

# Integrating EU Space Programme capabilities (EUSPC) into Europe's power grid to enhance its resilience

Executive overview | March 2025



# Foreword

**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 the 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 through 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.

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\* <https://vision.entsoe.eu/>

# Contents

<b>Executive Summary</b> .....	<b>4</b>
<b>Recommendations</b> .....	<b>5</b>
<b>1 System context: Why Grid resilience now demands a space dimension</b> .....	<b>6</b>
<b>2 Guiding Principles of this executive overview</b> .....	<b>7</b>
<b>3 Concrete Use Cases: From Theory to Practice</b> .....	<b>8</b>
3.1 Harnessing Earth Observation (EO) for Operational Intelligence .....	8
3.2 Precision and Resilience through Advanced Global Navigation Satellite System (GNSS) .....	9
3.3 Secure Satellite Communications as a Backbone .....	10
3.4 Space Situational Awareness for Environmental Risks .....	11
<b>4 Financing and Implementation Models – Enhanced with Strategic Funding Pathways</b> .....	<b>12</b>
<b>Conclusion</b> .....	<b>14</b>
<b>Abbreviations</b> .....	<b>15</b>

# Executive Summary

The European electricity transmission system operates in an environment of increasing technical complexity, heightened exposure to physical and cyber threats, and growing interdependencies across borders and sectors. Transmission System Operators (TSOs) are required to maintain high levels of operational security and system reliability in a context where situational awareness, secure communications and trusted timing have become indispensable enablers of system stability.

Against this background, ENTSO-E has developed this executive overview as a structured reference for assessing how capabilities of the [EU Space Programme \(EUSP\)](#) can complement existing terrestrial infrastructures used in electricity transmission system operations. This executive overview provides a common, operationally grounded basis for engagement between TSOs, European institutions and space programme authorities. This executive summary is not prescriptive and does not advocate the replacement of established operational systems. Instead, it identifies how space-based services can be integrated as additional layers within hybrid architectures, **reinforcing resilience while preserving operational autonomy and national responsibilities**.

The EUSP provides a mature, EU-owned portfolio of services – including [Earth Observation \(Copernicus\)](#), secure positioning and timing ([Galileo Public Regulated Service](#)), resilient satellite communications ([GOVSATCOM](#) and in the future [IRIS<sup>2</sup>](#)), and [Space Situational Awareness](#) – that are specifically designed for continuity, security, and public-authority use. Despite their maturity, the systematic integration of these capabilities into electricity transmission operations has so far remained limited.

This executive overview addresses this gap by defining a common approach through which TSOs can jointly explore, assess **use-case-driven applications**, and – where justified – deploy space-enabled capabilities in support of operational resilience. It positions TSOs not as passive consumers of satellite data, but as active contributors to the evolution of space services, ensuring that sector-specific requirements related to reliability, security, interoperability, and governance are appropriately reflected **from design through to deployment**.

**This executive overview focuses on clearly defined operational domains**, including enhanced environmental and infrastructure monitoring, resilient and secure timing for grid synchronisation, assured communications for emergency and restoration scenarios, and early warning of low-probability, high-impact risks such as space weather events. In all cases, space-based services are considered as complementary tools that augment existing systems rather than introducing new dependencies.

This executive overview is designed to be compatible with existing EU legislation, including the Critical Entities Resilience (CER) Directive<sup>1</sup> and the Network and Information Systems 2 (NIS2) Directive<sup>2</sup>, and to support compliance with applicable Network Codes **on system operation, emergency and restoration, and cybersecurity**, without introducing additional regulatory burden.

By providing a coherent reference for coordination among TSOs and structured engagement with European institutions and space programme authorities, this executive overview serves as an **operational bridge** that translates EU space policy objectives into tangible value for one of Europe's most critical infrastructures. It contributes to strengthening the resilience of the European power system while reinforcing strategic autonomy and continuity of service at Union level.

It is fully consistent with ENTSO-E's formal feedback<sup>3</sup> on the European Commission's proposed EU Space Act<sup>4</sup> and **operationalises** several of the policy recommendations expressed therein. ENTSO-E's primary recommendations focus on ensuring that space services are resilient, accessible, and demonstrably fit for the operational needs of critical energy infrastructure.

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1 Directive (EU) 2022/2557

2 Directive (EU) 2022/2555

3 [Feedback from: European Network of Transmission System Operators for Electricity \(ENTSO-E\)](#)

4 COM(2025) 335 final

# Recommendations

Building on its role as the voice of Europe's electricity TSOs and reflecting the operational experience of its members, ENTSO-E puts forward the following consolidated recommendations to stakeholders, institutions and service providers. These recommendations describe the conditions under which space-enabled capabilities can effectively support a secure, resilient and efficient European electricity system. They are formulated as cross-cutting ENTSO-E positions, independent of any single legislative instrument, and are intended to inform both policy development and implementation.

## ENTSO-E's recommendations

### Recognition of TSOs as critical users of space-enabled services

ENTSO-E recommends **formal recognition of TSOs as critical users** within the EU Space Programme (EUSP) framework. Given that grid synchronisation and situational awareness are now fundamentally dependent on space-enabled capabilities, TSOs require the same guaranteed continuity (**including low latency, high accuracy, availability and reliability**) and priority access (**including assured capacity**) afforded to other vital infrastructures. This recognition ensures that service governance and long-term design align with **TSOs' statutory mandate** to maintain uninterrupted pan-European energy stability.

### Assured operational access and continuity of services

ENTSO-E underscores the necessity for assured, high-security access to space-enabled services, specifically those capable of withstanding cyber-adversity or total terrestrial failure. **EU-led initiatives such as GOVSATCOM are essential components of this architecture.** By integrating these interference-resistant capabilities into TSO control centres and field operations, TSOs can ensure a fail-safe communication layer for system operation and restoration during extreme events. To be effective, such access must be seamlessly embedded into crisis management and restoration procedures, providing predictable performance even when conventional infrastructures are degraded or unavailable.

### Strategic interoperability and open standards

ENTSO-E advocates that, to safeguard the long-term evolution of the European power grid, space-enabled services must be built upon open standards and seamless interoperability. TSOs operate highly complex, multi-vendor environments with long asset lifecycles; consequently, any space-integrated solution must augment existing SCADA, EMS and digital substation architectures without creating proprietary lock-in or operational rigidity. **A design philosophy based on modularity and open interfaces is therefore essential,** enabling future innovation while preserving the integrity and stability of core operational systems.

### Trust, data provenance and transparency

ENTSO-E recommends that TSOs have access to the information necessary to assess the trustworthiness of space-enabled data and services used in system operation. This includes transparency regarding data provenance, service status, performance characteristics and relevant security assurances, commensurate with operational needs and confidentiality constraints. **In time-critical situations, operators must be able to make rapid, informed judgements on data reliability,** ensuring that operational decisions are based on trusted and authoritative inputs.

# 1 System context: Why Grid resilience now demands a space dimension

The operation of the European electricity transmission system increasingly depends on accurate, timely and trusted information across large geographical areas. TSOs are required to manage system stability under conditions of growing exposure to environmental hazards, cyber-physical threats and cross-border operational interdependencies. In parallel, EU regulatory frameworks place heightened emphasis on resilience, preparedness and the continuity of essential services.

Traditional terrestrial monitoring, positioning and communication infrastructures remain the backbone of grid operation. However, they are subject to geographic limitations, physical exposure and dependencies on shared infrastructures that may be degraded or unavailable during extreme events. Space-based capabilities offer a complementary dimension by providing wide-area visibility, EU-governed and resilient services, and relative independence from local disruptions.

The EU Space Programme provides operational, EU-owned capabilities specifically designed to support public authorities and critical infrastructures. Regulation (EU) 2021/696 establishing the Union Space Programme explicitly provides that the Programme shall support security-related needs, including the resilience of critical infrastructures (Article 3(2)(c)). These services are characterised by continuity, security governance and long-term availability, making them particularly relevant for electricity transmission system operations where failure tolerance is low and recovery timelines are critical.

For TSOs, the relevance of space-based capabilities lies not in technological novelty, but in their ability to strengthen resilience where terrestrial solutions alone may be insufficient. Space-enabled services can enhance situational awareness, reinforce secure positioning and timing, ensure communication continuity during extreme events, and provide early warning of environmental risks that threaten system stability. When integrated appropriately into existing operational architectures, they act as resilience enablers rather than substitutes for established systems.

These capabilities support compliance with outcome-based obligations under EU resilience and cybersecurity legislation without altering existing operational responsibilities.

In particular, the CER requires Member States to ensure that risks arising from natural hazards, technological hazards and human-induced threats are identified and addressed (Article 4(1)) and obliges critical entities to implement appropriate and proportionate technical, security and organisational measures to ensure their resilience (Article 13). Likewise, the NIS2 requires essential entities, including electricity TSOs, to implement cybersecurity risk-management measures ensuring the ability to prevent, detect, respond to and recover from incidents (Article 21(1)).

When applied in a technology-neutral manner, space-based services enable evidence-based implementation of these obligations, reinforcing preparedness, response and recovery capabilities while preserving subsidiarity, operational autonomy and established governance arrangements.

## 2 Guiding Principles of this executive overview

This executive overview is founded on a set of guiding principles designed to ensure operational relevance, proportionality and regulatory coherence.



### Technology neutrality

The framework does not privilege space-based solutions over terrestrial alternatives. Satellite-enabled services are assessed alongside existing tools, with adoption driven solely by demonstrated operational value and risk-mitigation effectiveness. This approach is consistent with the technology-neutral principles underpinning EU energy, cybersecurity and resilience legislation, ensuring that compliance is achieved through outcomes rather than prescribed technologies.



### Complementarity and hybrid architectures

Space-based capabilities are considered as additional layers within hybrid operational architectures. They are intended to reinforce, not replace, existing monitoring, timing and communication systems, thereby reducing systemic vulnerability rather than introducing new dependencies. This approach aligns with the CER, which requires resilience measures implemented by critical entities to be appropriate and proportionate to the risks identified (Article 13(2)).



### Use-case-driven and proportional deployment

Adoption of space-enabled capabilities is explicitly linked to clearly defined operational use cases and risk profiles. Deployment is proportionate, targeted and voluntary, reflecting the diversity of TSO system configurations, threat environments and national contexts. This ensures traceability between operational implementation and the risk assessments that critical entities are required to carry out, taking into account all relevant natural, technological and human-induced risks (Directive (EU) 2022/2557, Article 11(1)).



### Regulatory and security alignment

All integration pathways are framed within applicable EU and national legal frameworks, including cybersecurity, data governance, accreditation and security requirements. This includes alignment with the Network Codes on System Operation (Regulation (EU) 2017/1485), Electricity Emergency and Restoration (Regulation (EU) 2017/2196) and Cybersecurity (Regulation (EU) 2024/1366). Security, accreditation and assurance requirements are treated as intrinsic design constraints, consistent with NIS2 obligations requiring essential entities to implement policies on risk analysis and information system security (Article 21(2)(a)).



### Operational autonomy and subsidiarity

Decision-making authority remains with individual TSOs. ENTSO-E's role is to facilitate coordination, interoperability and knowledge sharing, without creating obligations or centralised operational control. This preserves subsidiarity and national responsibilities while enabling efficiency gains and coherence at European level.

# 3 Concrete Use Cases: From Theory to Practice

## 3.1 Harnessing Earth Observation (EO) for Operational Intelligence



Earth Observation (EO) services under the Copernicus programme provide wide-area, systematic and repeatable monitoring of environmental and infrastructure-related conditions. For TSOs, these capabilities enhance situational awareness of external risks affecting transmission assets, particularly where ground-based monitoring is constrained by geography, access limitations or degraded conditions during extreme events.

Operationally relevant applications include monitoring vegetation encroachment along transmission corridors, assessing soil moisture and flood risk near substations, evaluating snow cover and hydrological inflows relevant for generation forecasts, and supporting rapid post-event damage assessment following storms, wildfires, landslides or seismic activity. Synthetic Aperture Radar (SAR) enables all-weather, day-and-night monitoring and ground displacement analysis, while optical imagery supports high-resolution asset mapping and visual inspection across large territories. When combined with meteorological data and grid models, EO-derived information strengthens both preventive planning and real-time operational decision-making.

Copernicus data and services are delivered under an EU-governed framework with established quality assurance, continuity and access mechanisms, and are provided under a full, free and open data policy.

This facilitates consistent use across borders and reduces barriers to operational integration, supporting interoperability between TSOs and enabling coordinated responses to region-wide events.

From a regulatory perspective, the use of EO services directly supports obligations under the CER which requires critical entities to take appropriate and proportionate technical, security and organisational measures to ensure their resilience, as defined by their ability to prevent, protect against, respond to, resist, mitigate, absorb, adapt to and recover from incidents (Article 13). Copernicus data enables evidence-based implementation of these measures, particularly in relation to natural hazards and climate-related risks, while preserving technology neutrality.

Copernicus is established as a core component of the Union Space Programme under Regulation (EU) 2021/696 (Article 3(1)(c)), which explicitly promotes the uptake of space-based data and services by public authorities and critical infrastructure operators. In this context, Earth Observation constitutes a mature and legally accessible capability that can be integrated into existing TSO operational processes as a complementary layer, reinforcing resilience without altering established responsibilities or governance arrangement.



## 3.2 Precision and Resilience through Advanced Global Navigation Satellite System (GNSS)



Precise and reliable time synchronisation is a foundational requirement for electricity transmission system operation, underpinning monitoring, protection and control functions across interconnected grids. The increasing digitalisation of system operation – including the widespread deployment of synchro phasor measurements, event recording and real-time data exchange – has significantly increased reliance on Global Navigation Satellite System (GNSS)-based timing. This reliance exposes transmission systems to vulnerabilities arising from both unintentional disturbances and deliberate interference, including **jamming, spoofing and meaconing**<sup>5</sup> of open GNSS signals.

Galileo's Public Regulated Service (PRS) provides an encrypted, high-integrity and interference-resistant positioning and timing capability under governmental control. For authorised users, PRS is specifically designed to operate in degraded or hostile signal environments, offering protection against advanced interference techniques, including coordinated spoofing and meaconing. PRS-enabled receivers can supply high-precision timing to substations, control centres and wide-area monitoring systems, reinforcing grid synchronisation, improving event correlation and disturbance analysis, and sustaining operational confidence during stressed system conditions.

The operational necessity of secure and trusted timing is explicitly reflected in EU electricity system regulation. The System Operation Guideline (Regulation (EU) 2017/1485) requires Transmission System Operators to ensure accurate and consistent time synchronisation of operational data for system operation, monitoring and analysis, including wide-area monitoring functions (Articles 40 and 41). In parallel, the NIS2 obliges TSOs, as essential entities, to implement appropriate and proportionate cybersecurity risk-management measures to protect network and information systems supporting essential services, including measures addressing signal integrity and resilience against manipulation (Article 21).

Access to Galileo PRS is governed under Regulation (EU) 2021/696 establishing the Union Space Programme, which sets out the legal framework for the provision, security governance and controlled access to PRS (Articles 43 to 45). These provisions preserve Member State responsibility for authorisation and security oversight, while enabling the use of PRS by critical infrastructure operators where justified by operational resilience and security requirements.

In this context, secure GNSS timing through PRS represents a complementary resilience measure that can be integrated into existing hybrid timing architectures. It enhances protection against sophisticated GNSS interference, including meaconing, without displacing established terrestrial time-distribution systems or altering TSO operational responsibilities. As such, PRS strengthens system robustness while fully respecting technology neutrality, subsidiarity and existing regulatory frameworks.

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5 **Jamming:** Denial of Services (DoS) attack that disrupts or blocks wireless communication (Wi-Fi/cellular/Bluetooth/GPS) by broadcasting high-powered radio frequency (RF) signals.  
**Spoofing:** Cybersecurity tactic where an attacker disguises themselves as a trusted entity (person/device/network) to deceive victims, gain unauthorised access, or steal data.  
**Meaconing:** Intentional interception, manipulation, and re-broadcasting of radio navigation signals (GPS/GNSS) on the same frequency to deceive receivers, causing them to calculate incorrect positions or headings.



### 3.3 Secure Satellite Communications as a Backbone



Continuity of secure communications is essential for electricity transmission system operation, both under normal conditions and during major system disturbances or restoration phases. While terrestrial communication networks form the primary backbone for operational data exchange, voice coordination and control functions, they remain vulnerable to physical damage, cascading failures and cyber incidents, particularly during extreme events or wide-area crises.

Secure satellite communications under the EU Governmental Satellite Communications (GOVSATCOM) component and the future IRIS<sup>2</sup> infrastructure provide an independent, resilient and sovereign communication layer for authorised users. For TSOs, such services can serve as an ultimate fallback capability, ensuring the availability of command-and-control communications, coordination channels and situational reporting when terrestrial networks are degraded or unavailable.

The operational relevance of assured communication continuity is explicitly recognised in EU electricity system regulation. The Network Code on Electricity Emergency and Restoration (Regulation (EU) 2017/2196) requires TSOs to maintain reliable and resilient communication systems to support coordination, decision-making and information exchange during system disturbances and restoration processes (Articles 15 to 18). These obligations implicitly require communication pathways that remain available under extreme and degraded conditions.

In parallel, the NIS2 obliges TSOs, as essential entities, to implement appropriate and proportionate cybersecurity risk-management measures, including business continuity planning, backup communication capabilities and secure emergency communication systems (Article 21(2)(c) and (j)). Secure satellite communications directly support these requirements by providing an alternative communication path independent of terrestrial infrastructure and national public networks.

GOVSATCOM is established under Regulation (EU) 2021/696 establishing the Union Space Programme (Articles 61 to 66), which sets out the framework for the provision of secure, resilient satellite communication services for public authorities and critical infrastructure operators. Access is subject to national accreditation and security governance, preserving Member State responsibilities while enabling authorised users to benefit from EU-level capabilities. IRIS<sup>2</sup> is intended to further strengthen this architecture by providing enhanced capacity, resilience and coverage for governmental and critical uses.

In this context, satellite communications under GOVSATCOM and IRIS<sup>2</sup> constitute a complementary resilience layer within hybrid communication architectures. They enhance operational continuity and crisis resilience without replacing existing terrestrial networks or altering TSO operational responsibilities, fully respecting subsidiarity, technology neutrality and established security governance arrangements.



### 3.4 Space Situational Awareness for Environmental Risks



Certain environmental risks to electricity transmission systems originate beyond the Earth's atmosphere and cannot be adequately detected or anticipated through terrestrial monitoring alone. Space weather events – such as solar flares and coronal mass ejections – can induce **geomagnetically induced currents (GICs)** in high-voltage transmission networks, potentially causing transformer saturation, protection mis-operation and, in extreme cases, long-lasting equipment damage. These events represent low-probability but high-impact risks with potentially systemic consequences.

Space Situational Awareness (SSA), and in particular space weather services, provides early warning and forecasting capabilities that enable Transmission System Operators to anticipate and mitigate such risks. Timely alerts and forecasts allow TSOs to take proportionate preventive measures, including network reconfiguration, operational margin adjustments, heightened asset monitoring or coordination with neighbouring systems. Integrating SSA outputs into operational planning supports a shift from reactive response to anticipatory risk management.

The relevance of SSA to TSO obligations is grounded in EU resilience legislation. The CER requires critical entities to take appropriate and proportionate technical, security and organisational measures to ensure their resilience, defined as the ability to prevent, protect against, respond to, resist, mitigate, absorb, adapt to and recover from incidents (Article 13). Space weather constitutes a natural hazard capable of disrupting essential electricity transmission services at scale, and SSA data enables evidence-based implementation of resilience measures addressing such risks.

SSA services form part of the Union Space Programme under Regulation (EU) 2021/696 (Articles 7 and 51), which establishes EU-level capabilities for monitoring and assessing space-related hazards. These services are designed to support public authorities and critical infrastructure operators by providing authoritative, trusted and timely information relevant to safety and resilience.

In operational terms, SSA does not introduce new control dependencies but enhances situational awareness regarding external systemic risks. When integrated into existing risk assessment, preparedness and operational planning processes, SSA strengthens the capacity of TSOs to manage extreme but plausible hazard scenarios, fully aligned with existing regulatory obligations and without altering established governance or operational autonomy.

# 4 Financing and Implementation Models – Enhanced with Strategic Funding Pathways

The economic and institutional context for deploying space-based services has evolved significantly over the past decade. Space-enabled capabilities are increasingly delivered through **service-oriented frameworks** rather than bespoke infrastructure ownership, reducing upfront capital expenditure and enabling critical infrastructure operators to integrate resilience-enhancing functions through predictable and scalable operational costs. For TSOs, this reduces barriers to adoption while preserving flexibility, security, and long-term cost control.

Given the systemic importance of electricity transmission for EU energy security and the strategic relevance of space capabilities, coordinated action at European level offers the most efficient and resilient implementation pathway. Nationally fragmented approaches risk duplication, inconsistent technical interfaces, and inefficient use of public resources. Coordinated deployment through ENTSO-E-facilitated mechanisms

enables economies of scale, harmonised architectures and shared execution frameworks – while fully respecting Member States’ security frameworks and TSO operational mandates. The upcoming EU Multiannual Financial Framework (MFF) 2028 – 2034 is expected to reinforce strategic autonomy and resilience investments. Space-enabled resilience for critical infrastructure aligns closely with these priorities.

## A layered implementation model underpins this approach

### Exploratory and pilot phase

Voluntary pilot projects – involving interested TSOs with support from ESA or EC co-funding – enable the technical feasibility, security compliance and operational value of specific space-enabled use cases to be tested under real operational conditions. These pilots generate evidence-based insights for regulatory dialogue and lower uncertainty prior to wider adoption.

### Validation and standardisation phase

Lessons from pilots are consolidated into common reference architectures, interface specifications and operational guidelines, coordinated by ENTSO-E. This phase reinforces interoperability, reduces bespoke integration costs, and aligns space-enabled services with TSO operational systems (SCADA/EMS) and cybersecurity frameworks.

### Scaling and operational integration phase

Where justified, services can be progressively integrated into routine operational practices – either individually or through joint access arrangements – depending on national frameworks and TSO preferences. Aggregated TSO demand can facilitate cost-effective access arrangements (e.g., multi-party ESA/EC service contracts, framework agreements) that leverage European leverage and shared operational requirements.

## From a financing perspective, a mosaic of strategic EU instruments complements TSO investment and accelerates adoption

### European Space Agency (ESA) Programmes

ESA remains the primary technical vehicle for developing, validating and demonstrating space capabilities for critical infrastructure users. TSOs can engage with existing agency programmes (e.g., ARTES downstream applications, Telecom/Security domains) to co-fund pilots, interoperability testing and convergence activities. ESA's operational experience and co-funding models help bridge the gap between space capability maturity and sector-specific operational needs.

### European Commission (EC) Programmes

**Connecting Europe Facility (CEF) – Energy** supports cross-border energy infrastructure and resilience projects where demonstrable EU added value exists. Space-enabled services that materially reinforce cross-border communication continuity, situational awareness or emergency coordination align with CEF's objectives. Similarly, **Horizon Europe** supports research, innovation and demonstration under clusters focused on **civil security, digital resilience and critical infrastructure protection**. These funds can de-risk early adoption and foster demonstrator ecosystems that bring space technologies into TSO operational contexts.

### Complementary EU Programmes

Beyond CEF and Horizon Europe, relevant strands of the **Digital Europe Programme** or future space-specific instruments under an updated EU Space Programme (post-2027) offer avenues for shared digital infrastructure development and deployment. These programmes – especially when co-designed with TSO user requirements – can lower barriers to entry and enable standardised integration layers across Member States.

Importantly, these funding mechanisms are not intended to supplant TSO operational investment but to **de-risk early adoption**, accelerate learning curves, and ensure that solutions developed are interoperable, scalable, and aligned with strategic EU policy objectives (e.g., resilience of critical infrastructure under CER and NIS2). Over time, the cost of space-enabled services is expected to be absorbed within normal operational expenditure, reflecting their emergence as integral components of resilience architectures rather than exceptional add-ons.

Implementation governance remains **lightweight and facilitative**. ENTSO-E's role is to coordinate, aggregate requirements, and provide a platform for structured engagement with ESA, the European Commission (DG DEFIS, DG ENER, DG CONNECT), national authorities and funding bodies. Decisions on participation, investment and operational use remain with individual TSOs, consistent with their statutory mandates, national security constraints, and regulatory responsibilities.



## Conclusion

This executive overview demonstrates that EU space assets are operational, mature and legally accessible for use by electricity transmission system operators. To fully realise their potential for the European power grid, coordinated and use-case-driven integration is required. The integration of space-enabled services is no longer auxiliary; it is becoming an integral component of power system resilience. By aligning the evolving EU space policy framework with the operational realities of TSOs, the Union can strengthen the resilience of critical energy infrastructure, reduce external dependencies, and reinforce Europe's strategic autonomy.

The EU Space Programme offers governance-backed services that can materially enhance TSO resilience and operational efficiency. These are not speculative technologies: Copernicus data is already used by some TSOs for vegetation management and disaster mapping; Galileo's Public Regulated Service is operational for secure timing; and GOVSATCOM initial services were launched in 2024. The ENTSO-E analysis confirms that these assets can be deployed in support of concrete operational needs.

Space-enabled capabilities can enhance situational awareness, reinforce secure positioning and timing, provide resilient communication pathways and support anticipatory risk management. Crucially, these enhancements must be integrated within existing legal, technical and operational frameworks, including the CER, the NIS2 Directive and the forthcoming EU Space Act.

Key actions for policymakers and regulators include ensuring a supportive environment for pilot projects, aligning space policy with electricity system resilience objectives, and enabling cooperative research and demonstration activities under relevant EU programmes. ENTSO-E stands ready to support its members in this process and to facilitate structured engagement with European institutions and space programme authorities.

By pursuing a co-creative partnership with ESA and the European Commission – one that recognises TSOs as essential stakeholders in space-enabled resilience – Europe can strengthen the robustness of its power grid against the challenges of the coming decades.

ENTSO-E remains committed to serving as a centre of expertise, bridging the gap between space policy and the engineering realities of the European power system.

# Abbreviations

<b>ARTES</b>	Advanced Research in Telecommunications Systems
<b>CEF</b>	Connecting Europe Facility
<b>CER</b>	Critical Entities Resilience (Directive)
<b>DG CONNECT</b>	Directorate-General for Communications Networks, Content and Technology
<b>DG DEFIS</b>	Directorate-General for Defence Industry and Space
<b>DG ENER</b>	Directorate-General for Energy
<b>EC</b>	European Commission
<b>EMS</b>	Energy Management System
<b>ENTSO-E</b>	European Network of Transmission System Operators for Electricity
<b>EO</b>	Earth Observation
<b>ESA</b>	European Space Agency
<b>EUSP</b>	European Union Space Programme
<b>EUSPC</b>	EU Space Programme capabilities
<b>GIC</b>	Geomagnetically Induced Current
<b>GNSS</b>	Global Navigation Satellite System
<b>GOVSATCOM</b>	Governmental Satellite Communications
<b>IRIS<sup>2</sup></b>	Infrastructure for Resilience, Interconnectivity and Security by Satellite
<b>MFF</b>	Multiannual Financial Framework
<b>NIS2</b>	Network and Information Systems 2 (Directive)
<b>PRS</b>	Public Regulated Service (Galileo)
<b>RDIC</b>	Research, Development and Innovation Committee
<b>SAR</b>	Synthetic Aperture Radar
<b>SCADA</b>	Supervisory Control and Data Acquisition
<b>SSA</b>	Space Situational Awareness
<b>TSO</b>	Transmission System Operator

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