ENTSO-E IT tools and data environments such as OPDE. In accordance with Article 30.1(k) of the Electricity Regulation, ENTSO-E contributes to defining interoperability requirements and transparent, non-discriminatory data access procedures, maintaining the Electronic Data Interchange (EDI) library to enable seamless interaction among actors in the European electricity sector.

In 2025, the main standardisation activities included developing implementation guides based on the Unified Modelling Language (UML) technology mapped with the Common Information Model (CIM) including: updating the data exchange profiles required for the RCC services; updating the European Style Market Profile (ESMP) to support data exchanges required by the Commission Implementation (EU) 2023/1162 on interoperability requirements and non-discriminatory and transparent procedures for access to metering and consumption data (IR MCD) maintaining the Harmonised Electricity Market Role Model; developing Market Congestion Profiles for long-term market studies and System Development applications; and training activities for the TSO-RCC community.

In 2025, the Joint Working Group (JWG) – a cooperation framework between ENTSO-E and the DSO Entity, established in June 2023 to carry out the tasks set out in Articles 11, 12, and 13 of IR MCD – continued to support the development of key deliverables related to the IR MCD.

In July 2025, the JWG developed a repository to collect reports on national practices submitted by Member States to the European Commission regarding the implementation of the reference model defined in the IR MCD. In addition, in December 2025, the Joint Working Group successfully delivered the draft Implementing Regulation on interoperability requirements and non-discriminatory and transparent procedures for access to demand response data (IR DR) to the European Commission.

Conclusion

Through continuous investment in cybersecurity tools, secure software development practices, and compliance with the NC CS, ENTSO-E maintained a strong security posture in 2025. These efforts not only safeguard critical infrastructure but also ensure that ENTSO-E remains a trusted partner in delivering resilient, digitalised solutions for Europe's evolving power system.

The transition towards a more interoperable society implies developing high-level use cases for data exchanges, hereby fostering 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 from all stakeholders to embrace this evolution.

> The dynamic changes and developments in Europe's energy system, along with its digitalisation, currently require a special focus on security. ENTSO-E is developing systems with a high level of cybersecurity and the interoperability of tools and data as a priority.

Grzegorz Bojar

Information and Communication Technologies Committee Chair

10

Facilitating the Energy Transition – A Fit for Purpose Market Design

Following the entry into force in July 2024 of EMD Regulation, revising Regulation (EU) 2019/943 within the Electricity Market Design Reform, ENTSO-E continued to support its implementation and the wider EU policy agenda aiming at delivering a secure, competitive, and affordable electricity system.

This work was closely aligned with the European Commission's Affordable Energy Action Plan published on 26 February 2025 and the revision of the State Aid framework under the Clean Industrial Deal State Aid Framework (CISAF) adopted on 25 June 2025, both of which emphasise the role of well-functioning markets, flexibility, and investment certainty in reducing system costs.

Throughout 2025, ENTSO-E focused on key elements of EMD implementation and the subsequent policy push for enhanced competitiveness and affordability. In particular, activities concentrated on areas requiring further regulatory clarification and analytical support, most notably capacity mechanisms, renewable energy sources (RES) flexibility, and energy storage.

I Streamlining Capacity Mechanisms

Following the recognition of capacity mechanisms (CMs) as a structural component of the European electricity market framework under the EMDR, the European Commission published a communication outlining a pathway to streamline approval procedures. This included legislative and methodological developments such as the introduction of reference design elements under CISAF and the mandate to review the (ERAA) methodology.

In April 2025, ENTSO-E published a dedicated policy paper setting out recommendations to ensure that capacity mechanisms effectively support security of supply, competitiveness and decarbonisation, while strengthening cross-border coordination. This work was complemented by ENTSO-E's contribution to the CISAF consultation process and the submission of proposed methodological improvements to the ERAA framework.

Unlocking Flexibility from RES

The EMD Regulation and the Affordable Energy Action Plan both underline the need to unlock the full flexibility potential of RES. ENTSO-E's work in this area focused on improving the observability and controllability of RES assets and strengthening market incentives that reward system-supportive behaviour. These measures are essential to mitigate congestion, limit RES curtailment and negative price occurrences, and reduce the growing need for redispatch and other costs for system operations.

Enabling the Scale-up of System-friendly Energy Storage

Building on this policy momentum and the evolving flexibility agenda, ENTSO-E also published a policy paper on Market Design for Utility-Scale Energy Storage. This paper analyses how the electricity market framework can be enhanced to support timely, cost-effective and locationally efficient deployment of storage, and how storage can participate effectively across day-ahead, intraday, and balancing markets. Three different investment frameworks are assessed: merchant investments, capacity mechanisms, and non-fossil flexibility support schemes; alongside key operational enablers required to translate investment into system-beneficial behaviour that supports reliability, flexibility, and affordability objectives.

Network Code on Demand Response

The development of the proposal for the Network Code on Demand Response (NC DR) was initiated following the European Commission's request of 9 March 2023, in line with ACER's Framework Guideline on Demand Response dated 20 December 2022.

The proposal is significant for both TSOs and DSOs in three main areas: (i) ensuring the safe, efficient and reliable operation of the transmission and distribution systems, (ii) supporting further electricity market integration, and (iii) accelerating the decarbonisation of the power system by enabling technology-neutral demand-side flexibility at scale.

Following the mandate from the European Commission, ENTSO-E and the DSO Entity submitted the NC DR proposal to ACER on 8 May 2024. ACER subsequently reviewed the proposal and, on 7 March 2025, issued its final recommendation to the European Commission. In the second half of 2025 (from 14 July to 12 September 2025), the European Commission launched a targeted stakeholder consultation process to inform its work while reviewing the proposal.

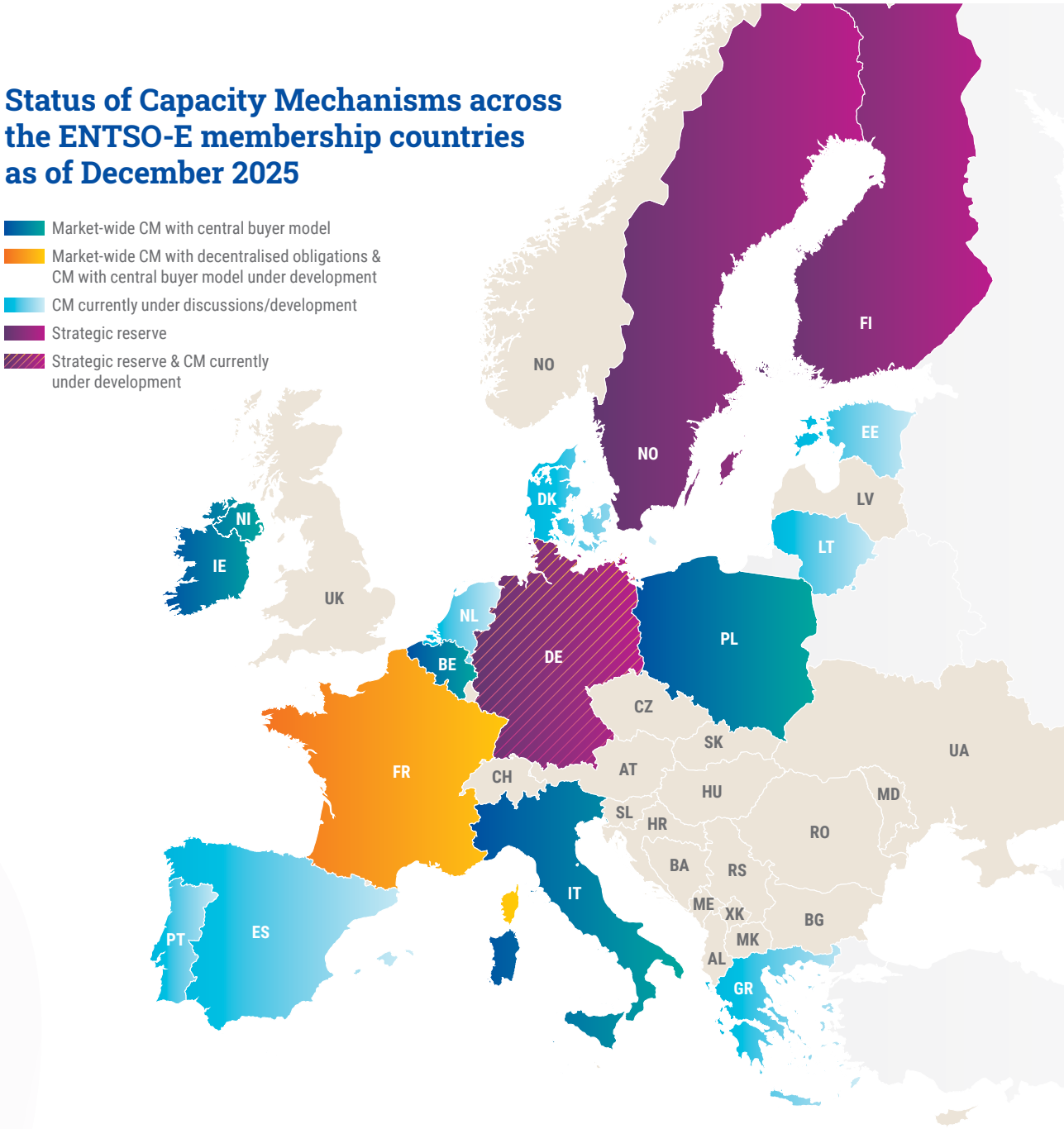
In 2025, ENTSO-E contributed to the European Commission's consultation on the draft NC DR package, addressing key considerations related to the package submitted by ACER. It continued joint implementation planning with the DSO Entity, preparing for anticipated tasks under the future NC DR framework and supporting TSOs in organising and coordinating national implementation discussions. ENTSO-E also supported, together with ACER and the DSO Entity, the establishment of the Demand Response European Stakeholder Group (DRESG) and held its first meeting on 3 November 2025.

ENTSO-E looks forward to continuing constructive cooperation with the European Commission, ACER, the DSO Entity, and all relevant stakeholders to support the timely adoption of NC DR and to prepare for effective and consistent implementation across Europe.

Conclusion

ENTSO-E continued to play a central role in shaping and supporting the implementation of the Electricity Market Design Reform, ensuring that market rules remain aligned with Europe's objectives on security of supply, competitiveness and affordability. Through targeted policy work on capacity mechanisms, renewable flexibility, energy storage and demand response, ENTSO-E contributed analytical expertise and practical solutions to strengthen investment certainty and system efficiency. These efforts support the development of a market framework that is fit for a decarbonised, flexibility-driven and increasingly electrified European power system.

Status of Capacity Mechanisms across the ENTSO-E membership countries as of December 2025



Appendix 1 - Staff

Sonya Twohig
Secretary-General

Bruno Gouverneur
Head of Operations Section

Florence Melchior
Head of General Counsel Section

Nicolas Richet
Head of ICT Solutions Section

Zoltan Gyulay
Head of Business Planning Section

Cara McLaughlin
Head of Member Relations and Association Policy Section

Anthony Zegers
Head of Innovation Section

Edwin Haesen
Head of System Development Section

Ivan Taleski
Head of Legal Section

Evelyne Driane
Head of People, Talent & Culture Section

Bertrand Macabeo
Head of Corporate Services Section

Christelle Verstraeten
Head of Policy, Communications and Stakeholder Management Section

Appendix 2 - Resources

ENTSO-E AISBL[1] 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 2025, the budget of ENTSO-E totalled EUR 73.9 million, funded by TSO membership fees for EUR 52.8 million and other revenues for EUR 21.1 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 2025, ENTSO-E counted 181 employees.

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

Appendix 3 - Collaboration 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 prepare under the guidance of the Specialised Committee on Energy Working Arrangement providing a framework for cooperation between ENTSO-E and the UK TSOs not involving, or conferring a status comparable to, membership in ENTSO-E; and
- EU and UK TSOs prepare technical procedures once requested by the Specialised Committee on Energy.

The Working Arrangement (WAs) between ENTSO-E and the UK TSOs provide for a dedicated cooperation platform – the Working Arrangements Coordination Meetings (WAC Meetings) – that allows both sides to address key shared priorities, including security of electricity infrastructure, expanding clean offshore energy planning like the North Sea Grid planning, and enhancing the efficient use of electricity interconnectors between the UK and Continental Europe. The WAs have been signed by both the UK TSOs and ENTSO-E and entered into effect on 2 July 2025.

Following Recommendation No. 1/2024 of 19 December 2024 issued by the Specialised Committee on Energy (SCE), ENTSO-E, facilitating the work of EU transmission system operators, and the UK transmission system operators have been mandated to provide a joint answer to a second set of technical questions to the European Commission and the UK Department for Energy, Security and Net Zero on the proposed trading solution Multi-Region Loose Volume Coupling (MRLVC). The MRLVC agreed in the Trade and Corporation Agreement between the European Union and the United Kingdom of Great Britain and Northern Ireland aims to reintegrate the 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 (EU TSOs directly connected to the UK and UK TSOs). These answers build on previous work mandated by the EU-UK Specialised Committee on Energy (SCE), that is a Cost Benefit Analysis (CBA) published in 2021 and a first set of answers to technical questions published in 2023. The report has been published by ENTSO-E in December 2025: Read the report

Appendix 4 – Network Codes, Guidelines, Clean Energy Package and Electricity Market Design Reform: Focus on implementation

The Network Codes (NCs) and Guidelines (GLs), the Clean Energy Package (CEP) and the Electricity Market Design Reform (EMDR) present a large part of the legislative framework under which ENTSO-E operates. The implementation of the NCs and GLs, the CEP and the EMDR represents a substantial effort which ENTSO-E is prioritising.

Beside the Network Code on Demand Response (NC DR) the recast of the Capacity Allocation and Congestion Management (CACM) Guideline (so-called CACM 2.0) and the Connection Network Codes 2.0, all NCs and GLs 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, NCs, GLs 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[2]
ENTSO-E	ENTSO-E tasks	ACER
Pan-European 'All TSOs'	All TSOs	ACER
Regional 'All TSOs'	TSOs in the region	NRAs of the region. ACER makes the final decision if NRAs cannot agree[3]
National	Depending on national legislation (TSO, DSO…) (ENTSO-E may provide supporting documents and guidance)	NRAs

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

'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').

2 In accordance with the CEP provisions of Electricity Regulation 2019/943.
3 In accordance with Article 5(3) of ACER Regulation 2019/942.

Monitoring the Implementation

Under the Clean Energy Package, ACER is responsible for monitoring and analysing the implementation of NCs and GLs and their effect on the harmonisation of applicable rules aimed at facilitating market integration as well as on non-discrimination, effective competition and the efficient functioning of the market (5). To support ACER fulfilling this obligation, ENTSO-E develops monitoring plans, and publishes reports, collects and provide data to ACER (termed 'lists of information') through dedicated interfaces. In this regard, ENTSO-E and ACER have an agreement on data collection and provision to ACER for NCs and GLs monitoring. This agreement and its Annexes are currently being used for sharing with ACER the lists of information related to the Capacity Allocation and Congestion Management (CACM) Guideline (defined in Annex 1, signed in 2019), the System Operation (SO) Guideline (defined in Annex 2, signed in 2020) and the Electricity Balancing (EB) Guideline (defined in Annex 3, signed in 2025) to be communicated to ACER for monitoring purposes and it should then be extended to other NCs and GLs.

While acknowledging that NCs and GLs monitoring obligations rest with ACER, Based on provisions under Regulation (EU) 2019/9436, ENTSO-E further cooperates with EU DSO Entity on the monitoring of the implementation of NCs and GLs, which are relevant to the operation and planning of distribution grids and the coordinated operation of the transmission and distribution networks.

Publisher
ENTSO-E aisbl
8 Rue de Spa | 1000 Brussels | Belgium
www.entsoe.eu | info@entsoe.eu

Images
iStockphoto.com

Publishing date
April 2026

entsoe