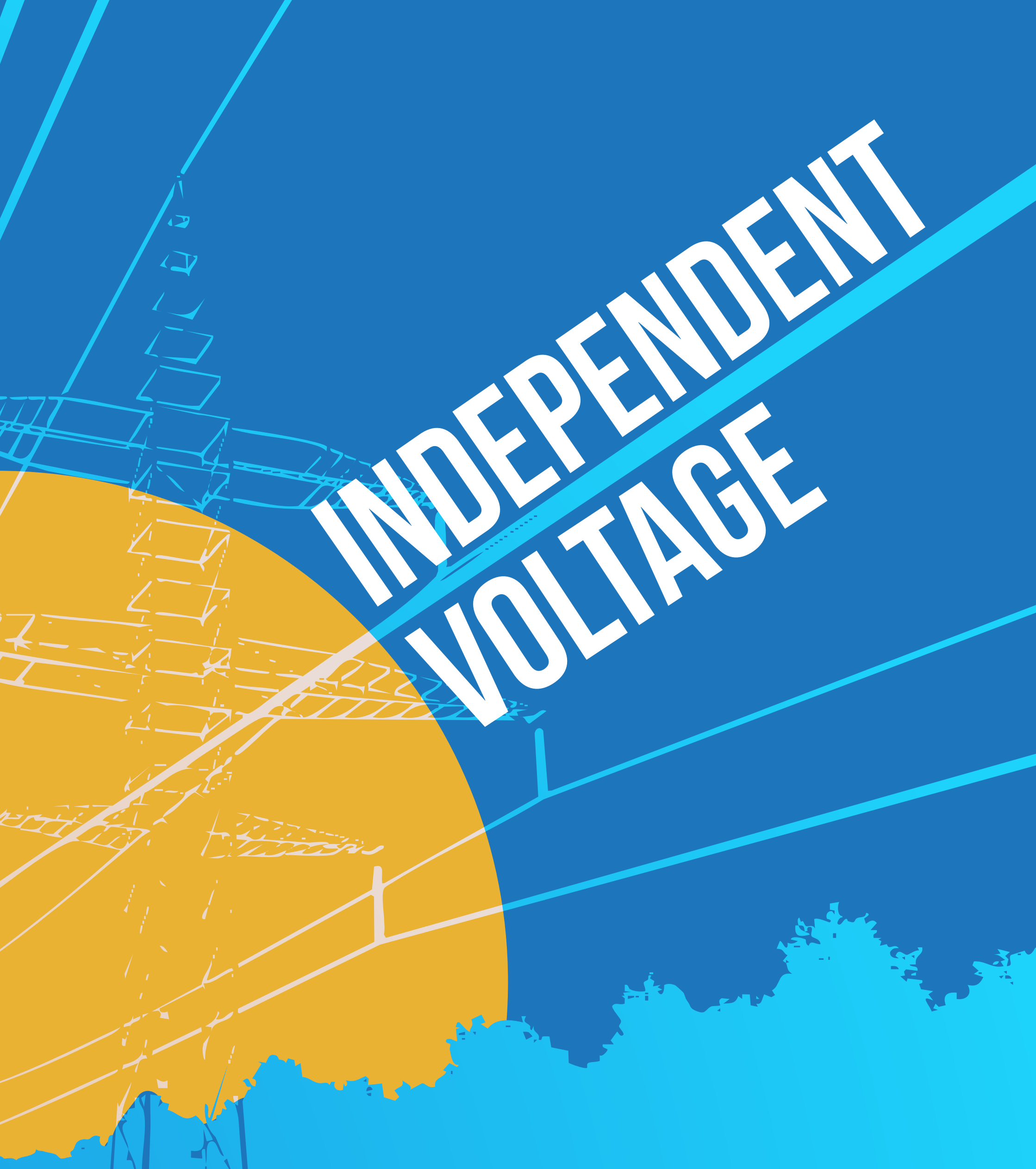

INDEPENDENT VOLTAGE

European Grid Resilience, Energy Sovereignty and EU Compatibility Standards

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Foreword

Anna Stürgkh

Member of the European Parliament
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Recent crises have fundamentally changed how we think about energy in Europe. From Russia's war of aggression against Ukraine to instability in global supply chains, we have had to learn that dependence on external actors for our energy supply comes at a high price. It exposes us to political pressure, fuels price volatility, and makes our economies dependent on the whims of political leaders elsewhere.

Over the last decade our stride for a more sustainable Europe has led us to focus on creating clean and renewable energy systems. Today, we have come to realise that these renewable energy systems make Europe not only more sustainable, but also more resilient and independent. Transforming our energy production is thus no longer just a question of making our continent more sustainable but also a matter of security, sovereignty, and strategic autonomy.

The need for action is clear, but Europe still has a long road ahead: every year, we continue to spend €375 billion on fossil fuel imports instead of investing in home-grown energy production. Tackling this challenge requires the transformation of our energy system as a whole. While the switch to renewable energy production has received a lot of attention in recent years, the modernisation and expansion of our electricity grid has been under-represented in the political discourse.

Electricity grids form the backbone of modern economies. However, Europe's grid infrastructure is vastly outdated and will require investments of more than €2 trillion by 2050 to keep our economies running and our homes lit. It is thus more urgent than ever to focus political action on what keeps our energy systems connected.

This is a challenge no Member State can tackle alone. Instead, the energy transition requires a truly integrated Energy Union – one in which electricity can flow freely across borders and where strong, interconnected grids and well-planned energy storage allow Europe to complete its transition towards clean, renewable, and independent energy production.

Resilient grids are therefore more than just infrastructure. They are the backbone of a secure, sovereign, and climate-neutral Europe. Delivering them is one of the most pressing political challenges of our time and must be achieved as quickly as possible. This publication offers solutions based on three case studies that may serve as good practice examples for future European policies.

Introduction

Eloi Borgne

Every year, Europe spends billions on foreign fossil fuels instead of investing in home-grown solutions. This dependence exposes us to political pressure, fuels price volatility, and threatens our economies. The solution is not isolation but integration: creating a truly integrated European energy union where electricity can flow freely across borders, supported by modern, resilient grids and strong interconnections.

Unfortunately, grids have been largely overlooked by the energy debate. While renewable energy has received significant political attention, the modernisation and expansion of our electricity grids has remained under-represented in policy discussions. This gap must be addressed. Without resilient, interconnected grids, the energy transition cannot succeed.

This publication examines electricity grids in three European countries: Austria, Bosnia and Herzegovina, and Spain. These three cases are not selected because of their success stories or failures. Rather, they are chosen because they reveal three different reasons why grid resilience remains difficult to achieve across Europe. Each country faces distinct challenges, but they are all working towards the same goal: becoming part of a secure, sovereign, and integrated European energy system.

By studying these three countries, we can understand the different barriers that block grid integration across Europe and identify the different solutions each barrier requires. This comparative approach offers lessons for policymakers and practitioners facing similar grid challenges in other European contexts.

At first glance, the terms ‘independent voltage’ and ‘energy sovereignty’ may appear to signal a push for greater divisions and separations between states. However, the three cases presented here demonstrate the importance of greater resilience in our shared European energy grids. It is important to make this distinction and to highlight that energy sovereignty means independent decision-making without external coercion, not self-sufficiency. This reframing is important because it shows that Austria (reliant on foreign fossil fuels), Bosnia (gas-dependent), and Spain (a renewable exporter) can all gain sovereignty through different pathways. Sovereignty is about having strategic control over your energy future, not about producing all of your energy in isolation.

The three countries – one wealthy and integrated with EU energy infrastructure (Austria), one EU candidate and transitioning (Bosnia and Herzegovina), one resource-rich but isolated (Spain) – reveal why achieving a truly integrated European energy union is so complex. Each of these countries faces a fundamentally different obstacle. Each requires a different approach. In this publication, experts will dive into the specifics of these countries and discuss the challenges they face and the lessons to learn from them. What unites the three cases is the challenge of achieving grid resilience at EU scale. These barriers are not insurmountable. By understanding the distinct obstacles facing each country and tailoring solutions accordingly, Europe can build the integrated energy architecture it requires: transforming dependence on single external energy suppliers into reliance on diversified, reliable renewable sources, and ensuring that Europe can exercise genuine strategic control over its energy future.

From Renewable Potential to Energy Sovereignty

Why Public Acceptance is the Missing Link in Austria

Markus Fischer

Abstract

Recent geopolitical disruptions have underscored the extent to which Europe's energy system remains exposed to external shocks, bringing renewed attention to the question of energy sovereignty. This chapter examines Austria as a critical case study, arguing that the country benefits from substantial domestic renewables and a highly reliable electricity system yet remains structurally dependent on foreign fossil fuels. Electrification and European interconnection offer a credible pathway to greater sovereignty. Yet the required expansion of grid infrastructure is not keeping pace with system needs due to delays in permitting that are linked to insufficient public acceptance.

Drawing on insights from behavioural economics, empirical studies, and interviews with politicians, the chapter shows that public acceptance is not a secondary concern but a decisive constraint. It argues that strengthening energy sovereignty requires complementing technical and regulatory reforms with a broader policy approach focused on societal buy-in. This includes aligning economic incentives with perceived local benefits, designing fair and transparent participation processes, leveraging social norms and local networks to build visible support, and developing more effective communication strategies to address misinformation and shape public attitudes towards the energy transition.

1.1 Introduction

Energy sovereignty has moved to the centre of the political debate. For the second time this decade, Europe is facing a major energy crisis. Russia's invasion of Ukraine and Iran's closure of the Strait of Hormuz expose a fundamental reality: dependence on foreign fossil fuels is not only an environmental risk but also an economic, strategic, and political vulnerability. Reliance on external suppliers amplifies price volatility, constrains political room for manoeuvre, and increases the risk that energy policy will become reactive rather than autonomous.

Austria provides a particularly relevant case study for European energy sovereignty due to its central position in the continental electricity system. Located at the crossroads of major north–south and east–west power flows, it plays a key role in linking European energy markets. This makes Austria a critical test case: if grid expansion, electrification, and cross-border integration fail here, the implications extend well beyond national borders.

Energy sovereignty should not be understood here as national self-sufficiency or isolation from markets. For a small, open economy embedded in the European Union, sovereignty in energy policy is best interpreted as the ability to make independent political choices within an interconnected European system.

The Alpine republic is blessed with renewable resources yet remains structurally dependent on foreign fossil fuels. Austria could rely on an existing hydropower backbone providing dispatchable power. Pumped hydro and batteries offer the opportunity to smooth wind and solar power generation by storing excess electricity when production is high and releasing it when output drops. The country also has strong domestic bioenergy and geothermal potential to offer stability in both power and heating. However, imported oil, gas, and coal account for more than half of Austria's total energy supply, driven by the transport, heating, and industry sectors.

This coexistence of a high potential for renewable electricity and continued fossil fuel reliance illustrates Austria's structural paradox. The challenge is not a lack of renewable potential, but the limited ability of the system to translate that potential into reduced fossil use and greater resilience. Constraints in infrastructure, system integration, and public acceptance prevent domestic renewable electricity from replacing imported fuels.

Against this background, this chapter focuses on electrification and European interconnection as the core strategy for strengthening Austria's energy sovereignty. Electrification is both a driver for energy efficiency and an enabler of renewables, while interconnection embeds

Austria in a more resilient and balanced European power system.

This analysis argues that technical solutions alone are insufficient. Permitting processes and public acceptance emerge as the critical political constraints that determine whether renewables buildout, grid expansion, and interconnection can proceed at the required pace. Energy sovereignty therefore depends not only on engineering and investments but also on political communication and societal buy-in.

Without public acceptance, the impact of permitting reforms will remain limited;; without faster permitting, grid expansion will stall; without sufficient grid expansion, electrification cannot scale; without electrification, fossil import dependency persists; and without reducing this dependency, Austria's energy sovereignty remains structurally constrained.

This chapter proceeds as follows: after reviewing the relevant literature on energy sovereignty and public acceptance, it outlines the methodological approach of this study. It then provides an overview of Austria's import dependency, interconnection levels, and grid expansion challenges. Finally, the chapter examines the underlying challenges in permitting and public acceptance before concluding with policy recommendations to improve Austria's energy sovereignty.

1.2 Literature review

1.2.1 Energy sovereignty

Contemporary debates on energy policy build on the classic energy trilemma: balancing security, affordability/access, and environmental sustainability.[1] This case study frames energy policy through the European Commission's work on strategic foresight.

This framework distinguishes between 'open strategic autonomy' (the EU's capacity to set its own priorities and act independently by reducing one-sided dependencies) and the operational necessity of 'strategic preparedness'. The latter refers to the 'ability to anticipate, prevent, and respond to a full spectrum of threats and risks (e.g. cyberattacks on LNG import terminals or a naval blockade on oil imports) by fostering a "preparedness by design" culture across all levels of governance and society'.[2]

In this context, resilience is defined as the ability 'to withstand and cope with challenges'. In the energy sector, this can be interpreted as the system's capacity to absorb a shock (such as a gas cutoff), adapt to the subsequent disruption (using storage or interconnectors), and recover (returning to normal or 'bouncing forward' to a better state).[3]

In the literature, 'energy sovereignty' is described as the ability of a state to make independent decisions about its energy mix and infrastructure without being vulnerable to external coercion..[4] This contrasts with the term 'energy security', which has a stronger focus on physical supply and is defined as the 'uninterrupted availability of energy sources at an affordable price'.[5] 'Energy independence' refers to a situation in which an

1 World Energy Council (2011), World Energy Sustainability Index 2011, https://www.worldenergy.org/assets/downloads/PUB_wec_2011_assessment_of_energy_and_climate_policies_executive_summary_2011_WEC.pdf.
2 European Commission High Representative of the Union for Foreign Affairs and Security Policy (2025), Joint Communication to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions on the European Preparedness Strategy, European
3 European Commission (2020), 2020 Strategic Foresight Report: Strategic Foresight – Charting the Course towards a More Resilient Europe (COM(2020) 493 final), Publications Office of the European Union, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0493.
4 K. Westphal, M. Pastukhova, and J. M. Pepe (2022), 'Geopolitics of Electricity: Grids, Space and (Political) Power', SWP Research Paper 6, March, Stiftung Wissenschaft und Politik / German Institute for International and Security Affairs, https://www.swp-berlin.org/publications/products/research_papers/2022RP06_GeopoliticsOfElectricity.pdf.
5 IEA (2026), 'Energy Security', Glossary. https://www.iea.org/glossary.

economy can satisfy its energy demand without relying on a substantial amount of energy imports.[6] In other words, energy security is about the reliability of the system; energy independence looks purely at imports of resources; and energy sovereignty is about who holds the power over that system.

Energy sovereignty must therefore be seen as a concept that embeds not only current physical security realities but also future objectives that will enable resilience and open strategic autonomy. In the words of Westphal, 'sovereignty in energy affairs is therefore not synonymous with supply security but instead requires a technically robust energy system that is resilient in crises and fortified against political influence, thereby forming the basis of the state's strategic autonomy and capability to act in energy affairs'.[7]

1.2.2 Permitting and public acceptance

The interlinkage of permitting and public acceptance in the development of energy transition infrastructure has been widely discussed. The European Commission explicitly identifies permitting as a central bottleneck for both renewable deployment and grid expansion across the EU, mentioning a lack of public acceptance as a key structural constraint in permitting.[8]

Hübner and colleagues identify five drivers of public acceptance: (1) economic impacts (perceived economic benefits or costs to the community), (2) attitude towards the energy transition (general belief in and support for moving to renewables, reflecting values and norms), (3) planning process (quality of participation, transparency, fairness), (4) impacts on nature and residents (perceived environmental and social effects, encompassing risk perceptions such as noise, wildlife, visual impact), and (5) social norms (perceptions of community support or

6 J. Jewell et al., 'Comparison and Interactions between the Long-Term Pursuit of Energy Independence and Climate Policies', Nature Energy, 1(6), article 16073, https://www.nature.com/articles/nenergy201s673.
7 K. Westphal (2021), 'Strategic Sovereignty in Energy Affairs: Reflections on Germany and the EU's Ability to Act', SWP Comment, no. 7 (January), https://www.swp-berlin.org/publications/products/comments/2021C07_SovereigntyEnergyAffairs.pdf.
8 European Commission (2025), European Grids Package, https://energy.ec.europa.eu/topics/infrastructure/european-grids_en.

opposition).[9]

Academic research suggests that transparency and perceived fairness play a key role. Segreto and colleagues synthesised European evidence and conclude that 'trust in principal actors remains a significant driver in local acceptance'.[10] Morrissey and Scheller replicate this finding at the local level in Germany.[11] Radtke's meta-analysis of 129 studies from Austria, Germany, and Switzerland finds that 'effective public participation fosters transparency, trust, and social acceptance'.[12]

Insights from political psychology and behavioural economics illuminate why technical arguments alone rarely secure public support. Lakoff, Westen, and Haidt argue that attitudes and opinion are shaped more by emotion and morality than by reasoning or cost–benefit analysis.[13] Kahneman demonstrates that intuitive 'fast thinking' often prevails over deliberative analysis. Applied to energy infrastructure, this literature suggests that successful permitting and acceptance depend not only on legal reform but also on framing, identity, and trust-building.[14]

Together, these insights suggest that public acceptance challenges, and thereby the pace of energy infrastructure development, are not fully explained by rational considerations alone but are strongly shaped by perceived fairness, trust, and transparency.

1.3 **Methods**

This case study applies a qualitative and quantitative desk research design complemented by expert interviews. The desk research maps Austria's

9 G. Hübner et al. (2023), 'Broadening the Social Acceptance of Wind Energy – An Integrated Acceptance Model', Energy Policy, 173, article 113360, https://doi.org/10.1016/j.enpol.2022.113360.

10 M. Segreto et al. (2020), 'Trends in Social Acceptance of Renewable Energy Across Europe – A Literature Review', International Journal of Environmental Research and Public Health, 17(24), 9161, https://doi.org/10.3390/ijerph17249161.

11 K. Morrissey and F. Scheller (2024), 'It Takes a Village: The Role of Community Attributes in Shaping Solar Photovoltaic Adoption Intention in Germany', Renewable Energy, 237, Part A, 121542, https://doi.org/10.1016/j.renene.2024.121542.

12 J. Radtke (2025), 'Barriers and Benefits of Public Participation in Energy Transitions: A Meta-analysis of Empirical Evidence from Central Europe', Renewable and Sustainable Energy Reviews, 221, 1–27, https://doi.org/10.1016/j.rser.2025.115693.

13 G. Lakoff (2004), Don't Think of an Elephant! Know Your Values and Frame the Debate (White River Junction, VT: Chelsea Green Publishing); D. Westen (2008), The Political Brain: The Role of Emotion in Deciding the Fate of the Nation (New York: PublicAffairs); J. Haidt (2012), The Righteous Mind: Why Good People are Divided by Politics and Religion (New York: Pantheon Books).

14 D. Kahneman (2011), Thinking, Fast and Slow (New York: Farrar, Straus and Giroux).

energy system, fossil import dependency, renewables potential, and grid infrastructure needs and status. Data is drawn from publicly available and official sources, including the International Energy Agency (IEA), the European Network of Transmission System Operators for Electricity (ENTSO-E), Eurostat, E-Control, Austrian Power Grid (APG), and relevant publications of Austrian ministries and the European Commission.

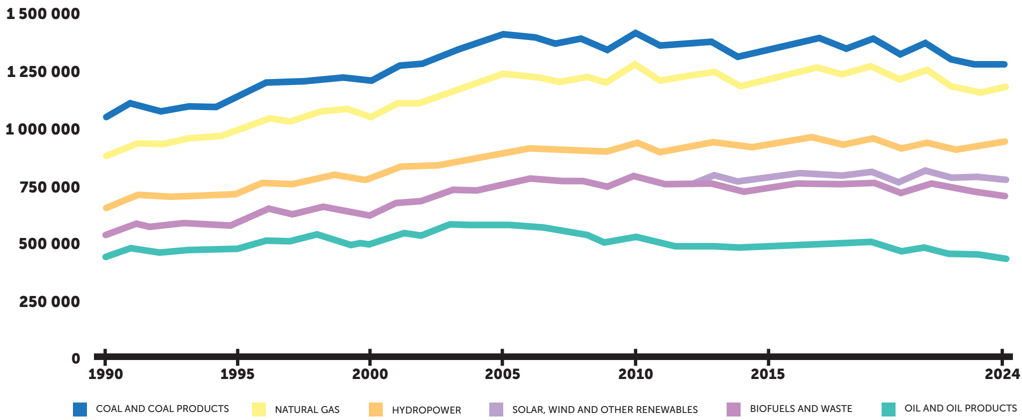
In addition, semi-structured interviews with energy-focused politicians provide qualitative insights into the realities of permitting, public acceptance dynamics, resistance to grid expansion, and the role of political communication in shaping societal support for infrastructure projects.

1.4 **Results and discussion**

1.4.1 The Austrian energy system

Austria combines strong renewable electricity capacity with a primary energy structure that remains significantly dependent on foreign fossil fuels (see Figure 1). In the power system, hydro provides a stable and flexible backbone. In recent years, wind and solar power have expanded rapidly, while pumped hydro and battery storage increasingly balance the intermittence of renewables. Biomass plays a complementary role, particularly in heating and in combined heat and power applications. Furthermore, the east of the country has substantial geothermal resources. Finally, Austria has advanced its energy efficiency efforts over the last decade.

Figure 1. Total energy supply by source, Austria, 1990–2024, terajoules (TJ).



Source: IEA (2025), Energy Statistics Data Browser, https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=AUSTRIA&fuel=Energy%20supply&indicator=TESbySource.

Still, oil and gas continue to account for a large share of Austria's total energy supply, particularly in transport and building sectors. Coal is a dominant source for industry, particularly for high-temperature-process heat. This structural composition underlines Austria's sovereignty challenge, which lies less in electricity generation alone and more in the broader energy system.

97% of oil and 77% of fossil gas consumed in Austria in 2024 was imported, according to Eurostat. Austria's fossil fuel import dependency has not changed for decades, with the 2004 numbers amounting to 95% for oil and 79% for gas. However, thanks to an increasing share in renewables, biofuels, and waste as well as energy efficiency, Austria substantially improved its energy import dependency rate, measured in net imports as a percentage of gross available energy. The overall dependency went from 72% in 2004 to 53% in 2024.

Source: Eurostat (2026), Energy in Europe: Imports Dependency, 18 March, https://ec.europa.eu/eurostat/web/products-eurostat-news/w/wdn-20260318-1.

Austria's high dependence on imported oil and gas creates a direct risk. Disruptions far beyond its borders can quickly increase domestic prices, threaten supply security, and balloon government spending. In 2024, Austria spent over €12 billion on oil and gas imports.[15] Moreover, domestic policymaking cannot control supply or price levels. This vulnerability again became visible with the start of the Iran war in spring 2026. Rising global oil prices fed through rapidly into higher gasoline and diesel costs in Austria, leading to the political need for short-sighted market interventions and tax rebates that further strain the state budget.

The implications are clear: as long as large parts of Austria's transport, heating, and industrial demand remain tied to foreign fossil fuels, the country remains exposed to shocks originating in politically unstable regions, leaving very limited room to manoeuvre for Austrian policymakers.

Renewables and energy efficiency – both enabled by electrification – represent the most credible route to strengthening Austria's energy sovereignty. Austria's substantial domestic renewable resources are most effectively utilised through electrification. For end-use sectors such as transport, heating, and industry, shifting from fossil fuels to electricity allows these domestic resources to substitute for imported energy. At the same time, electrification delivers significant efficiency gains: technologies such as heat pumps and electric vehicles convert energy more efficiently than combustion-based systems, reducing overall energy demand.

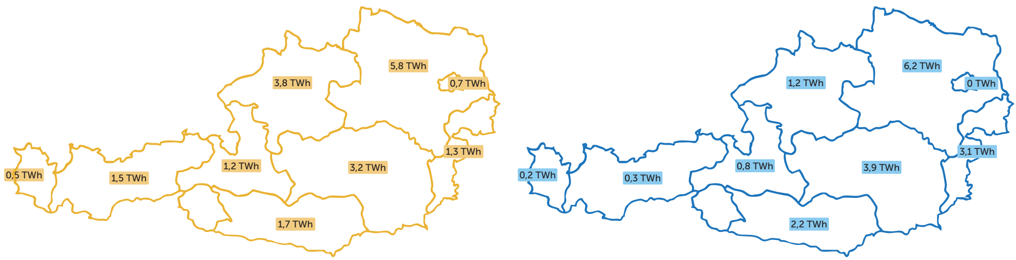
The electrification potential in Austria's major demand sectors is substantial (see Figure 2). For industry, a 2025 Agora Industry and Frauenhofer report shows that direct electrification could reduce fossil fuel use in low- and medium-temperature heat processes by around 50%.[16] The report also finds that industrial heat pumps can be economical. For processes up to 100°C, heat pumps can be competitive at an electricity-to-gas price ratio of almost 3, while heat up to 150°C generally requires the ratio to fall below 2. This underlines that electrification is not only a

15 Statistik Austria (2025), Der Außenhandel Österreichs: Gesamtjahr 2024, https://www.statistik.at/fileadmin/pages/201/ITGSkompakt_01.-12.2024e.pdf

16 Agora Industrie and Fraunhofer ISI (2025), 'Industriewärme elektrifizieren und Kosten sparen. Potenziale im niedrigen und mittleren Temperaturbereich', https://www.agora-industrie.de/fileadmin/Projekte/2023/2023-36_IND_Electrification_low_heat/A-IND_389_Industriew%C3%A4rme_elektrifizieren_und_Kosten_sparen_WEB.pdf.

climate option but, under the right framework conditions, a competitive strategy for industry.

Figure 2. Renewable energy buildout potential by 2030 by Austrian state for photovoltaic (left) and wind (right).



Source: Klimadashboard Österreich (n.d.), 'Ausbau der erneuerbaren Stromerzeugung', https://klimadashboard.at/energie/erneuerbare-energien

A similar logic applies to transport and to residential heating. While the upfront cost of electric vehicles remains a barrier, the gap is narrowing: in Germany, according to the IEA, 71% of EVs sold in 2024 still carried a price premium over combustion engine vehicles, but this was down from 85% in 2021.[17] Moreover, in many cases, the total cost of ownership of an EV is more favorable to the buyer due to lower fuel and maintenance costs. For heating, the case for electrification is even stronger: heat pumps are typically three to five times more energy efficient than gas boilers. Together, these comparisons suggest that electrification in transport and buildings can simultaneously reduce overall energy demand and enable better use of domestic resources.

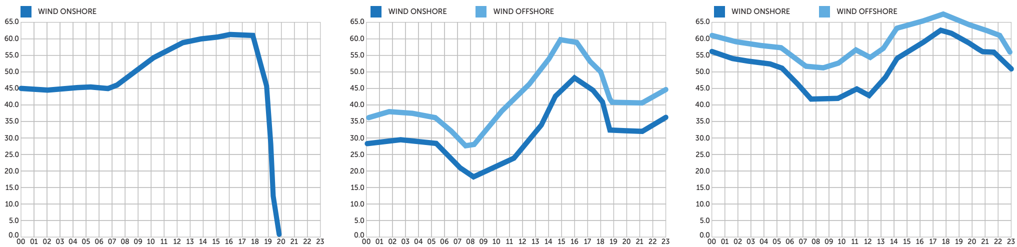
1.4.2 Assessment of Austria's interconnection

Grids and European interconnection are the physical foundation of both electrification and renewables in Austria. As power demand rises, generation becomes more decentralised and weather-dependent (see Figure 3). This makes both strong domestic grids and cross-border interconnection essential to meet demand from industry and households, balance fluctuations, access flexibility, better integrate

17 IEA (2025), Global EV Outlook 2025, https://www.iea.org/reports/global-ev-outlook-2025.

wind and solar, and reduce curtailment.

Figure 3. Wind energy generation on 2 April 2026 in Austria (left), in Austria and Germany (centre), and across the EU and the UK (right).



Source: WindEurope (n.d.), 'Hourly Wind Energy Generation: France, Germany, Italy, Netherlands, Switzerland, Austria, Belgium, Denmark', https://windeurope.org/about-wind/daily-wind/hourly-generation

Austria's electricity grid is best described as highly reliable but increasingly under strain. APG's 2025 network development planning emphasises that Austria continues to enjoy very high security of supply, with grid availability above 99.99%.[18] At the same time, renewable expansion, electrification, and changing load flows are creating growing pressure on the transmission system and increasing the need for new corridors and reinforcement projects. E-Control's 2025 activity report points in the same direction: the expansion of renewables and the improvements to the flexibility of the electricity system require major grid investments, which are already feeding through into higher network charges.[19]

The operational relevance of these bottlenecks became visible in January 2026, when low hydro output and weak solar generation turned Austria into a net-import-dependent system for parts of the month; APG stated that only high imports, full use of available gas-fired generation, and pumped storage were able to maintain security of supply. Together, these findings suggest that Austria's grid is functioning, but no longer comfortably ahead of the energy transition: it is already moving from adequacy towards structural constraint.

APG's current grid planning indicates that by 2035, Austria will need

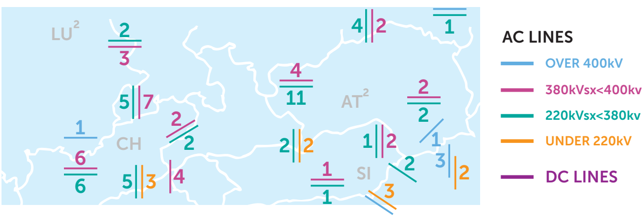
18 APG (2025a), 'Netzentwicklungsplan', https://www.apg.at/stromnetz/netzausbau/netzentwicklungsplan-2025/
19 E-Control (2025), 'Tätigkeitsbericht der E-Control 2025', https://www.e-control.at/taetigkeitsbericht-2025-online

to deliver a substantial expansion of its transmission system, including approximately 920 km of new transmission lines, around 730 km of line refurbishments, upgrades of about 70 km to higher voltage levels, the construction of 23 new substations, and the installation of roughly 80 transformers with a combined capacity of around 30,000 MVA to connect different grid levels.[20]

Austria is comparatively well integrated into the European electricity system in formal terms: it is interconnected with all neighbouring countries except Liechtenstein. According to the European Commission, the Alpine republic has consistently exceeded the EU's 15% electricity interconnection target.[21] In early 2026, Austria's interconnection level stood at 24.26%, well above the 2030 target, although below its earlier levels of 31.50% in 2021 and 28.96% in 2024, indicating that relative interconnectivity has weakened as domestic generation capacity has grown. Further, Austria's geographical location in central Europe makes it relatively easy to reach high interconnection numbers.

A comparison with Switzerland provides suggestive evidence that Austria's cross-border integration could be stronger (see Figure 4), although differences in measurement limit direct comparability. Still, Switzerland is connected to neighbouring systems via 41 cross-border lines at a total of almost 12,000 KV, while Austria has a total of 36 at less than 10,000 KV.[22]

Figure 4. Number and capacity of interconnections in Switzerland and Austria.



Source: ENTSO-E (2025), Statistical Factsheet 2024, https://eepublicdownloads.blob.core windows.net/public-cdn-container/clean-documents/Publications/Statistics/Factsheet/entsoe_sfs2024_web.pdf.

The trade figures reinforce this picture. According to ENTSO-E,

20 APG (2025a), 'Netzentwicklungsplan'
21 European Commission (2026), Electricity Interconnection Targets, https://energy.ec.europa.eu/topics/infrastructure/electricity-interconnection-targets_en.
22 ENTSO-E (2025), Statistical Factsheet 2024, https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Publications/Statistics/Factsheet/entsoe_sfs2024_web.pdf

Switzerland in 2024 imported 19,825 GWh and exported 31,865 GWh. Austria, by contrast, imported only 13,973 GWh and exported 18,717 GWh.[23] This is not a like-for-like measure of total traded electricity, but it still suggests that

Switzerland functions as a more deeply integrated cross-border electricity hub than Austria, despite being outside the EU internal market.

For Austria, that matters strategically: if cross-border capacity and power exchange remain below what its central location would allow, this will slow the balancing of a more electrified renewables-based system and, with it, the country's path towards greater energy sovereignty.

The Commission also stresses that the 15% metric is only a partial indicator and should be complemented by other measures such as the relation of interconnector capacity to peak load and renewable generation. Austria's headline performance is therefore solid, but the broader policy question is not only whether the formal target is met but whether cross-border capacity is expanding fast enough to support a more electrified and renewables-based system.

The expansion of Austria's power grid has progressed substantially slower than required for the desired pace of renewable deployment and electrification. Of course, APG's network development plan sets out a comprehensive expansion pathway, identifying the need for several thousand kilometres of grid reinforcement and new lines to integrate renewables, enable electrification, and maintain security of supply.[24] However, key transmission projects face major delays, indicating that grid expansion is not keeping pace with the speed of renewable deployment and electrification needs. According to Karin Doppelbauer (Member of Parliament, NEOS Party), 'grid buildout in Austria faces a systemic barrier due to slow digitalization, inefficient federal structures, and a lack of integrated infrastructure planning'.

23 ENTSO-E (2025), Statistical Factsheet 2024.
24 APG (2025b), Network Development Plan 2025; https://www.apg.at/en/power-grid/grid-expansion/network-development-plan-2025/

1.4.3 Permitting and public acceptance

Permitting has emerged as a fundamental bottleneck to faster grid buildout in Europe. The European Commission states that electricity transmission grids take around ten years to complete, with permitting accounting for more than half of that time, and notes that 78% of respondents to the public consultation on the grids package identified permitting as the leading obstacle to ensuring that grid infrastructure develops as needed for the energy transition.[25] The Commission also makes clear that the problem is not limited to formal deadlines alone: delays are driven by fragmented administrative systems, insufficient staffing, lengthy environmental assessments, weak digitisation, and lack of public acceptance. In practice, local opposition often translates into legal objections, appeals, and political resistance, which materially extend permitting timelines and delay project realisation. In this sense, permitting is not merely an administrative hurdle at the end of the process; it is the central constraint through which many other obstacles to grid expansion are expressed.

Two key legislative initiatives are currently underway to address these permitting bottlenecks at both European and national levels. At the EU level, the proposal of the European Grids Package Commission seeks to streamline and accelerate permitting procedures for grids by introducing binding time limits, tacit approval mechanisms, and clearer rules for environmental assessments.[26] It also aims to strengthen coordination through single contact points and digital one-stop-shop platforms, while establishing more predictable procedures for grid connection and infrastructure development across Member States. It contains some provisions for renewables, such as prohibiting Member States from creating no-go zones for wind or solar.
In parallel, the Austrian government has introduced the Renewable Buildout Acceleration Law (Erneuerbaren Ausbau Beschleunigungsgesetz, EABG), which aims to simplify and speed up approval procedures for grids, renewable energy, and related infrastructure projects.[27] It transposes

25 European Union (2025), Proposal for a Directive of the European Parliament and of the Council Amending Directives (EU) 2018/2001, (EU) 2019/944, (EU) 2024/1788 as Regards Acceleration of Permit-Granting Procedures, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52025PC1007&qid=1770212786010.
26 European Commission (2025), European Grids Package.
27 Austrian Parliament (2026), 449 der Beilagen zu den Stenographischen Protokollen des Nationalrates XXVIII. https://www.parlament.gv.at/dokument/XXVIII/I/449/fname_1747495.pdf.

permitting provisions from the Renewable Energy Directive into Austrian law, for example by introducing provisions for overriding public interest, one-stop shops, and clearer responsibilities and timelines in permitting. A central element is the designation of so-called Trassenkorridore for electricity lines: these are safeguarded routing corridors intended to reserve enough space for future grid infrastructure and make subsequent project approval faster and more predictable. For lines crossing more than one federal state, the draft assigns a strong coordinating role at federal level while obliging transmission and distribution operators to propose parcel-specific corridors in advance.

Together, these reforms bring much-needed improvements in the efficiency and predictability of permitting frameworks. However, such governance, process, and legalistic measures are not a universal panacea. Public acceptance is fundamental for them to work. Even the most streamlined legal framework will struggle if projects continue to trigger distrust, local resistance, and political conflict. In a democracy, the state certainly needs strong tools to deliver strategically necessary infrastructure, but it cannot sustainably build against the wishes society at large. If this is not addressed, today's acceleration in development risks becoming tomorrow's legitimacy crisis. Just as policymakers are strengthening the legal framework to deliver energy transition infrastructure even in the face of opposition, they must also address the sociological, psychological, and communicative conditions that determine whether these projects are accepted in the first place.

Both the European Grids Package and the EABG give limited attention to communications and public acceptance. Of course, the two files have some relevant provisions. The Grids Package aims to improve public acceptance by requiring benefit sharing for large renewable projects and by introducing an independent facilitator to support dialogue between project developers and local communities. While these are steps in the right direction, they are not far-reaching enough because they lack communications strategies to provide transparent facts and counter disinformation. The EABG, for example in paragraph 53 on public participation, provides a passive option allowing the public to submit a written consultation. However, it does not contain measures targeted at increasing transparent dialogue or including the public's suggestions. The Austrian draft law equally lacks measures to fight misand disinformation.

Local opposition to energy transition infrastructure is already prevalent in Austria. In Carinthia, a non-binding referendum rejected the expansion of wind power altogether, although courts clarified that such votes cannot override federal and constitutional competences. At the municipal level, multiple wind projects have been halted or rejected in recent years through local votes, reflecting a broader pattern of resistance. In March 2025, against the backdrop of rising energy costs following the phase-out of emergency measures, a municipality in Lower Austria voted against a wind project despite its expected fiscal benefits for the local budget, highlighting the tension between economic incentives and local acceptance.[28] At the same time, public criticism of planned wind developments continues.[29] More broadly, organised anti-wind movements have gained visibility across Austria, mobilising around concerns such as landscape impact, health, and distrust in decision-making processes, indicating that opposition is not isolated but part of a wider societal dynamic.[30]

While objection to wind is the most prominent example of local opposition, such criticism is also problematic for grid infrastructure. For example, the Salzburgleitung – a key transmission project linking Salzburg and Upper Austria – faced more than a decade of delays due to local resistance, legal challenges, and political disputes before construction could proceed. Anna Stürgkh, Member of European Parliament Renew/ NEOS Party, says that 'grid buildout has been absent from the public debate for years, limiting public awareness of its societal benefits. The topic only comes up on the local level if a concrete project is already in the advanced planning stage, but then it is often too late.'

The evidence presented here shows that public acceptance remains a critical constraint. While reforms on the governance and procedural sides are very helpful, they must be accompanied by measures targeting public acceptance. As Karin Doppelbauer puts it: 'Politics can no longer be decided behind closed doors when it comes to where, how and

28 NOE (2026), 'Burgschleinitz stimmte knapp gegen Windräder', 15 March, https://noe.orf.at/stories/3345905/
29 J. Weichhart (2026), 'Live-Diskussion: Sollen Windräder im Traisental gebaut werden?' Kurier, 26 March, https://kurier.at/chronik/niederoesterreich/ein-ort-am-wort-orf-windraeder-traismauer-herzogenburg-sitzen-berg-reidling/403142671#google_vignette.
30 E. Crisan (2023) 'Gegenwind: Wie mächtig sind die Windkraft-Gegner?' Profil, 23 November, https://www.profil.at/oesterreich/gegenwind-wie-maechtig-sind-die-windkraft-gegner/402679000.

when energy infrastructure is built. We must be transparent and work with citizens on an equal footing.' Similarly, Anna Stürgkh says that 'openness and transparency are crucial to increase public acceptance'.

1.5 **Policy recommendations**

1.5.1 Economic benefits

Economic benefits relate not only to direct financial compensation but also to the broader distribution of tangible local gains from energy projects – such as lower electricity prices, local tax revenues, jobs, co-ownership opportunities, and community infrastructure like schools or community centres. Such benefits can materially improve acceptance when they are perceived as fair and meaningful. What matters is often not the economic benefit as such but the perceived economic benefit.

Economic effects are among the strongest predictors of acceptance, but they operate through how local residents judge the benefits for their community and households, not through an objective balance sheet alone.

A vote in March 2026 against a wind farm in Lower Austria illustrates the point. The proposed three-turbine project would have generated electricity for 17,000 households, and the project developer publicly offered local residents a fixed electricity tariff of 9.6 cents/kWh for 20 years plus compensation payments of €44,000 per turbine per year to the municipality budget; yet voters still rejected the project. In narrow economic terms that outcome is hard to explain, but a behavioural interpretation offers a better lens: people tend to over-weigh visible local losses, distrust promised gains and respond more strongly to perceived unfairness or identity threats than to abstract long-term financial benefits.

Policy design should therefore move beyond purely financial compensation and explicitly incorporate behavioural insights. First, compensation schemes should not focus only on monetary terms; they must be seen as part of a fair and respectful process. This includes discussing benefits early, openly, and in combination with opportunities for participation. Benefits should feature co-design elements and visible community improvements such as a new children's playground. Second, policymakers should actively frame projects in terms of avoiding losses – such as energy price volatility or dependency on unstable suppliers – rather than only highlighting long-term gains, in order to visibly counter loss aversion. Third, communication strategies about the benefits must anticipate cognitive biases: proactively addressing misinformation (to counter availability bias), making financial support visible (to counter status quo and confirmation bias), and emphasising near-term, tangible benefits rather than distant climate gains (to counter hyperbolic discounting). In practice, this implies combining financial incentives with targeted communication, early engagement, and locally salient narratives to align perceived and actual benefits.

1.5.2 Attitude towards energy transition

People's attitude towards energy transition is linked to their general belief in, and normative support for, the shift towards clean energy. In other words, it depends on whether they see the transition as necessary, useful, fair, and worth pursuing in principle. The literature reviewed in this chapter suggests that even though general support does not automatically translate into acceptance of individual projects when local concerns arise, this broad orientation matters strongly for acceptance.

In practical terms, support for renewables and grids cannot be built through technical explanation alone; it must be anchored in emotionally resonant narratives about security, fairness, affordability, and national purpose. Opinion-shaping strategies must build on concepts from psychology-driven political communications. For Austrian energy policy, that implies moving from reactive, localised project communication towards proactive agenda-setting that makes the energy transition feel meaningful, desirable, and socially normal.

Four concrete recommendations follow. First, trade associations should be encouraged to run a nationwide public campaign for renewables and grid expansion that frames them not only as climate policy but also as freedom from foreign fossil fuels, protection against future price shocks, and a source of domestic value creation. The 'Holz ist genial' campaign by the Austrian wood industry association is a successful example of how such a campaign can be done. Second, Austria should develop more systematic anti-disinformation measures around energy infrastructure, including rapid-response myth correction, transparent fact platforms, and stronger visibility for trusted local messengers, established before opposition narratives harden. Third, policymakers should strengthen citizen involvement and accessibility by turning energy infrastructure into visible and accessible public spaces – combining landmark-style design with open-site formats such as guided tours and educational programmes, as demonstrated by the Ausflugs-Windrad Bruck, a publicly accessible demonstration wind turbine with a viewing platform designed to familiarise visitors with wind energy through direct experience.

Last but not least, policymakers should work more actively with social media influencers, artists, and cultural events to translate infrastructure into aspirational imagery; a strong positive example is the Camo & Krooked DJ set played from a wind turbine, which reached close to 1 million views on YouTube and shows how wind power can be associated with creativity, pride, and modernity rather than only with conflict.

1.5.3 Social norms

Social norms represent people's perception of whether others in their community support or oppose a project – that is, the sense of what is socially normal, accepted, or controversial. This matters because individuals do not evaluate energy projects in isolation: they look to neighbours, local elites, media narratives, and visible public debate as cues for how to think and act. One of the most important drivers prompting a person in Germany to install rooftop solar is that the neighbours have done so – the so-called spatial peer effect. Social acceptance is shaped by relational and societal factors such as community dynamics, information flows, and trust. Social norms play an especially strong role at the early stage of an initiative, when people have little direct knowledge and rely heavily on perceived community opinion. In short, if opposition appears socially dominant, it can discourage support; if acceptance is visible and normalised, it can help projects gain legitimacy.

Two recommendations follow directly from the role of social norms. First, policymakers should actively leverage peer effects and visible endorsement, for example by working with early adopters or energy-transition champions to signal that support for renewable and grid projects is socially widespread. Spatial peer effects can be particularly helpful for harder-to-convince groups, as making support visible can shift behaviour beyond purely rational considerations. Second, policymakers should activate and amplify existing supporters, rather than focusing communication primarily on opponents. Individuals with strong technology interest or pro-environmental values can act as multipliers if their support becomes visible; this requires creating platforms – such as local forums, participatory formats, and digital tools – that make positive attitudes observable early in the process. Making neutral or supportive positions visible at an early stage is crucial to triggering a positive social dynamic, rather than allowing opposition to dominate the narrative by default.

1.5.4 Impacts on local nature, landscape, and residents

Critical to acceptance are the perceived environmental and social effects of energy infrastructure at the local level – above all concerns about noise, visual intrusion, effects on biodiversity, health, and changes to everyday living conditions. This dimension matters because even people who broadly support renewables may oppose a concrete project if they expect it to harm their landscape, quality of life, or local environment. In short, this dimension is about how people experience or anticipate the local costs of the transition and whether these costs are seen as acceptable, manageable, and fairly addressed.

A key implication for policy is to work through local political networks and place-based engagement, rather than dismissing opposition as simple NIMBYism. As Tip O'Neill's famous dictum goes, 'all politics is local'.

This applies directly to energy infrastructure. Landscapes carry strong emotional and cultural meaning, and visible changes such as pylons can be perceived as a threat to local identity, especially among residents with strong ties to their area. This implies that effective policy must be rooted in local credibility and proximity: involving mayors, community leaders, and trusted local actors early in the process, and tailoring project design and communication to local contexts. By embedding projects within local political and social networks, policymakers can shift the debate from confrontation to co-ownership and reduce the perceived conflict between energy transition goals and local identity.

1.5.5 Planning process

Acceptance of the planning process can be dependent on the quality of participation, transparency, procedural fairness, and the perceived degree of real influence that citizens have over energy projects. *The literature shows that acceptance depends not only on what is built, but on how decisions are made.* In short, this dimension is about whether people experience planning as fair, open, and responsive, or as something imposed on them from above.

The first recommendation is to design participation processes that are well-planned, transparent, and meaningful rather than merely formal. Stakeholders should be involved early, have insight into the processes, and feel that they have real influence; by contrast, late-stage engagement, power imbalances, and superficial consultation should be avoided because these can increase mistrust and resistance. For policymakers, this means moving beyond information-focused one-off hearings and passive written consultations, and towards formats that let residents co-shape project design, routing, mitigation measures, and benefit-sharing, initiating such measures before positions harden.

A second recommendation is to build bottom-up participation capacity instead of relying mainly on top-down communication. If citizens feel they have little real influence, the potential to foster trust and acceptance are limited. In practice, this argues for local citizen panels, community working groups, village-level conveners, and small-scale dialogue formats anchored in trusted local networks. It also means that project developers need to be visibly present in the debate: procedural justice has intrinsic value, and people are more likely to accept decisions if they feel heard and treated fairly, even when not all of their demands are met.

Third, participation should be adapted to the emotional timing of projects. The research reviewed in this chapter suggests that acceptance is not static: it often weakens during contentious planning phases and can recover later if outcomes prove less harmful than feared. This U-shaped acceptance curve implies a staged participation strategy: early communication should explain necessity and alternatives; mid-stage processes should focus on fairness, mitigation, and local influence; later stages should maintain contact, monitor impacts, and visibly deliver promised benefits. In other words, participation should not be treated as a legal box to tick but as a continuing political process that sustains legitimacy over time.

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Grid Resilience and Energy Sovereignty in Bosnia and Herzegovina

Challenges and Alignment with EU Energy Transition

Nihad Harbaš

Abstract

This chapter examines the resilience, interoperability, and strategic preparedness of the electricity grid system of Bosnia and Herzegovina within the context of the European energy transition. Using desk research based on data from Eurostat, ENTSO-E, the International Energy Agency, and national energy institutions, the chapter analyses the current structure of electricity generation, transmission infrastructure, and cross-border interconnections. The analysis identifies structural strengths, including significant hydropower capacity and strong regional interconnections, as well as vulnerabilities related to ageing infrastructure, climate variability, and dependence on coal generation. The chapter evaluates Bosnia and Herzegovina's alignment with EU energy and climate policies and discusses implications for energy sovereignty and grid resilience. Finally, policy recommendations are proposed to support grid modernisation, renewable energy integration, and deeper regional market integration.

2.1 **Introduction–** why grid resilience matters now

The electricity sector of Bosnia and Herzegovina occupies a strategically important position within the Western Balkans and the broader European energy system. As the European Union accelerates the transition towards climate neutrality while simultaneously addressing challenges related to energy security, geopolitical instability, and market volatility, the resilience and interoperability of neighbouring electricity systems have become issues of common European interest. Electricity grids are no longer viewed solely as technical infrastructure. Rather, they represent critical assets for economic stability, energy sovereignty, and regional cooperation.

In recent years, the European energy landscape has undergone profound transformation. The increasing penetration of renewable energy sources, electrification of end-use sectors, and growing cross-border electricity trade require transmission systems capable of operating flexibly under conditions of variable generation patterns and uncertain demand dynamics. At the same time, climate-related risks, supply disruptions, and fluctuating energy prices have exposed structural vulnerabilities across many European electricity systems.[1]

For Bosnia and Herzegovina, these developments represent both opportunities and challenges. The country possesses significant generation resources, particularly hydropower, and maintains strong physical interconnections with neighbouring systems. However, ageing infrastructure, institutional fragmentation, evolving market rules, and exposure to hydrological variability create constraints for deeper integration with the European electricity market. As a contracting party to the Energy Community Treaty, Bosnia and Herzegovina is gradually aligning its regulatory and market framework with the EU energy acquis, making grid modernisation and interoperability increasingly important policy priorities.[2]

Where Chapter 1 examined an EU Member State constrained primarily by public acceptance and permitting, this chapter examines an EU candidate country where institutional fragmentation and coal dependency present the most binding constraints on energy sovereignty and transition.

2.2 **Literature review–** energy security and grid resilience in Europe

The resilience of electricity systems has become a central topic in European energy policy and academic research in the field, particularly in the context of the ongoing energy transition and increasing electrification. Recent studies emphasise that energy security within

1 European Commission (2023), Electricity Interconnection Targets, https://energy.ec.europa.eu/topics/infrastructure/electricity-interconnection-targets_en.

2 Energy Community Secretariat (2023), Annual Implementation Report, https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.energy-community.org/dam/jcr:3da7c4f8-ea23-4169-b1e9-66b0ed05fcb7/EnC_IR2023.pdf&ved=2ahUKEwivxbODy9SUAxVeZ0EAHYTVLkoQFnoECBkQAQ&usg=AOvVaw0Syimf-cQ-shn3B1tLQrMnh.

the EU is no longer defined solely by access to primary fuel resources, but increasingly by the reliability, flexibility, and adaptability of electricity networks capable of integrating variable renewable energy sources while maintaining stable cross-border power flows.[3]

A growing body of literature highlights the critical role of transmission infrastructure in enabling large-scale renewable energy integration. The expansion of wind and solar generation introduces variability and uncertainty into power system operation, requiring enhanced grid flexibility, improved balancing mechanisms, and strengthened regional cooperation. The International Energy Agency underlines that modern electricity systems depend on digitally supported transmission networks and integrated electricity markets to ensure operational stability under high shares of renewable generation.[4]

In the Western Balkans, electricity sector reforms have largely been shaped by the Energy Community framework, which extends EU internal energy market rules to contracting parties. This framework is established by the Energy Community Treaty, an international agreement that is legally binding for its members, including Bosnia and Herzegovina. Under the Treaty, contracting parties are required to transpose and implement key elements of the EU energy acquis, covering electricity market liberalisation, renewable energy, and energy efficiency. Reports by the Energy Community Secretariat identify several structural barriers in Bosnia and Herzegovina to deeper market integration, including ageing infrastructure, institutional fragmentation, limited investment capacity, and slower implementation of regulatory reforms than in EU Member States.[5] For Bosnia and Herzegovina, this membership implies the adoption of EU-aligned market rules, institutional reforms such as unbundling and independent regulation, and commitments to renewable energy, energy efficiency, and regional market integration.

Overall, existing literature converges on the conclusion that key determinants of electricity system resilience in Europe are grid modernisation, strengthened interconnections, regulatory

3 International Energy Agency (IEA) (2023), Bosnia and Herzegovina – Electricity, https://www.iea.org/countries/bosnia-and-herzegovina/electricity.
4 IEA (2023), Bosnia and Herzegovina – Electricity.
5 Energy Community Secretariat (2023), Annual Implementation Report; Parliamentary Assembly of Bosnia and Herzegovina. Law on Transmission of Electric Power, Regulator and System Operator of BiH (Official Gazette of BiH no. 7/2002, 13/2003, 76/2009 i 1/2011); Elektroprenos BiH; NOSBiH institutional documentation.

harmonisation, and regional market integration. These findings provide the conceptual foundation for assessing the resilience and interoperability of Bosnia and Herzegovina's electricity system within the broader European energy transition.

2.3 Baseline overview of the electricity sector in Bosnia and Herzegovina

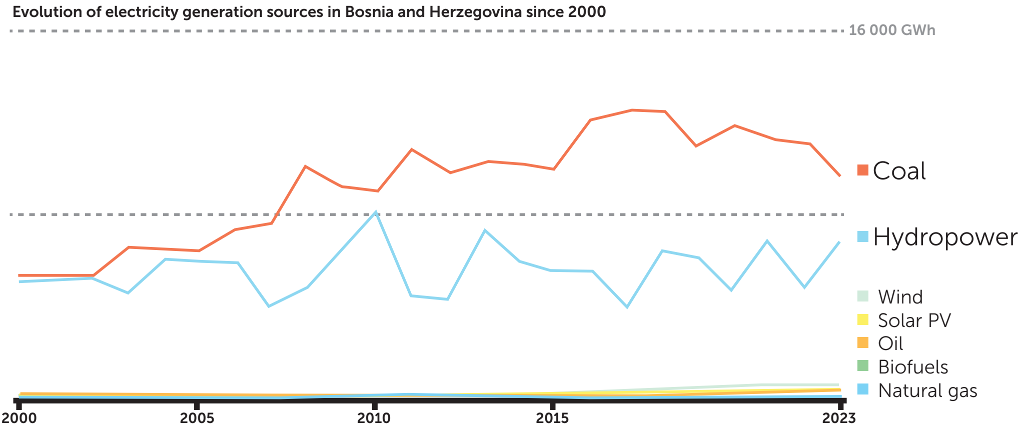
The electricity system of Bosnia and Herzegovina is among the more production-intensive energy systems in the Western Balkans and is characterised by a strong reliance on domestic energy resources and a relatively high level of self-sufficiency in electricity generation. The sector is largely based on coal-fired generation capacity and hydropower. While this structure has enabled electricity exports in certain years, it also creates challenges related to ageing infrastructure, decarbonisation requirements, and the growing need for system flexibility in line with European energy transition objectives.[6]

Primary energy supply in Bosnia and Herzegovina is dominated by solid fossil fuels (mainly lignite coal) and renewable energy sources, primarily hydropower. Figure 1 shows the relative shares of key energy sources in the overall supply mix. Coal remains a key source of electricity generation due to domestic reserves and existing thermal power plants. Hydropower contributes a significant share of annual electricity production, making system performance sensitive to hydrological conditions. Oil products are largely import-dependent and mainly used in transport and heating rather than electricity generation.[7] Although natural gas plays a relatively limited role compared with the EU average, its supply is entirely import-dependent: Bosnia and Herzegovina relies on a single supply route from Russia via Serbia, with total natural gas imports amounting to 224.3

6 IEA (2023), Bosnia and Herzegovina – Electricity.
7 IEA Energy Statistics; Eurostat (2024), Energy Balances. https://www.iea.org/data-and-statistics/data-product/world-energy-balances.

mcm in 2024.[8] This single-source dependency represents a strategic vulnerability in terms of energy security.

Figure 1. Primary energy supply by source.



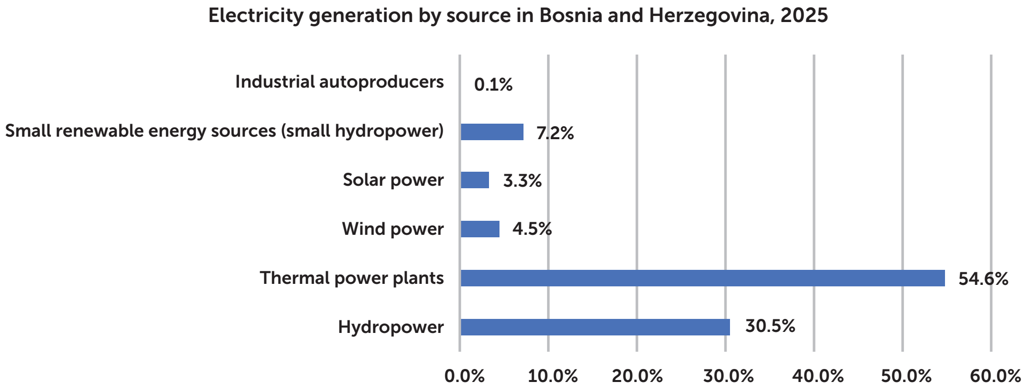
Source: IEA Energy Statistics / Eurostat Energy Balances.

At the same time, renewable energy sources have continued to expand, particularly wind and solar generation, which have recorded strong growth and further strengthened their role in the overall electricity portfolio.

As shown in Figure 2, hydropower continues to represent a significant share of electricity generation. In 2025, its contribution declined compared with the previous year due to a period of unfavourable hydrological conditions; such declines confirm the system's sensitivity to water availability. Lignite-fired power plants remained the main source of baseload generation; however, production in 2025 reached its lowest level since 2006, indicating a gradual structural shift in the generation mix.

8 Agency for Statistics of Bosnia and Herzegovina (2025), Energy statistics, Natural gas, https://bhas.gov.ba/Calendar/Category?id=26&page=1&statGroup=26&tabId=0.

Figure 2. Share of electricity sources in Bosnia and Herzegovina, 2025.



Source: DERK (2025), Report on the Energy Sector in Bosnia and Herzegovina.

Institutionally, Bosnia and Herzegovina has a decentralised electricity governance structure shaped by its constitutional framework. The transmission system is operated at the state level by Elektroprenos Bosne i Hercegovine, responsible for maintaining and developing the transmission network, while system operation and balancing are managed by the Independent System Operator (NOSBiH) in coordination with the operational standards of the European Network of Transmission System Operators for Electricity (ENTSO-E). Electricity generation and distribution are carried out by three vertically integrated public utilities: JP Elektroprivreda BiH, Elektroprivreda HZHB, and Elektroprivreda Republike Srpske.[9]

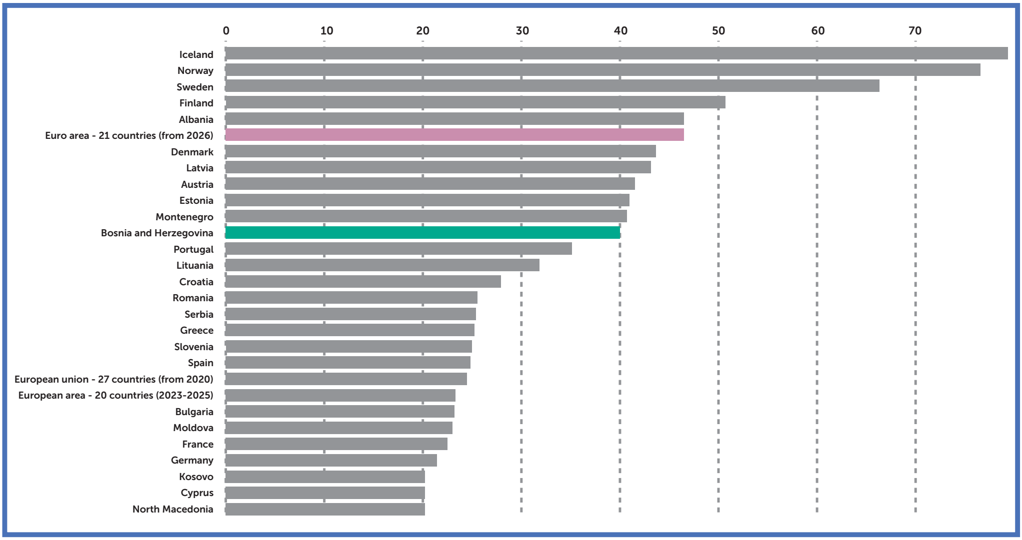
This institutional structure creates coordination challenges, particularly in investment planning, regulatory alignment, and market reform implementation. Nevertheless, Bosnia and Herzegovina participates in regional electricity cooperation through the Energy Community Treaty, which requires gradual alignment with EU energy legislation and market integration principles.[10]

9 Parliamentary Assembly of Bosnia and Herzegovina, Law on Transmission of Electric Power, Regulator and System Operator of BiH.
10 Parliamentary Assembly of Bosnia and Herzegovina, Law on Transmission of Electric Power, Regulator and System Operator of BiH.

Due to its geographical position and interconnected transmission corridors, Bosnia and Herzegovina plays an important role in electricity flows in southeast Europe.

Generation capacity relative to domestic demand allows the country to contribute to regional adequacy under favourable conditions. However, modernisation needs, increasing renewable energy integration, and evolving EU regulatory requirements, partly binding through the Energy Community framework and further reinforced by the EU accession process, are driving the need for further adaptation of infrastructure and market arrangements.[11] Figure 3 compares renewable electricity generation trends in Bosnia and Herzegovina with the EU average, highlighting the country's relatively high renewable share, primarily driven by hydropower.

Figure 3. Share of renewable electricity generation in Bosnia and Herzegovina compared with EU average, 2015–2023.

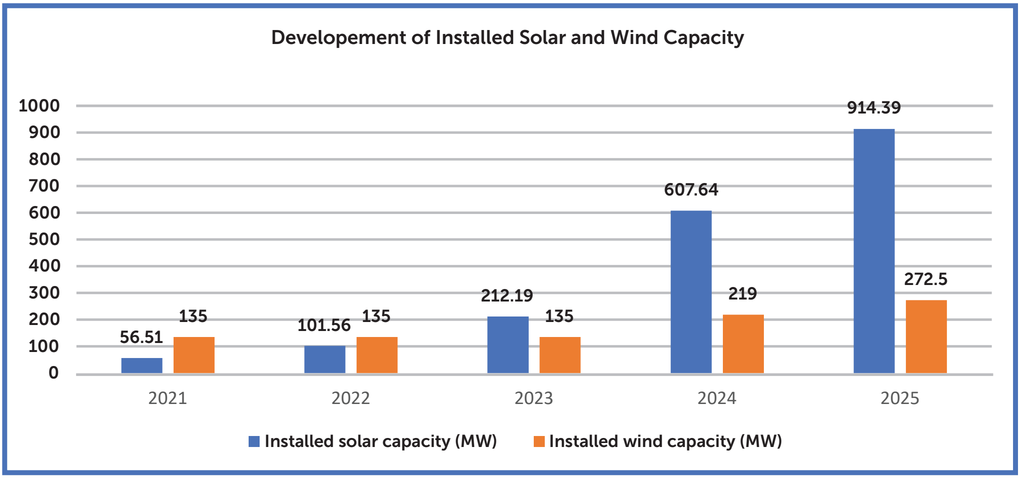


Source: Eurostat Energy Statistics.

11 IEA (2021), Energy Policies Beyond IEA Countries: Bosnia and Herzegovina.

The current energy system reflects both strong legacy generation assets that support energy independence and growing pressures for modernisation, decarbonisation, and deeper integration into the European electricity market. At the same time, the renewable energy landscape is evolving rapidly, particularly in the solar and wind segments. As illustrated in Figure 4, installed solar capacity has expanded significantly, tripling in 2024 to around 608 MW, while wind capacity reached approximately 219 MW, indicating a clear trend of diversification of the generation mix.

Figure 4.Installed solar and wind capacity in Bosnia and Herzegovina, 2021–2025.



Source: DERK (2025), Report on the Energy Sector in Bosnia and Herzegovina.

This growth momentum has continued into 2025, with further increases in installed capacity (solar exceeding 900 MW and wind surpassing 270 MW), alongside the commencement of the construction of Bosnia and Herzegovina's largest photovoltaic project to date, a 125 MW solar plant at Komanja Brdo. In the electricity sector, the draft National Energy and Climate Plan (NECP) sets a target to increase the share of renewable energy sources to 70.1% of electricity consumption by 2030, representing a substantial expansion of renewable electricity generation within the national power system.

Understanding this baseline provides the foundation for assessing grid resilience and future policy priorities discussed in the following sections.

2.4 **State of the electricity grid and interconnection**

The electricity transmission network of Bosnia and Herzegovina represents a critical component of national energy security and regional power system stability in southeast Europe. Due to its geographical position between Central Europe and the Western Balkans, the country functions as an important transit corridor for cross-border electricity flows, contributing to regional system balancing and electricity market exchanges. Consequently, the resilience and operational performance of the transmission network have implications extending beyond national borders.

Within contemporary energy policy frameworks, power system resilience is assessed across several interconnected dimensions, including transmission capacity adequacy, the level of interconnection with neighbouring systems, generation portfolio flexibility, availability of balancing reserves, degree of grid digitisation, and institutional capacity for crisis management. Evaluated through these indicators, Bosnia and Herzegovina's electricity system demonstrates relative strengths in regional connectivity and generation resources, alongside structural challenges related to infrastructure modernisation and market integration.

The transmission system is operated by Elektroprenos Bosne i Hercegovine, which manages approximately 4,000 km of high-voltage transmission lines at voltage levels of 400 kV, 220 kV, and 110 kV, together with substations forming the backbone of the national grid (see Table 1). System operation, dispatching, and balancing responsibilities are performed by the Independent System Operator (NOSBiH), which coordinates real-time system stability and maintains synchronisation with the Continental Europe synchronous area operating under

ENTSO-E standards.[12]

Table 1. Transmission interconnections

Voltage level	Number of power lines	Number of interconnectors	Length (km)
400 kV	**15**	**4**	**865.97**
220 kV	**43**	**10**	**1,526.25**
110 kV	**253**	**23**	**4,093.75**
110 kV (cable)	**11**	**–**	**34.68**
Total	**322**	**37**	**6,520.65**

2.4.1 Cross-border interconnection and regional integration

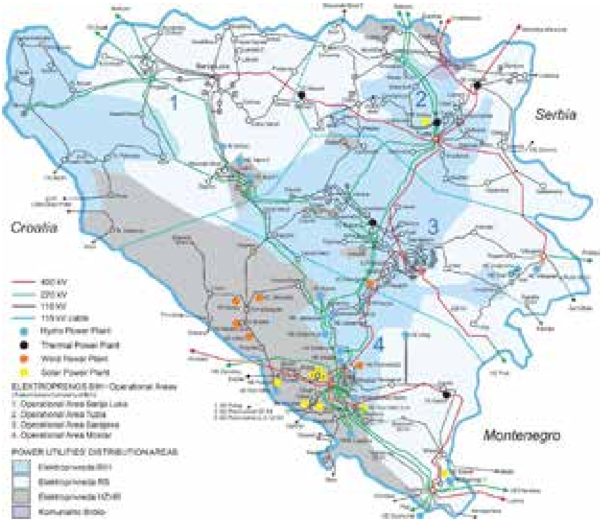
Bosnia and Herzegovina maintains interconnections with all neighbouring electricity systems, including Croatia, Serbia, and Montenegro, enabling participation in regional electricity markets and contributing to system adequacy across southeast Europe. These interconnections allow electricity exports during periods of surplus generation and imports during hydrologically unfavourable years, thereby improving overall system flexibility.

The EU promotes electricity interconnectivity as a cornerstone of energy security and market integration policy. A key benchmark is the 15% electricity interconnection target, which measures installed cross-border transmission capacity relative to domestic generation capacity. Achieving adequate interconnection levels enhances system resilience by enabling energy sharing between countries, reducing price volatility, and facilitating renewable energy integration across wider geographical areas.[13]

12 Elektroprenos Bosne i Hercegovine a.d. Banja Luka, Annual Reports and Technical Data on the Transmission Network, https://www.elektroprenos.ba/dokumenti.
13 European Commission (2017), Clean Energy for All Europeans Package, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52016DC0860

The transmission network shown in Figure 5 connects Bosnia and Herzegovina with neighbouring systems in Croatia, Serbia, and Montenegro, enabling significant cross-border electricity exchange within southeast Europe.

Figure 5. Bosnia and Herzegovina's cross-border electric power connections.



Source: DERK, Report on the Energy Sector in Bosnia and Herzegovina. https://www.derk.ba/DocumentsPDFs/BIH-SERC-Annual-Report-2025.pdf

Although Bosnia and Herzegovina is not an EU Member State, its participation in the Energy Community framework requires gradual alignment with EU electricity market principles, including strengthened cross-border cooperation and coordinated transmission planning. Existing interconnections provide a solid technical foundation; however, additional investments will be necessary to accommodate increasing renewable generation in the region and expected growth in cross-border electricity trade.[14] As see in Table 2, electricity trade dynamics further illustrate the importance of regional integration.

14 State Electricity Regulatory Commission (DERK) (2025), Report on the Energy Sector in Bosnia and Herzegovina, https://ec.europa.eu/eurostat/web/energy/data.

Table 2. Electricity imports and exports in Bosnia and Herzegovina

Year	Electricity generation (GWh)	Imports (GWh)	Exports (GWh)	Total cross-border exchange
2025	14,540	2,810	5,137	7,947 (55%)
2024	14,554	2,021	4,524	6,545 (45%)
2023	15,822	917	5,148	6,065 (38%)
2022	15,036	868	3,947	4,815 (32%)
2021	17,055	1,390	6,173	7,563 (44%)
2020	15,391	1,496	5,543	7,039 (46%)

While the existing level of cross-border interconnection provides Bosnia and Herzegovina with a solid foundation for regional electricity trade and system adequacy, the increasing penetration of variable renewable energy sources introduces new operational requirements that extend beyond physical connectivity alone. The ability of the transmission system to respond flexibly to fluctuations in generation and demand will become equally important for maintaining system stability and reliability. In this context, grid flexibility, balancing capacity, and advanced system management capabilities are emerging as key determinants of future grid resilience and effective regional integration.

2.4.2 Grid flexibility and operational challenges

The transition towards variable renewable energy sources across Europe introduces new operational requirements for transmission system operators. Unlike conventional generation, wind and solar power introduce variability and forecasting uncertainty, increasing the importance of grid flexibility, balancing reserves, and voltage regulation mechanisms.

Bosnia and Herzegovina's system currently benefits from hydropower plants capable of providing balancing services. However, climate variability affecting water inflows may reduce this flexibility over time. In addition, limited deployment of advanced grid technologies such as smart substations, dynamic line rating, and automated congestion management may constrain future system adaptability.

Figure 6 illustrates current cross-border transmission capacity and regional energy flows, highlighting the pathways through which Bosnia and Herzegovina interacts with neighbouring countries. As shown, major interconnections exist with Croatia, Serbia, and Montenegro, providing opportunities for energy imports, exports, and regional balancing services.

Figure 6. Cross-border transmission capacity and regional energy flows.

Source: ENTSO-E Transparency Platform.

From a regional perspective, strengthening transmission infrastructure in Bosnia and Herzegovina directly contributes to broader European objectives for energy system resilience.[15] Improved interconnections enable diversification of supply sources, enhance market liquidity, and

15 ENTSO-E (2024), Transparency Platform – Cross-Border Physical Flows and System Data.

reduce dependence on individual generation technologies or external suppliers. Grid modernisation should therefore be understood not only as a national infrastructure priority but also as part of the wider European energy security architecture.

The development of energy storage systems is increasingly recognised as a key component of grid resilience across Europe. Storage integration enables mitigation of short-term renewable generation fluctuations, optimisation of peak load management, and improved voltage and frequency stability. For Bosnia and Herzegovina, pilot projects in battery energy storage systems could represent an important step towards increasing system flexibility and enabling more efficient integration of solar and wind generation without imposing significant stress on existing transmission infrastructure.

2.4.3 Voltage management and system stability

Maintaining stable voltage levels represents a fundamental requirement for reliable operation of modern power systems. As the share of variable renewable energy sources increases, voltage fluctuations may become more frequent due to changing generation patterns and shifting power flows across the transmission network.

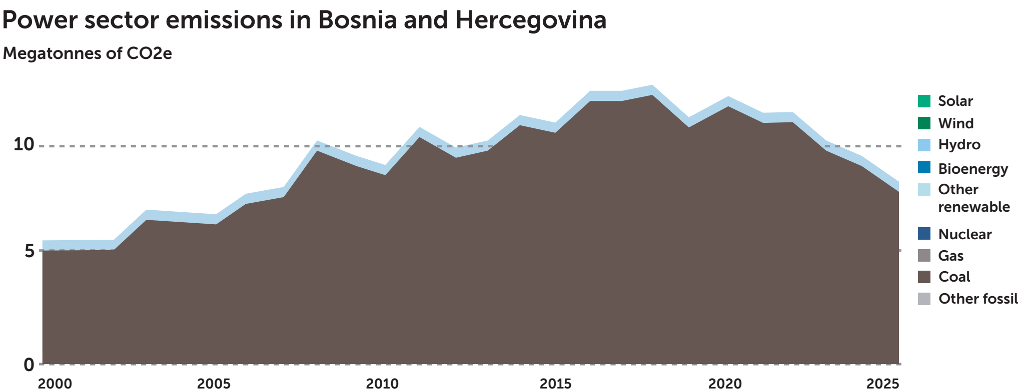
Independent voltage control mechanisms, including reactive power compensation, advanced grid management systems, and coordinated transmission system operation, are becoming increasingly important for ensuring system stability. For Bosnia and Herzegovina, strengthening voltage management capabilities will be particularly important for enabling higher renewable energy penetration while maintaining compatibility with ENTSO-E operational standards.

2.5 **Energy security and system vulnerabilities**

Energy security remains a central policy issue shaping electricity systems across Europe. In Bosnia and Herzegovina, energy security is influenced by the structure of the power sector, regional market dynamics, and increasing climate-related risks. While the country benefits from significant domestic generation capacity, several vulnerabilities affect the long-term resilience and adaptability of its electricity system.

A key structural feature of Bosnia and Herzegovina's power sector is its reliance on a limited number of large plants, particularly coal-fired and hydroelectric facilities. Although this system has historically supported self-sufficiency and export potential, it also creates exposure to operational disruptions, fuel supply constraints, and environmental policy pressures linked to decarbonisation. As illustrated in Figure 7, emissions remain strongly linked to coal-based generation, indicating the scale of the decarbonisation challenge.

Figure 7. CO_2 emissions from electricity generation in Bosnia and Herzegovina, 2000–2025.



Source: EMBER.

Hydropower, a major renewable source in Bosnia and Herzegovina, is subject to variability tied to hydrological conditions. Periods of drought or reduced rainfall can reduce hydroelectric output, affecting exports and increasing import needs. Climate projections for southeast Europe suggest that extreme events and altered precipitation patterns may become more frequent, impacting long-term hydro availability.[16]

Aging infrastructure and underinvestment in transmission and generation assets challenge operational reliability. Many plants and grid segments are decades old, making modernisation essential. Institutional complexity, with responsibilities divided across multiple entities, further complicates strategic planning, regulatory alignment, and market reforms.[17]

Regional electricity market dynamics, including rising renewable capacity and evolving market structures, may affect exports and price stability. Strengthening resilience will require improved system flexibility, cross-border integration, and diversification of generation sources. The EU Carbon Border Adjustment Mechanism (CBAM) may further incentivise decarbonisation and the modernisation of coal-dependent generation.[18]

In the case of Bosnia and Herzegovina, these external pressures intersect with the domestic structural characteristics of the energy sector. The pace of the coal transition is shaped not only by institutional and investment constraints but also by the socio-economic dependence of coal-intensive regions on mining activities. Debates on these issues tend not to be ideologically polarised and are strongly centred on employment security and regional economic stability. While there is limited large-scale societal opposition to renewable energy deployment, concerns related to just transition, job losses, and the long-term viability of coal-dependent communities remain key factors influencing the transition trajectory.

Overall, these vulnerabilities highlight structural pressures that could affect the long-term resilience of Bosnia and Herzegovina's electricity sector. Addressing them requires coordinated policy actions,

16 IPCC (2022), AR6 Climate Change 2022: Impacts, Adaptation and Vulnerability, https://www.ipcc.ch/report/ar6/wg2/.
17 Energy Community Secretariat (2023), Annual Implementation Report
18 European Commission (2023), Carbon Border Adjustment Mechanism (CBAM).

infrastructure modernisation, regulatory alignment with EU markets, and gradual diversification of the generation mix while ensuring security and affordability.

2.6 **Energy imports, market exposure, and prices**

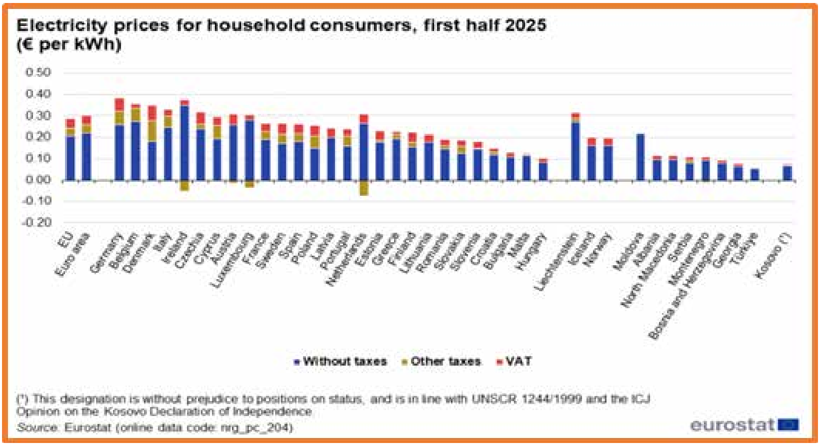
Electricity trade plays a key role in Bosnia and Herzegovina's energy system, reflecting the country's position within the interconnected southeastern European electricity market. Although Bosnia and Herzegovina has traditionally been a net electricity exporter due to coal and hydropower generation, annual trade balances fluctuate depending on hydrological conditions, domestic demand, and regional market dynamics.

In years with favourable hydrological conditions, hydro production increases, allowing Bosnia and Herzegovina to export surplus electricity to neighbouring markets. Conversely, during dry periods, the country may need to import electricity to maintain system balance and meet domestic demand. This variability underscores the importance of strong cross-border transmission infrastructure and regional market integration for supply security.

Trade flows are primarily directed towards neighbouring Western Balkan countries and the EU, including Croatia, Serbia, and Montenegro. Participation in regional electricity markets allows Bosnia and Herzegovina to exploit price arbitrage opportunities while providing flexibility in balancing supply and demand. However, increased integration also exposes the domestic sector to regional price fluctuations and volatile market conditions.

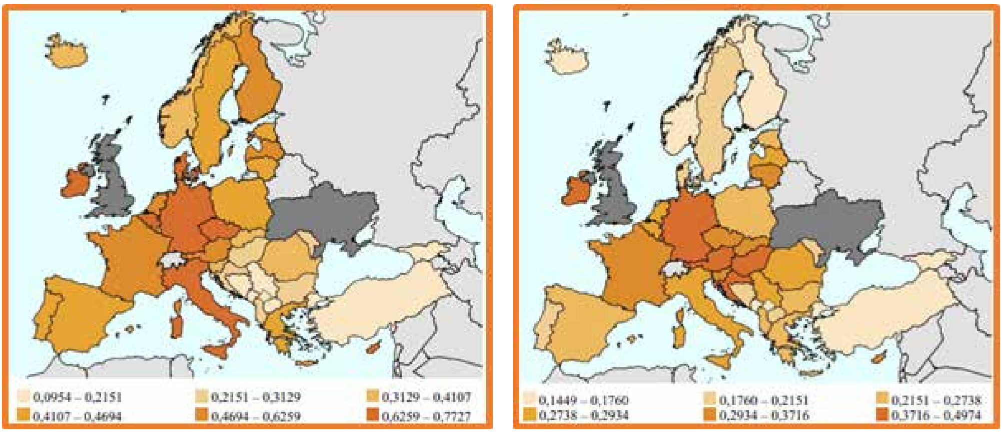
Electricity prices for households in Bosnia and Herzegovina have historically been low compared with those of many EU countries, reflecting domestic coal and hydropower resources, as shown in Figures 8 and 9. However, European electricity price dynamics in recent years, driven by fuel cost increases, market volatility, and EU carbon pricing, have affected domestic costs.

Figure 8. Electricity prices in KM/kWh for households (annual consumption from 2,500 to 5,000 kWh) in the first half of 2025, according to Eurostat methodology.



Source: Eurostat Energy Statistics / ENTSO-E Transparency Platform.

Figure 9. Electricity prices for industry (right) and households (left) (in KM/kWh) in the first half of 2024, according to Eurostat methodology.



Source: Eurostat Energy Statistics / ENTSO-E Transparency Platform.

Future price developments will depend on several factors: investments in renewable capacity, modernisation of existing plants, carbon pricing, and energy efficiency improvements. Strengthening grid resilience and enhancing cross-border interconnections can mitigate price volatility, while gradual diversification of the generation mix and increased renewable energy use can contribute to long-term price stability and improved energy security.[19]

2.7 Alignment with EU energy and climate policies

The electricity sector of Bosnia and Herzegovina operates within the broader framework of European energy cooperation through its membership in the Energy Community, which extends the EU's internal energy market rules to countries of southeast Europe and neighbouring regions. Within this framework, Bosnia and Herzegovina has committed to gradually aligning its regulatory and institutional structures with the EU energy acquis, including legislation related to electricity market liberalisation, renewable energy development, energy efficiency, and infrastructure planning.[20]

An important recent step towards regulatory alignment is the adoption of the Draft Law on the Regulator, Transmission and Electricity Market in Bosnia and Herzegovina by the House of Representatives of the Parliamentary Assembly of Bosnia and Herzegovina, with final adoption pending approval by the House of Peoples. The law establishes a comprehensive legal framework for the organisation and supervision of the transmission system and wholesale electricity market, aiming to take in key elements of EU electricity market legislation and the Energy Community acquis. Its objectives include the creation of an organised wholesale market, the establishment of a national electricity exchange, and stronger integration with regional and European electricity markets. By enhancing market transparency, competition, and security of supply while supporting renewable energy investment and decarbonisation, the

19 IEA (2023), Electricity Market Report, https://www.iea.org/reports/electricity-market-report-2023.
20 European Commission (2023), Bosnia and Herzegovina Report – Enlargement Package (energy chapter).

new regulatory framework represents a significant milestone towards compliance with European energy policy requirements.[21]

A central objective of European energy policy is the creation of an integrated electricity market capable of ensuring secure supply, competitive prices, and efficient cross-border electricity flows. The EU therefore promotes stronger electricity interconnections, recommending cross-border transmission capacity equivalent of at least 15% of installed generation capacity.[22] Although Bosnia and Herzegovina is not formally bound by this target, progress towards it is widely considered an indicator of readiness for deeper market integration. Existing transmission links with Croatia, Serbia, and Montenegro provide a solid basis for regional electricity exchange; however, further investments in transmission infrastructure and grid management will be necessary to accommodate growing renewable energy deployment and regional trade.

Alignment with EU climate and energy policy also implies the gradual decarbonisation of electricity generation. The EU aims to achieve climate neutrality by 2050 through initiatives such as the European Green Deal and the 'Fit for 55' package, which promote renewable energy expansion, electrification, and greenhouse gas emission reductions across sectors.[23] For Bosnia and Herzegovina, this transition presents both challenges and opportunities. Because electricity generation remains heavily dependent on coal, it is increasingly exposed to regulatory and economic pressures associated with carbon pricing, while significant hydropower, wind, and solar potential offers pathways towards a more sustainable energy system.

Participation in the Energy Community provides an institutional framework supporting regulatory harmonisation, infrastructure development, and regional electricity market integration. Continued implementation of EU-aligned energy policies will therefore be essential for strengthening energy security, improving investment conditions, and enabling deeper integration into the evolving European electricity

21 Council of Ministers of Bosnia and Herzegovina (2025), Proposal of the Law on the Regulator, Transmission and Electricity Market in Bosnia and Herzegovina.
22 European Commission (2017), Clean Energy for All Europeans Package
23 European Commission (2021), Fit for 55 Package, https://commission.europa.eu/topics/climate-action/delivering-european-green-deal/fit-55-delivering-proposals_en.

system.[24]

2.8 **Strategic implications for energy sovereignty**

The analysis presented in the previous sections highlights the dual nature of Bosnia and Herzegovina's electricity system. On one hand, the country benefits from significant domestic generation resources and relatively strong transmission interconnections with neighbouring electricity systems. On the other hand, structural vulnerabilities related to aging infrastructure, climate variability, and evolving energy market conditions present important challenges for long-term system resilience.

As established in Chapter 1, energy sovereignty should not be understood as energy isolation, but rather as the capacity of a country to maintain a secure, reliable, and affordable energy supply while actively participating in regional and international energy markets. When applied to Bosnia and Herzegovina, the operationalisation of this concept is shaped by additional structural constraints that differentiate it from EU Member States such as Austria. These include institutional fragmentation within the governance of the energy sector and a persistent dependence on coal-based generation, which limits the pace of diversification of the energy mix. Unlike Austria, which benefits from a well-developed renewable energy backbone and integrated EU market mechanisms, Bosnia and Herzegovina faces a more complex transition context where strategic autonomy must be balanced with legacy generation assets and slower investment cycles.

For Bosnia and Herzegovina, strengthening grid resilience represents a key element of this broader strategy. Investments in modern transmission infrastructure, digital monitoring systems, and advanced grid management technologies can significantly improve system

24 Energy Community Secretariat (2024), Annual Implementation Report – Bosnia and Herzegovina, https://www.google.com/url?sa=t&source=web&rct=j&opi=89978449&url=https://www.energy-community.org/dam/jcr:3d066877-d597-41c7-8b31-f85ba5392ef0/IR2024_BosniaHerzegovina.pdf&ved=2ahUKEwjtwJnuy9SUAxUJQEEAHVodEaUQFnoECBcQAQ&usg=AOvVaw21nCDVWbEOl2lWEUTwRpqm.

reliability and enable greater integration of renewable energy sources. At the same time, improved coordination among national institutions and stronger alignment with European regulatory frameworks can facilitate investment and market development.

Regional cooperation also plays a crucial role in enhancing electricity system resilience. Integrated electricity markets allow countries to share generation resources, reduce reserve capacity requirements, and mitigate supply disruptions. Given its geographical position and existing transmission infrastructure, Bosnia and Herzegovina has the potential to act as an important regional electricity hub, supporting energy security across southeast Europe.

The transition towards a more interconnected and decarbonised European energy system will therefore require coordinated efforts at national, regional, and European levels. Bosnia and Herzegovina's future energy strategy must balance infrastructure modernisation, renewable energy development, and regulatory reform in order to ensure that the electricity sector remains resilient, competitive, and aligned with evolving European energy policies.

2.9 **Policy recommendations**

The main structural strengths and challenges identified through this analysis are summarised in Table 3. While Bosnia and Herzegovina benefits from a relatively strong generation base and significant regional interconnections, the system remains constrained by structural vulnerabilities, including ageing infrastructure, dependence on coal, and exposure to climate variability. These findings highlight the need for a comprehensive and forward-looking policy approach that simultaneously addresses infrastructure modernisation, market integration, and energy transition objectives. In this context, strengthening grid resilience requires not only technical upgrades but also regulatory reforms and enhanced regional cooperation. Based on these findings, several policy directions can be identified to strengthen grid resilience, enhance energy security, and support Bosnia and Herzegovina's integration into the European electricity market.

Table 3. Key strengths and challenges in Bosnia and Herzegovina's electricity system

System dimension	Existing strengths	Key challenges
Generation capacity	Hydropower and baseload generation	Dependence on coal
Interconnections	High level of regional connectivity	Future capacity constraints
System flexibility	Hydropower balancing capability	Climate variability
Regulatory framework	Energy community framework	Slow implementation of reforms
Infrastructure	Stable grid foundation	Ageing equipment

1. Accelerate grid modernisation with a focus on renewable energy integration (short-term priority)

Grid modernisation should be explicitly aligned with the rapid expansion of solar capacity, which reached approximately 914 MW in 2025 and continues to grow at a strong pace. Unlike traditional generation, a significant share of new solar capacity is being connected at the distribution level, creating emerging bottlenecks that are not sufficiently addressed by transmission-focused investments.

Priority should therefore be given to distribution network reinforcement, digitisation, and improved system visibility, including advanced metering infrastructure and real-time monitoring systems. In parallel, the deployment of dynamic line rating, congestion management tools, and smart grid solutions can help optimise existing infrastructure.

Short- to medium-term flexibility can be further enhanced through the gradual development of virtual power plant and aggregation frameworks. These solutions can help integrate variable renewable generation without requiring immediate large-scale transmission expansion, thereby reducing system stress during peak generation periods.

2. Strengthen cross-border interconnections (medium- to long-term priority)

Expanding cross-border transmission capacity with neighbouring countries should build on Bosnia and Herzegovina's already high level of regional connectivity while addressing emerging bottlenecks linked to increasing cross-border electricity flows. Priority projects should focus on corridors with Croatia, Serbia, and Montenegro, where additional capacity can facilitate both market integration and the export of surplus renewable electricity.

Given the expected growth in variable renewable energy, stronger interconnections will be essential for balancing fluctuations in generation and maintaining system stability. Alignment with ENTSO-E planning processes and EU Projects of Common Interest frameworks can further support investment and project implementation.

3. Diversify the electricity generation mix (medium- to long-term priority)

Diversification of the generation mix should reflect Bosnia and Herzegovina's ongoing transition from a coal-dominated system towards a more balanced portfolio of renewable energy sources. While hydropower will continue to play a central role, the rapid expansion of solar energy and increasing interest in wind projects indicate a shift towards a more decentralised and variable generation structure.

Achieving NECP targets will require not only scaling up renewable capacity but also ensuring system flexibility through complementary measures such as energy storage, demand-side management, and hybrid systems. A gradual and socially balanced reduction of coal generation should be pursued in parallel, taking into account the socio-economic importance of coal regions.

4. Improve regulatory alignment with EU energy markets (short- to medium-term priority)

Further alignment with EU energy legislation remains a critical enabler of market integration and investment in Bosnia and Herzegovina. While progress has been made through the Energy Community framework, key reforms remain incomplete, including the adoption and implementation of the NECP, market coupling, and the development of balancing and intraday markets.

Strengthening regulatory certainty, improving transparency, and harmonising rules across entities are essential steps for creating a more predictable investment environment. Advancing these reforms will also support integration into the EU internal electricity market and facilitate compliance with emerging mechanisms such as CBAM.

5. Strengthen regional energy cooperation (medium-term priority)

Regional cooperation should move beyond formal commitments towards more operational integration of electricity markets in southeast Europe. Bosnia and Herzegovina can play an active role in ongoing regional initiatives, including market coupling and coordinated capacity allocation mechanisms.

Closer cooperation between transmission system operators, as well as participation in regional balancing platforms, can improve system efficiency and reduce the need for reserve capacity. Given its geographical position and existing infrastructure, Bosnia and Herzegovina has the potential to strengthen its role as a regional transit and flexibility provider, particularly in the context of increasing renewable energy penetration across the region.

6. Establish a state-level energy coordination mechanism as a prerequisite for effective reform implementation (immediate to short-term priority)

The effectiveness of all these proposed measures ultimately depends on institutional capacity and coordination. Bosnia and Herzegovina's electricity sector remains characterised by a fragmented governance structure, with key competencies divided across entities and limited coordination at the state level. This institutional complexity slows down the adoption and implementation of strategic frameworks, including the NECP, and creates uncertainty for investors.

Establishing a functional state-level energy coordination mechanism should therefore be treated as a strategic priority. Such a body would not replace existing institutions but would enable coordinated planning, alignment of regulatory frameworks, and more efficient implementation of EU-aligned energy policies.

Importantly, strengthening governance structures is increasingly linked to EU accession conditionality and access to financial instruments, including funding under the Instrument for Pre-accession Assistance (IPA III) and other EU-supported investment mechanisms. Improved coordination would therefore not only enhance policy effectiveness but also unlock access to critical financing for infrastructure modernisation and energy transition projects.

2.10 Conclusion

Bosnia and Herzegovina's electricity system occupies an important position in the regional energy landscape of southeast Europe. The country's existing generation capacities and transmission interconnections provide a solid foundation for maintaining energy security and participating in regional electricity markets. However, evolving technological, environmental, and regulatory conditions require strategic investments and policy reforms to ensure the long-term resilience of the system.

In this context, the resilience of Bosnia and Herzegovina's electricity grid should be viewed not only as a national infrastructure priority but also as a contribution to the collective resilience of the European energy system. Strengthening grid infrastructure, improving regulatory alignment with European energy policies, and diversifying the electricity generation mix will be essential for adapting to the rapidly changing European energy landscape.

At the same time, the successful integration of rapidly expanding renewable energy capacity will increasingly depend on the modernisation and digitisation of distribution networks, enhanced system flexibility, and improved coordination of infrastructure planning and investment priorities. Addressing emerging bottlenecks at the distribution level and strengthening cross-border interconnections will be critical for maintaining system reliability while enabling the further growth of renewable electricity generation.

Increased integration with regional electricity markets and enhanced cross-border cooperation can further support system stability while creating opportunities for economic development and the expansion of renewable energy sources.

By pursuing these strategic priorities, Bosnia and Herzegovina can strengthen its role within the European energy system while reinforcing national energy sovereignty, improving infrastructure resilience, and supporting the transition towards a more sustainable and interconnected electricity sector.

Strengthening grid resilience in Bosnia and Herzegovina will therefore not only enhance national energy security but also contribute to the stability and integration of the wider European electricity system.

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Spain as a Strategic Node in the Independent Voltage Energy Architecture

Grid Resilience, Energy Sovereignty, and EU System Integration

William Hongsong Wang

Abstract

This chapter examines Spain's electricity system from the perspective of grid resilience, cross-border interoperability, and compatibility with European Union energy policy. It argues that Spain's central challenge is not a lack of ambition for renewable energy or domestic grid development, but a persistent gap between its internal electricity transition and its level of integration with the wider European market. Although Spain has expanded renewable generation, strengthened its transmission network, and remained a net electricity exporter, it continues to fall far short of the EU's electricity interconnection benchmark. This matters because the European Commission explicitly links cross-border interconnection to security of supply, renewable integration, and market functioning, while the International Energy Agency identifies increased interconnectivity, regional market integration, fewer market barriers, storage, and demand-side response as necessary conditions for a more flexible Spanish electricity market.[1] The chapter, therefore, treats Spain as a strategically important but structurally constrained case within the wider European energy architecture. In doing so, it highlights how the future value of Spain's energy transition depends not only on domestic decarbonisation but also on the speed and scale of its integration with continental Europe.

3.1 Introduction

The resilience of Europe's electricity system forms the broader policy context for all three country chapters in this publication. In the European Union's current framework, cross-border interconnection is treated here not as a secondary technical issue but as part of the infrastructure needed to improve the security of electricity supply and integrate more renewables into energy markets. The European Commission states

* The author would like to thank the Fundación Jesús Huerta de Soto Ballester for its support of research for this chapter.

1 European Commission (2023), Electricity Interconnection Targets, https://energy.ec.europa.eu/topics/infrastructure/electricity-interconnection-targets_en; International Energy Agency (2021), Spain 2021 Energy Policy Review; International Energy Agency (2026), Spain, https://www.iea.org/countries/spain

that the EU has set an interconnection target of at least 15% by 2030, defined as the level of infrastructure needed for each member state to import electricity equivalent to 15% of its installed electricity production capacity.[2] The same source explains that this target is complemented by additional indicators linked to wholesale price differentials, peak load, and installed renewable generation capacity, which shows that interconnection is understood as part of a broader system of market integration and resilience.[3]

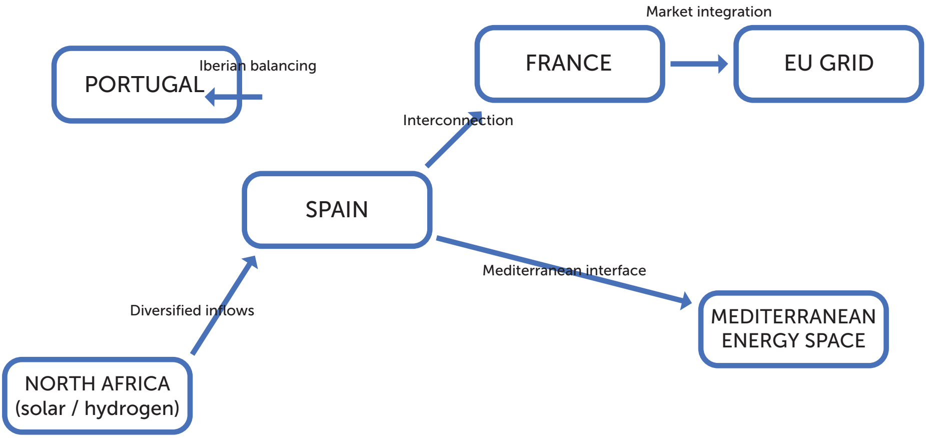
Within this broader framework, Spain is a particularly important case. According to the International Energy Agency (IEA), Spain's current energy and climate framework is based on the 2050 objectives of national climate neutrality, 100% renewable energy in the electricity mix, and 97% renewable energy in the total energy mix. The IEA also recommends that Spain create a more flexible electricity market through increased interconnectivity, continued integration of regional markets, and the development of demand-side response and storage.[4] These priorities make Spain relevant not only as a national case of renewable energy expansion, but also as a test of whether domestic decarbonisation can contribute to a more integrated and resilient European electricity system.

At the same time, Spain's physical energy integration with the rest of Europe remains limited. The European Commission's interconnection table shows that Spain's interconnection level was 3.62% in 2025, well below the EU benchmark of 15%.[5] In parallel, the Commission's southwest Europe framework states that the High-Level Group on Interconnections for South-West Europe aims to better integrate the Iberian Peninsula's energy markets with the rest of Europe and identifies electricity interconnection for the Bay of Biscay as a project that will raise the France–Spain interconnection capacity to 5,000 MW.[6] These official documents indicate that Spain's electricity challenge is not simply domestic but regional and European in scale. This strategic positioning can be visualised more clearly by locating Spain within the wider

2 European Commission (2023), Electricity Interconnection Targets.
3 European Commission (2023), Electricity Interconnection Targets.
4 International Energy Agency (2021), Spain 2021 Energy Policy Review.
5 European Commission (2023), Electricity Interconnection Targets.
6 W. H. Wang, V. I. Espinosa, & J. Huerta de Soto (2022), 'A Free-Market Environmentalist Enquiry on Spain's Energy Transition along with Its Recent Increasing Electricity Prices', International Journal of Environmental Research and Public Health, 19(15), https://doi.org/10.3390/ijerph19159493

European electricity architecture, where interconnection capacity and regional energy flows shape Spain's role in European energy resilience (see Figure 1).

Figure 1. Spain as a strategic node in the European electricity system.



This chapter, therefore, approaches Spain as a strategic node within the wider European energy architecture.

Spain should be understood not as a peripheral case but as a system whose grid stability affects Europe's broader energy sovereignty.

Its position at the intersection of continental Europe, the Mediterranean, and northern Africa gives it significance that goes beyond the conventional image of the Iberian Peninsula as an energy-edge market.[7] The central question is thus not only whether Spain is progressing in renewable deployment and domestic grid reinforcement, but whether that progress is being translated into the interoperability, preparedness, and resilience required by the EU's own policy framework.[8]

Against this background, the chapter examines Spain's electricity system

7 W. H. Wang (2023), 'The Legislative and Regulatory Framework for PPAs in Spain', in R. Gravina (ed.), PPAs: A Comparative Study towards the EU Green Deal (Brussels: European Liberal Forum and Fondazione Luigi Einaudi), pp. 113–121; W. H. Wang (2024), 'Costes ocultos: Fiscalidad de la energía y dinámica del mercado en España', in S. Calvo, V. Moreno-Casas, J. J. Toral, & W. Wang (coord.), Cinco reformas

8 W. H. Wang, V. Moreno-Casas, & J. Huerta de Soto (2021), 'A Free-Market Environmentalist Transition toward Renewable Energy: The Cases of Germany, Denmark, and the United Kingdom', Energies, 14(15), https://doi.org/10.3390/en14154659

through the lenses of interconnection, infrastructure, and system integration. It first reviews the relevant literature and then explains the desk-research method used in the chapter, before presenting the main findings on Spain's interconnection position, grid development, and infrastructure projects. The discussion then considers what those findings imply for Spain's compatibility with EU energy objectives and for its wider strategic role in Europe's electricity system. In this sense, the chapter argues that Spain's energy transition is not only a national transformation but also a European integration challenge.

The Spain case should also be read in comparative relation to the chapters on Austria and on Bosnia and Herzegovina in this publication. All three chapters examine grid resilience, interoperability, and strategic preparedness under a shared EU policy framework, but they do so from different infrastructural and geopolitical positions. This comparative perspective helps situate Spain's low interconnection ratio not as an isolated anomaly but as one distinct manifestation of a wider European challenge of uneven grid integration.

3.2 **Literature review**

As with both Austria and Bosnia and Herzegovina, the Spain case is situated within recent European Commission and International Energy Agency documents that frame energy security. In the EU policy context, electricity systems are presented as interconnected infrastructures whose resilience depends on cross-border links, network adequacy, and the ability to integrate growing volumes of renewable generation.

A central element of this policy framework is electricity interconnection. The European Commission states that the EU has set an interconnection target of at least 15% by 2030, meaning that each member state should have infrastructure allowing it to import electricity from neighbouring EU countries equivalent to 15% of its installed electricity production capacity. The same Commission source explains that this target is intended to support security of supply and the integration of renewables into energy markets. It also notes that the 15% benchmark is complemented by additional indicators linked to wholesale price differentials, peak load, and installed renewable generation capacity, which shows that interconnection is treated as a broad system-integration issue rather than a narrow engineering metric.[9]

The importance of grid infrastructure is reinforced in the Commission's EU Action Plan for Grids. That document describes interconnected and stable electricity grids as the backbone of a well-functioning energy market and argues that Europe needs stronger, more interconnected, more digitised, and more cyber-resilient grids to meet its energy transition objectives. It also identifies investment, permitting, and regional cooperation as key implementation challenges. In this literature, grid expansion is thus presented not as a secondary consequence of decarbonisation but as one of the conditions that make decarbonisation operational at scale.[10]

Within this broader framework, Spain occupies a distinctive position. The IEA describes Spain as being at the forefront of the energy transition and states that its current energy and climate framework is based on the 2050 objectives of climate neutrality, 100% renewable electricity, and 97% renewable energy in the total energy mix. At the same time, the IEA stresses that Spain will need a more flexible electricity system based on increased interconnectivity, continued regional market integration, fewer market barriers, demand-side response, and storage. This makes Spain especially relevant in this analysis because it combines ambitious decarbonisation goals with a clear dependence on stronger network integration.[11]

At the level of observed interconnection performance, Spain remains well below the EU benchmark. The Commission's data show that Spain's interconnection level stood at 3.62% in 2025, compared with 14.01% for Portugal, 10.18% for Germany, and 36.53% for Denmark. The same Commission source adds that more interconnections are still needed in some regions, particularly given the increase in capacity of new renewable generation. For Spain, this evidence supports the view that renewable ambition alone does not eliminate structural constraints

9 European Commission (2023), Electricity Interconnection Targets
10 European Commission (2024), Grids, the Missing Link: An EU Action Plan for Grids.pdf, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023DC0757
11 European Commission (2025), Interconnections for South-West Europe, https://energy.ec.europa.eu/topics/infrastructure/high-level-groups/interconnections-south-west-europe_en.

arising from weak physical integration with the wider European grid.[12]

Official EU material on southwest Europe places this issue in a regional context. The Commission's page on interconnections for southwest Europe states that the High-Level Group aims to better integrate the Iberian Peninsula' energy markets with the rest of Europe. This framing is important because the limited integration of Iberia is treated not as a purely domestic Spanish issue but as a regional European infrastructure problem. This same logic can be translated into the argument that Spain should be understood as a strategic node rather than a peripheral case, especially given its location at the intersection of continental Europe, the Mediterranean, and northern Africa.

The European Network of Transmission System Operators for Electricity's (ENTSO-E) Regional Investment Plan: Continental South West provides additional support for this diagnosis. In its executive summary, ENTSO-E identifies insufficient cross-border capacity as one of the main historical drivers of grid development in the region and links this directly to the integration of the Iberian Peninsula into the European continental market through the development of the France–Spain interconnection. The same report states that there is a need for further market integration in the region, with special focus on the isolation of the Iberian Peninsula, and that additional cross-border development needs are associated with the 15% target for 2030. This makes the ENTSO-E literature especially valuable because it integrates long-term system planning, renewable integration, and Iberian interconnection in a single analytical framework.[13]

The IEA's report on Spain's electricity security policy reaches a similar conclusion regarding operational reliability. It notes that Spain is interconnected with France, Andorra, Portugal, and Morocco, but that interconnection with France remains limited relative to the scale of the Spanish electricity system. This matters because, as the same IEA assessment suggests, Spain's electricity security increasingly depends on how effectively the system can accommodate rising shares of variable renewable generation while preserving reliability and flexibility. In other words, the literature reviewed here consistently treats interconnection

12 European Commission (2023), Electricity Interconnection Targets
13 ENTSO-E (2023), Regional Investment Plan Continental South West.

not as an isolated infrastructure issue but as a core component of electricity security in a highly renewables-based system.[14]

Taken together, the literature supports three conclusions. First, current EU and IEA policy analysis treats energy security increasingly in terms of grid resilience, interconnection, and system flexibility. Second, Spain is a strategically important but structurally constrained case, combining strong renewable ambitions with persistently low interconnection levels. Third, the policy direction identified across these sources is broadly consistent: stronger grids, deeper cross-border integration, and greater system flexibility are necessary if Spain is to align more fully with EU energy and climate objectives.

In comparative terms, this chapter complements the Austria and Bosnia and Herzegovina cases by showing how similar European policy objectives can generate different infrastructure problems depending on geography, market integration, and existing grid architecture.

3.3 **Methods**

This chapter is based on desk research and uses a qualitative–quantitative policy analysis approach to examine Spain's electricity grid resilience, interconnection capacity, and alignment with European Union energy policy. The analysis focuses on the institutional and infrastructural dimensions of energy security, with particular attention to the common EU interconnection benchmark used across the chapters in this publication, together with grid interoperability and strategic preparedness in the context of the energy transition.[15]

The source base consists of verified institutional and technical materials. These include European Commission documents on electricity interconnection targets, interconnections in southwWest Europe, and the EU Action Plan for Grids; ENTSO-E planning documents, especially the Regional Investment Plan: Continental South West; and

14 International Energy Agency (2022), Spain Electricity Security Policy, https://www.iea.org/articles/spain-electricity-security-policy
15 European Commission (2023), Electricity Interconnection Targets

IEA publications on Spain's energy system and electricity security.[16] The chapter also follows a common analytical structure shared with the Austria and Bosnia and Herzegovina case studies, which supports cross-country comparison within this publication.

The chapter presents the three steps conducted in this research. First, it identifies the current institutional and infrastructural context of Spain's electricity system by reviewing official policy documents and system-planning materials, as mentioned above. Second, it examines Spain's degree of alignment with EU energy and climate objectives, particularly the interconnection benchmark, by comparing Spain's position with the standards and priorities set out in EU documents. Third, it evaluates the main risks to Spain's energy security through a close reading of institutional assessments of Spain's energy system, electricity security, and regional market integration.

Methodologically, the chapter does not rely on econometric modeling, interviews, or original fieldwork. Instead, it applies comparative interpretation of official sources, supported by descriptive policy analysis, in order to identify the principal structural constraints affecting Spain's role within the European electricity system.

A final limitation should be noted. Because the chapter relies on desk research, its conclusions are conditioned by the scope and quality of available institutional publications. For that reason, priority has been given to official European Commission, ENTSO-E, and IEA sources, together with clearly identified project materials, so that major factual claims can be traced to verifiable documents.

16 ENTSO-E (2023), Regional Investment Plan Continental South West; European Commission (2024), Grids, the Missing Link.

3.4 Results

3.4.1 Spain's position in the EU interconnection framework

Spain remains well below the European Union's electricity interconnection benchmark.

According to the European Commission, Spain's interconnection level was 3.62% in 2025 and 3.11% in 2026, compared with the EU target of at least 15% by 2030. On the same 2026 table, Portugal stood at 13.33%, France at 5.44%, Germany at 9.37%, and Denmark at 35.46%. The Commission also reports that, at the beginning of 2026, 16 countries had exceeded the 2030 target, 2 countries were above the 10% threshold, and 9 countries were still below the previous 10% target.[17] To place Spain's position in comparative perspective, Table 1 reports the interconnection levels of selected EU countries against the Union's 15% benchmark.

Table 1. Electricity interconnection levels in selected EU countries (2025–2026)

Country	2025 interconnection level	2026 interconnection level	Gap from 15% target (2026, p.p.)
Spain	3.62%	3.11%	-11.89
Portugal	14.01%	13.33%	-1.67
France	4.72%	5.44%	-9.56
Germany	10.18%	9.37%	-5.63
Denmark	36.53%	35.46%	+20.46
EU benchmark	15.00%	15.00%	0.00

Note: European Commission interconnection table; the right-hand column shows the distance from the EU's 15% benchmark using 2026 values.

17 European Commission (2023), Electricity Interconnection Targets; European Commission (2025), Interconnections for South-West Europe

The Commission defines the interconnection target as the level of infrastructure required for a member state to import electricity from neighbouring EU countries in an amount equivalent to 15% of its installed electricity production capacity. The same source states that improved cross-border interconnections are intended to strengthen security of supply and facilitate the integration of renewable energy into electricity markets.[18]

As in the other chapters, the EU interconnection benchmark functions here as a common reference point; however, the Spanish case highlights a particularly striking gap between domestic transition progress and cross-border integration capacity.

3.4.2 Existing cross-border connections

Red Eléctrica states that Spain is currently interconnected with France, Portugal, Andorra, and Morocco. It describes the connection with France as the gateway linking the Iberian Peninsula with the rest of Europe and reports that the exchange capacity of that interconnection is around 3 GW, which it characterises as a low level of interconnection for the Peninsula.[19]

The IEA provides more detailed figures for these links. According to the IEA, Spain's interconnection capacity with France is 2.8 GW, equivalent to 2.8% of installed capacity, while its interconnection capacity with Portugal is 2.3 GW, or 2.3% of installed capacity. The same source states that the Spain–Morocco interconnection capacity is 900 MW in the Spain-to-Morocco direction and 600 MW in the Morocco-to-Spain direction. For 2019, the IEA reports that the French interconnection was congested for 80% of the hours in which the available crossborder transmission capacity was fully used and became a binding constraint, whereas the Portuguese interconnection was congested for only 5% of such hours.[20] Table 2 summarises Spain's principal cross-border

18 European Commission (2023), Electricity Interconnection Targets
19 Red Eléctrica (2026a), Capacidad de intercambio, https://www.sistemaelectrico-ree.es/es/informe-del-sistema-electrico/intercambios/capacidad-intercambio?utm_source=chatgpt.com
20 International Energy Agency (2022), Spain Electricity Security Policy

electricity interconnections and highlights the limited scale of the France link relative to Spain's broader electricity system.

Table 2. Spain's main cross-border electricity interconnections

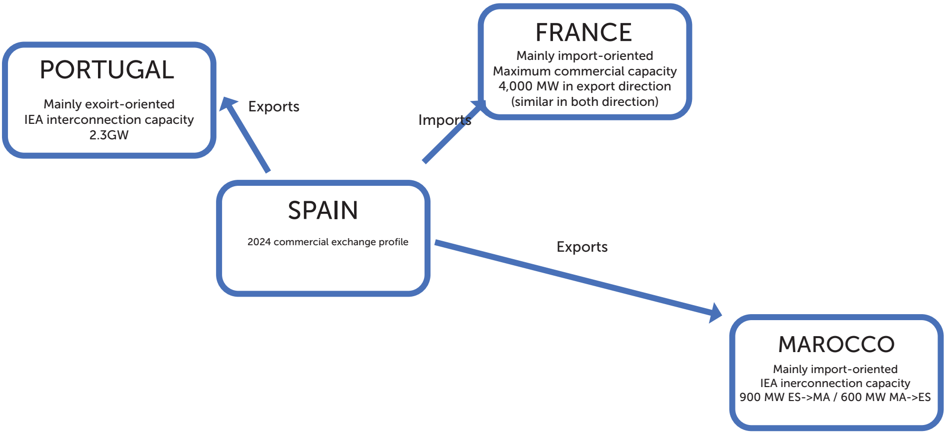
Connection	Verified capacity	Keynote
France	**2.8 GW (IEA); around 3 GW (REE)**	**Gateway linking the Peninsula with the rest of Europe; 80% of hours congested in 2019**
Portugal	**2.3 GW**	**11 AC lines; only 5% of hours congested in 2019**
Morocco	**900 MW ES->MA / 600 MW MA->ES**	**Two DC submarine electrical cables**
Andorra	**Connected; no capacity figure cited in selected sources**	**Mentioned as an existing connection by IEA and REE**

Source: Data from the IEA and Red Eléctrica.

More recent operational information is available from Red Eléctrica's 2024 exchange-capacity report page. For 2024, the maximum commercial capacity on the France interconnection was similar in both directions, with the export direction 200 MW higher, reaching 4,000 MW. The same source states that average commercial exchange-capacity utilisation was mainly import-oriented on the France interconnection and mainly export-oriented on the Portugal and Morocco interconnections.[21] Figure 2 illustrates the asymmetry in the use of Spain's interconnection capacity in 2024, especially the import-oriented pattern on the France interconnection and the export-oriented pattern on the Portugal and Morocco links.

21 Red Eléctrica (2026c), Instalaciones de la red de transporte, https://www.sistemaelectrico-ree.es/es/informe-del-sistema-electrico/transporte/instalaciones-de-la-red-de-transporte?utm_source=chatgpt.com.

Figure 2. Selected indicators of Spain's electricity system performance in 2025.



Source basis: Red Eléctrica (2024 exchange-capacity report page) for utilisation pattern and France's maximum commercial capacity; International Energy Agency.

3.4.3 Ongoing and planned interconnection projects

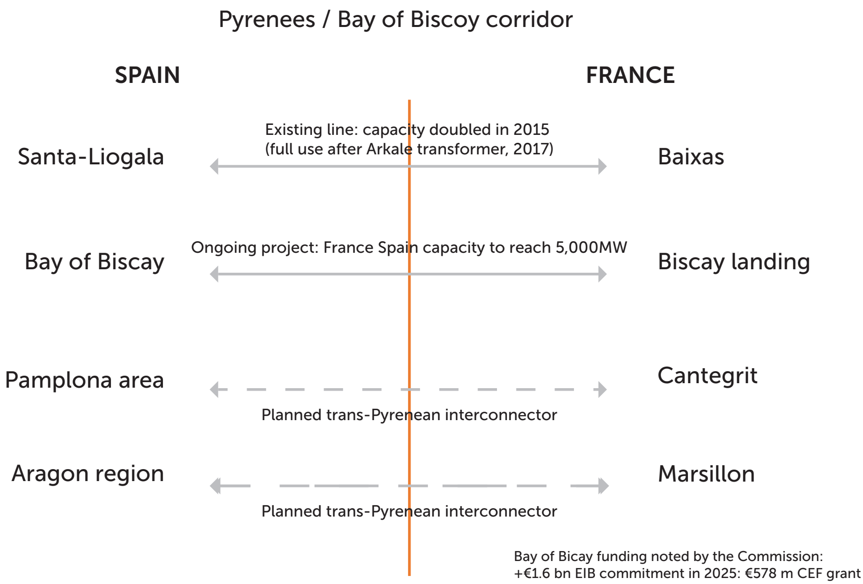
The European Commission's southwest Europe interconnections page reports that the Santa-Llogaia–Baixas electricity line, commissioned in 2015, doubled the electricity interconnection capacity between France and Spain. It also states that the completion of the transformer in Arkale in 2017 enabled the full utilisation of that line. The same Commission source identifies the Bay of Biscay electricity interconnection as an ongoing project that will increase interconnection capacity between France and Spain to 5,000 MW when completed.[22]

The same Commission page reports that, in June 2025, the European Investment Bank committed an additional €1.6 billion to the Bay of Biscay project, on top of the €578 million already allocated under the Connecting Europe Facility. It also lists two further planned interconnectors: one between the Pamplona area in Spain and Cantegrit

22 European Commission (2025), Interconnections for South-West Europe

in France, and another between Marsillon in France and the Aragón region in Spain. In addition, the Commission notes that the Navarra–Landes project received more than €11 million in CEF funding for studies in January 2025.[23] The concentration of existing and planned France–Spain interconnection projects can be seen more clearly in Figure 3.

Figure 3. Main existing and planned France–Spain electricity interconnection projects.



Note: Schematic based on the European Commission's southwest Europe interconnections page.

The IEA likewise reports that the direct-current interconnection under construction through the Bay of Biscay is expected to raise France's interconnection capacity to 5 GW, equivalent to 5% of total installed capacity, with expected completion in the third quarter of 2027.[24]

The 2025 monitoring report of the Agency for the Cooperation of Energy Regulators (ACER) includes a case study on the Spain–France interconnection that is currently under construction. ACER describes it as a 2 GW interconnection supported by EUR 2.8 billion in investment;

23 European Commission (2025), Interconnections for South-West Europe
24 International Energy Agency (2022), Spain Electricity Security Policy

it reports that a simulation for the whole of 2024, assuming the interconnection was already in place, suggests that the additional capacity would significantly improve price convergence, facilitate the integration of renewables, and strengthen system-wide resilience.[25]

3.4.4 Recent domestic system indicators relevant to grid resilience

According to Red Eléctrica's summary of the Spanish Electricity System Report 2025, national electricity demand in Spain increased by 2.8% in 2025. The same source states that nearly 10 GW of new wind and solar photovoltaic capacity were commissioned during the year, rising to 11.6 GW when self-consumption installations are included. Red Eléctrica also reports that renewable generation accounted for 55.5% of all electricity generated in Spain in 2025, rising to 56.6% when the estimated contribution from self-consumption facilities is included.[26]

The same Red Eléctrica source reported that Spain's electricity exchange programmes with other countries would close 2025 with a positive balance for the fourth consecutive year. 26,206 GWh were programmed for export, 1.5% more than the previous year, and 13,202 GWh for import, a figure 15.5% lower than in 2024. The net balance was positive at 13,004 GWh, 27.8% higher than the previous year. To summarise the domestic performance of the Spanish electricity system, Table 3 presents the principal operational indicators reported for 2025.

25 ACER (2025), Progress of EU Electricity Wholesale Market Integration, https://www.acer.europa.eu/monitoring/electricity_market_integration_2024.
26 Red Eléctrica (2026b), Informe del Sistema Eléctrico 2025

Table 3. Selected indicators of Spain's electricity system performance in 2025

Indicator	2025 value
Electricity demand growth	+2.8%
New wind and solar PV capacity	Nearly 10 GW
Capacity incl. self-consumption	11.6 GW
Renewable share of generation	55.5%
Renewable share incl. self-consumption	56.6%
Increase in electricity exports	+25.1%
Net export balance	12,794 GWh
Transmission investment	€1.424 billion
Added line circuit	486 km
Added substation positions	212
Added transformation capacity	1,455 MVA
Total transmission network	46,155 km
Total transformation capacity	99,071 MVA

Note: Operational and infrastructure indicators reported by Red Eléctrica for 2025.

On the transmission side, Red Eléctrica states that transmission assets increased by 486 kilometrs of circuit and 212 substation positions, bringing the total national transmission network to 46,155 kilometres. Transformation capacity increased by 1,455 MVA,[27] bringing the total to 99,071 MVA. Figure 4 highlights the scale of transmission-network expansion reported for Spain in 2025.

27 Red Eléctrica (2025a), El sistema eléctrico español en 2025: Aumenta la demanda de electricidad, la generación y la potencia instalada, https://www.ree.es/es/sala-de-prensa/actualidad/nota-de-prensa/2026/03/el-sistema-electrico-es-panol-en-2025-aumenta-la-demanda-de-electricidad-la-generacion-y-la-potencia-instalada?utm_source=chatgpt.com.

Figure 4. Expansion of Spain's transmission network in 2025.

+486 km
Added circuit lenght
Total network: 46,155 km

+212
New substitution positions
Network positions expanded in 2025

+212
Added transportation capacity
Total capacity: 99,071 MVA

€1.424 bilion
Transmission-network investment in 2025
45.9% higher than the previous year

Source: Red Eléctrica, Instalaciones de la red de transporte (year-end 2025 indicators).

Overall, the official evidence shows that Spain entered 2026 with expanding renewable generation, higher transmission investment, and stable net export status, while remaining far below the EU interconnection benchmark and still relying on major cross-border projects that are either under construction or in planning.[28]

3.5 **Discussion**

The results indicate that Spain's electricity challenge is not primarily a shortage of generation capacity but a problem of system integration. Spain entered 2026 with raised electricity demand, strong renewable generation performance, rising transmission investment, and continued net export status; yet its interconnection level was only 3.11% in 2026,

28 ACER (2025), Progress of EU Electricity Wholesale Market Integration; European Commission (2023), Electricity Interconnection Targets; European Commission (2024), Grids, the Missing Link; European Commission (2025), Interconnections for South-West Europe; International Energy Agency (2021), Spain 2021 Energy Policy Review; International Energy Agency (2022), Spain Electricity Security Policy; Red Eléctrica (2025); Red Eléctrica (2025a, 2025b, 2026a, 2026b, 2026c).

far below the EU target of at least 15% by 2030, as previously analysed.[29] This gap is significant because the European Commission explicitly links stronger cross-border interconnections to both security of electricity supply and the integration of renewables into energy markets.

Read alongside the Austria and Bosnia and Herzegovina chapters, the Spain case reinforces the comparative logic of this publication: the common European objective is interoperability and resilience, but the constraints differ significantly by country. In Spain, the decisive issue is the limited scale of physical integration with continental Europe despite strong domestic progress in renewable deployment and network development.

This interpretation is consistent with the broader EU policy framework.

The Commission defines the interconnection target as infrastructure enabling a member state to import electricity equivalent to 15% of its installed electricity production capacity, and supplements that benchmark with indicators of wholesale price differentials, peak load, and installed renewable generation capacity.[30] The Commission's EU Action Plan for Grids goes further by describing interconnected and stable electricity grids as the backbone of a well-functioning energy market and by calling for grids that are stronger, more interconnected, more digitised, and cyber-resilient.[31] Taken together, these official documents suggest that interconnection is treated not as a narrow engineering issue but as a structural condition for electricity market integration and resilience.

The evidence also indicates that the central structural constraint remains the France–Spain interconnection corridor. As noted earlier, Red Eléctrica describes the French interconnection as the Iberian Peninsula's gateway to the rest of Europe and states that its exchange capacity is only around 3 GW, which it characterises as a low level of interconnection for the

29 European Commission (2023), Electricity Interconnection Targets; European Commission (2025), Interconnections for South-West Europe.
30 European Commission (2023), Electricity Interconnection Targets; European Commission (2025), Interconnections for South-West Europe
31 European Commission (2023), Electricity Interconnection Targets.

Peninsula.[32] The IEA similarly reports that interconnection capacity with France is 2.8 GW, equal to 2.8% of installed capacity, and that this link was congested for 80% of hours in 2019.[33] Even allowing for the age of the congestion figure, the official source base consistently presents the France–Spain corridor as a persistent constraint on fuller Iberian integration into the European electricity market.

At the same time, the official evidence points to a clear direction of change. The European Commission identifies the Bay of Biscay interconnection as a major ongoing project that will raise interconnection capacity between France and Spain to 5,000 MW, while also listing additional planned trans-Pyrenean links and new funding support, including an additional €1.6 billion commitment by the European Investment Bank in 2025.[34] ACER's 2025 monitoring report provides a market interpretation of this infrastructure, describing the new line as a 2 GW interconnection backed by EUR 2.8 billion in investment and reporting that a simulation for the whole of 2024 suggests that the additional capacity would improve price convergence, facilitate renewables integration, and strengthen system-wide resilience.[35] This supports the interpretation that interconnection is not only about larger trade volumes, but also about market efficiency and resilience under stress.

A further implication concerns the relationship between renewable expansion and system flexibility. The IEA states that Spain's 2050 framework is based on national climate neutrality, 100% renewable electricity, and 97% renewable energy in the total energy mix, while also recommending increased interconnectivity, continued regional market integration, fewer market barriers, demand-side response, and storage to create a more flexible electricity market.[36] This is particularly relevant in light of Red Eléctrica's 2025 data showing that renewables accounted for 55.5% of electricity generation, rising to 56.6% when self-consumption is included.[37] The official sources, therefore, suggest that greater renewable penetration does not reduce the importance of interconnection; rather, it increases the need for flexibility and cross-border balancing capacity.

32 Red Eléctrica (2025b), Interconexiones, https://www.ree.es/es/transicion-ecologica/interconexiones
33 International Energy Agency (2022), Spain Electricity Security Policy.
34 European Commission (2025), Interconnections for South-West Europe.
35 ACER (2025), Progress of EU Electricity Wholesale Market Integration.
36 International Energy Agency (2022), Spain Electricity Security Policy
37 Red Eléctrica (2025a), El sistema eléctrico español en 2025

Overall, the verified evidence supports a clear conclusion: Spain's strategic importance within Europe's electricity system is increasing, but its ability to function as a fully integrated node remains constrained by insufficient interconnection with continental Europe. Domestic renewable growth and higher transmission investment have strengthened Spain's internal electricity position, but the broader European value of that progress depends on whether cross-border infrastructure catches up with national decarbonisation and grid expansion.

3.6 **Conclusion**

This chapter has shown that Spain occupies a strategically important but still structurally constrained position within the European electricity system. Official EU, IEA, ACER, and Red Eléctrica sources all point in the same direction. Spain has advanced significantly in domestic electricity system transformation, with rising renewable generation, increased transmission investment, and continued net export status, but it remains far below the European Union's interconnection benchmark of at least 15% by 2030. In 2026, Spain's interconnection level stood at 3.11%, confirming that its integration with the wider European grid remains limited when compared with both EU objectives and the performance of several other member states.

In that respect, Spain's experience supports the broader comparative finding of this publication: European energy resilience depends not only on national transition efforts but also on the degree to which those efforts are translated into cross-border interoperability under shared EU objectives.

The evidence therefore supports a clear conclusion: Spain's main electricity system weakness is not a lack of generation ambition but insufficient cross-border integration. The European Commission explicitly links stronger interconnection to security of supply and the integration of renewable electricity, while the IEA stresses that Spain's long-term transition goals will require greater interconnectivity, continued regional market integration, fewer market barriers, demand-side response, and storage.[38] The problem identified in this chapter is thus structural. Spain is strengthening its domestic electricity system, but the European value of that progress remains partially constrained by the limited scale of Spain's interconnection with continental Europe.

A second conclusion follows from the evidence on infrastructure. The France–Spain corridor remains the decisive bottleneck in Spain's position within the EU market. Red Eléctrica describes the French connection as the Iberian Peninsula's gateway to the rest of Europe, yet still characterises its level of interconnection as low, while the IEA records only 2.8 GW of capacity with France in its electricity security assessment. At the same time, the official source base shows that the direction of policy is already defined. The Bay of Biscay interconnection, additional planned trans-Pyrenean links, and wider southwest Europe initiatives all point towards the same strategic objective: the fuller integration of the Iberian Peninsula into the European electricity market.

On this basis, three policy recommendations follow. First, Spain and its European partners should continue to prioritise the rapid completion of the Bay of Biscay interconnection and associated France–Spain reinforcement projects, since official Commission and ACER evidence indicates that these projects would improve price convergence, renewables integration, and system-wide resilience. Second, cross-border infrastructure policy should be treated not as a narrow transmission issue but as a central component of European energy security, because the Commission's own framework makes clear that interconnection is a condition for both market integration and supply resilience. Third, Spain's domestic transition should continue to be accompanied by policies that strengthen system flexibility, especially storage, regional integration, and demand-side response, in line with the priorities identified by the IEA.

In summary, Spain can no longer be understood simply as a national electricity market at the southwestern edge of Europe. The verified evidence presented in this chapter supports the view that Spain is becoming an increasingly important node in the wider European energy architecture. Yet that role will remain only partially realised

38 For free-market based environmental reform, see J. Huerta de Soto (2009), 'A Hayekian Strategy to Implement Free Market Reforms', in J. Huerta de Soto, The Theory of Dynamic Efficiency (London: Routledge), pp. 182–199.

unless domestic grid development is matched by deeper and faster interconnection with the rest of the continent. In that sense, the central issue is not whether Spain is advancing in the energy transition. It is whether that transition is being translated into the kind of interoperability, resilience, and strategic preparedness that the European Union itself has identified as essential for long-term energy security.

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Conclusion

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As noted in the foreword by MEP Anna Stürgkh, the energy grids challenge is a challenge no Member State can tackle alone. It might sound paradoxical at first, but sovereignty will be achieved through integration, not isolation. None of the three countries studied in this publication is sovereign in isolation, but they can be when integrated. This transforms the characterisation of 'interconnection' from technical requirement to political necessity.

What Europe needs is not uniform investment but coordinated solutions to three challenges: public acceptance, institutional capacity, and physical grid infrastructure. This uniform investment is the real '€2 trillion grid challenge', which refers to the massive investment the EU needs to upgrade, expand, and modernise its electricity grids to make the energy transition work. Solving the Union's grid challenge requires different instruments for different countries. This is not because their goals differ but because their barriers are structurally different.

Austria's grid pathway shows the importance of understanding human behaviour. Despite achieving a relatively high level of interconnection, Austria has seen progress stall as public opposition increasingly shapes outcomes. The priority, therefore, is not largescale capital deployment but strengthening public acceptance. With comparatively low overall cost and a realistic timeline of five years, this approach treats grid expansion as a communications challenge. At the EU level, the appropriate response lies in sharing best practices on project-level measures that can improve public acceptance. The EU should also design strategies to increase the overall attitude towards the energy transition, for example by fighting mis- and disinformation.

The author of this chapter, Markus Fischer, concludes that public acceptance depends on addressing behavioural aspects when designing economic benefits, leveraging peer effects to display early project support, and designing transparent and inclusive public participation processes. It also involves paying attention to the emotional aspects of local and landscape impacts, ensuring a positive attitude towards the energy transition, and, in general, making public acceptance a clear policy priority.

Bosnia and Herzegovina sits at the opposite end of the spectrum, requiring a longer, deeper, and more resource-intensive transition pathway. Here, significant investments would be needed to simultaneously support institutional capacitybuilding, renewable energy deployment, and a managed transition away from coal; these factors make it the highestcost and longesthorizon case, spanning ten to twenty years. Fragmented governance structures and limited fiscal capacity mean that progress cannot be achieved through infrastructure spending alone. Instead, the EU's added value lies in deploying blended finance instruments: combining concessional loans, grants, and sustained technical assistance. This is not only an enlargement or development issue; Bosnia and Herzegovina's dependence on imported natural gas – primarily via a single supply route – adds an additional layer of energy security vulnerability, particularly in the context of regional supply disruptions and broader European gas market volatility.

Nihad Harbaš, the author of this chapter, shows how rapid renewable growth is: solar capacity has expanded from approximately 608 MW in 2024 to over 900 MW in 2025, reflecting an accelerating decentralisation of the generation mix. This trend increases the need for distribution network reinforcement, improved system visibility, and enhanced operational flexibility, particularly at lower voltage levels where most new capacity is being connected.

Spain's pathway, finally, demonstrates how abundance without integration remains an unrealised asset. With some of Europe's strongest renewable potential, Spain does not primarily need more generation capacity but, rather, requires strategic crossborder infrastructure and smart grid investments to connect that capacity meaningfully to the continental system. The Bay of Biscay interconnector is emblematic of this challenge: a project whose value is not just through national benefits but in unlocking shared system resilience and flexibility. Here, EUlevel cofinancing under the Connecting Europe Facility, combined with tight bilateral coordination between Spain and France, is essential. Spain's renewable surplus becomes a European strength only once it can flow freely across borders, which would lower prices, stabilise systems, and deliver mutual gains on both sides of the Pyrenees.

William Hongsong Wang, the chapter's author, demonstrates how Spain's 55% renewable generation could translate into European resilience if the Bay of Biscay interconnector were prioritised as strategic EU infrastructure, not just Spanish infrastructure.

Operationally, the findings presented in these chapters mean that the EU's grid investment architecture should reflect such distinctions: establishing a 'public acceptance playbook' to leverage best practices from communications and behavioural economics for Austrian grid developers; deploying blended finance and technical assistance packages for Bosnia-type cases; and treating cross-border infrastructure (Spain-type) as a strategic priority with EU co-financing obligations. The goals of the €2 trillion challenge are achievable not necessarily by increasing the total investment but by directing existing and new investment into the right instruments to combat the right barriers.

When looking past their distinct barriers, we can distil a critical insight: across Europe, renewable energy deployment is racing ahead of grid modernisation. Austria needs grids and interconnection to match its strong renewables potential; Bosnia's solar deployment is tripling despite institutional constraints; Spain's generation is abundant despite its isolation. The European challenge is not fundamentally about renewable capacity; it is about building grids and institutions fast enough to keep pace with the renewable transition already underway. It is time for Europe to make the right decisions and recognise, as noted in the Foreword, that resilient grids are 'the backbone of a secure, sovereign, and climate-neutral Europe'. This publication demonstrates why: only by tailoring solutions to each country's distinct challenges can Europe build the integrated energy architecture that genuine sovereignty requires.

Author Bios– Independent Voltage:

Chapter 1
Austria

Markus Fischer has eight years of experience in the energy transition. He is a thought-leader on energy policy at NEOS and serves as a regional party executive focussing on Austrians living abroad. For more than five years, Markus worked at Ørsted, a global leader in renewable energy, across both business and policy functions. Prior to that, he gained experience at Engie, Tesla, and the United Nations. He studied environmental and energy policy at Sciences Po Paris and Peking University, and international business at WU Vienna. You can connect with him via linkedin.

Chapter 2
Bosnia and Herzegovina

Nihad Harbaš is one of the leading Climate & Energy experts in BiH. Nihad has a background in engineering, project management and company management. He holds a Master of Science degree in Mechanical Engineering, specializing in Energy, from the University of Sarajevo. His focuses are Renewable Energy and Energy Efficiency focusing on Bosnia and Herzegovina reforming processes of energy sector according to the European experience and practice, as well as the obligations arising from the Energy Community Treaty. Nihad is member of Energy Community Secretariat, IRENA, UN roster of experts etc. Nihad has over 15 years of experience working with NGOs, the private sector and public institutions. In addition, he has been actively involved in numerous projects aimed at harmonizing the energy sector in line with the obligations of the Energy Community Treaty.

Chapter 3
Spain

Dr. William Hongsong Wang is an Associate Professor (Profesor contratado doctor accredited by ANECA) of economics and the director of the Master's Degree in International Trade and Economic Relations at Universidad Europea de Madrid. He is also a fellow of the Fundación Para el Avance de la Libertad in Spain and teaches political economy and public choice as an adjunct professor at Saint Louis University (Madrid campus). The author also thanks the research support from Fundación Jesús Huerta de Soto Ballester.

About us

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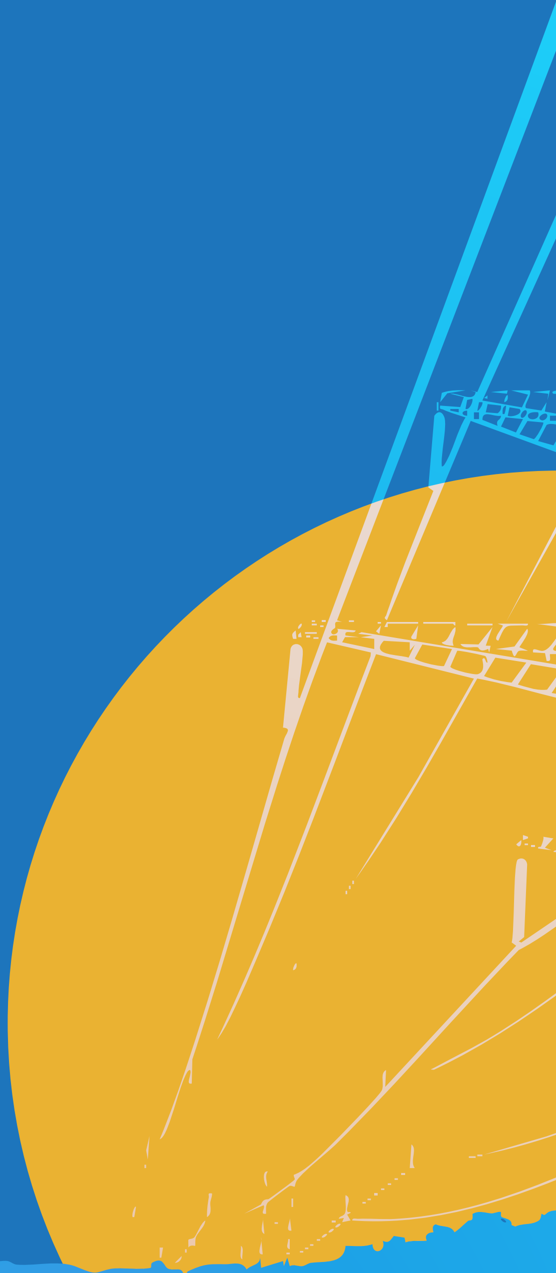
European Grid Resilience, Energy Sovereignty and EU Compatibility Standards



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