EU energy infrastructure: Boosting energy security

SUMMARY
In the aftermath of Russia's invasion of Ukraine and the ensuing energy crisis, the EU has undertaken a number of steps to develop its energy infrastructure. These included diversifying import routes, developing energy networks and improving cross-border interconnections.

The EU legislative framework on energy infrastructure is based on the Regulation on trans-European networks for energy (TEN-E). It sets out guidelines for EU cross-border infrastructure, including projects of common interest (PCIs) to improve energy interconnections between countries. Every two years, the European Commission publishes a delegated act with an updated PCI list, then submits this to the European Parliament and Council for approval. The next list is expected in November 2023.

Energy system integration and interconnections help improve energy security and energy systems’ resilience. At EU level, interconnection targets currently only exist for electricity (a general target of 15% electricity interconnectivity by 2030 and a target of 70% reserved for cross-zonal capacity by 2025). The EU provides funding for various types of cross-border energy interconnections, for instance from the Connecting Europe Facility and the Recovery and Resilience Facility.

The EU energy infrastructure is undergoing a transformation in line with the green transition set out in the European Green Deal, and the energy security priorities outlined in the REPowerEU plan. The ten-year network development plans for gas and electricity, prepared by transmission system operators, propose scenarios for infrastructure development and include a list of relevant projects that can then become PCIs. The main challenges identified in the plans are adjustments to the growing share of renewables and increased demand for electrification, the phasing out of fossil fuels, and a new role for biomethane and green hydrogen. Creating an interconnected and resilient EU energy network is an important step to help boost energy security.

IN THIS BRIEFING
- Introduction
- EU legislation and initiatives
- Energy networks
- European Parliament
- Outlook
Introduction

The energy crisis has changed EU energy infrastructure planning and priorities. Shifting away from Russian fossil fuels required urgent adjustment to energy networks to accommodate new import routes and reduce bottlenecks in existing infrastructure, as well as reflection on the long-term replacement of gas, for instance with renewable electricity, biomethane and green hydrogen.

Energy system integration and expanding interconnections have gained particular importance in the context of ensuring a secure energy supply on the EU market. Cross-border connections support the creation of an integrated and resilient energy market that helps achieve that goal. Interconnectors offer the opportunity to integrate a larger share of variable renewables, help exchange electricity surpluses, balance the energy system and prevent blackouts. Cross-border exchange can also help prevent price shocks, as well as help improve energy security, and the energy system's stability and flexibility.

While the EU cannot intervene in Member States' right to determine their energy mix, it has a Treaty-based obligation to ensure the functioning of the energy market and the security of energy supply and to promote energy efficiency, renewable energy, and the interconnection of energy networks (Article 194 TFEU).

EU legislation and initiatives

TEN-E regulation

The 2022 revision of a regulation first adopted in 2013, Regulation (EU) 2022/869 on trans-European networks for energy (TEN-E), sets out guidelines for the development of EU cross-border infrastructure. The regulation aims at ensuring interconnections, security of supply, market and system integration, competitiveness and affordable prices. The revised regulation aligned the EU energy infrastructure support with the European Green Deal and EU climate objectives. This included ending support for new gas and oil projects, and introducing mandatory sustainability criteria for all projects. The new provisions also simplified administrative procedures.

The trans-European energy networks link Member States' infrastructure. Annex I to the TEN-E regulation outlines a number of priority corridors (for electricity, offshore grids, and hydrogen and electrolysers) and priority thematic areas (smart electricity grids deployment, cross-border carbon dioxide network and smart gas grids), along with geographic coverage (i.e. Member States concerned). In line with the priorities set out in Annex I, the revised TEN-E Regulation also includes the following list of energy infrastructure categories to be developed (Annex II):

- Electricity (transmission, storage, smart electricity grids),
- Smart gas grids,
- Hydrogen,
- Electrolyser facilities,
- CO₂ networks.

Electricity investments prioritise rapid electrification, renewable electricity generation, digitalisation and technology innovations. While new gas infrastructure projects are not eligible, investment in integrating renewable gases (such as biogas and hydrogen) into existing gas networks will be possible. Investment in hydrogen, CO₂ and offshore networks is also encouraged.

Projects of common interest

The TEN-E Regulation also outlines the process for selecting projects of common interest (PCI) within the EU and projects of mutual interest (PMI) – the latter with third countries. PCIs must involve at least two Member States and have relevance for at least one of the priority corridors and areas (specified in Annex I to the regulation). The Member State where the proposed project is located has a veto power. PMIs must involve at least one Member State and one third country. They must
Contribute to the EU’s and the third country’s energy and climate objectives. For both PCIs and PMIs, the benefits must outweigh the costs. The main benefit of PCIs and PMIs is that they involve faster permitting and enable access to EU funding from the Connecting Europe Facility.

Every two years, the European Commission adopts a delegated act with an updated list of PCIs, proposed by Member States clustered in regional groups, after an extensive consultation with a number of stakeholders. The Commission then submits the list to the European Parliament and the Council, which have two months to adopt or reject it (without the possibility to amend the list). This deadline can be extended by another two months. The Commission is expected to publish the next delegated act (the 6th PCI list) in November 2023. It will be the first PCI list under the revised TEN-E Regulation, which only entered into force in June 2022.

According to the European Commission, since the TEN-E Regulation was established in 2013, gas PCIs have helped establish a more resilient European gas infrastructure, reduce bottlenecks and diversify supply sources. Once the current PCI projects are implemented, all Member States will have access to at least three gas sources or the global liquefied natural gas (LNG) market.

Ten-year network development plans for gas and electricity (TYNDYPs)

The TEN-E governance framework includes the establishment of ten-year network development plans (TYNDPs) for gas and electricity. The plans are prepared by the European Network of Transmission System Operators for Gas (ENTSOG) and for Electricity (ENTSO-E), in consultation with stakeholders and on the basis of guidelines provided by the EU Agency for the Cooperation of Energy Regulators (ACER). The plans are updated every two years and only those gas and electricity projects included in the TYNDYPs can become PCIs and PMIs. The latest versions of TYNDYPs for gas and electricity date from 2022. Both plans situate the EU energy infrastructure in the context of the European Green Deal and the REPowerEU plan. The process of preparing the 2024 TYNDYPs is currently ongoing.

Energy Union

The Energy Union was established in 2015, with the aim to transform the EU’s energy system – made up of 28 national frameworks – into one EU-wide framework. It has five dimensions: 1) Energy security, 2) Integrated internal energy market, 3) Energy efficiency, 4) Decarbonisation, and 5) Research, innovation and competitiveness. Every year (usually in October), the European Commission presents a State of the Energy Union report, analysing the EU’s progress in these five dimensions.

In terms of EU energy infrastructure, the 'integrated internal energy market' and 'energy security' dimensions are the most relevant. The 2015 communication establishing the Energy Union strategy proposed more interconnections between EU countries to facilitate energy flows, boosting investments in infrastructure projects and ensuring an effective regulatory framework. In terms of energy security, it advocated diversification of supply – in particular of gas – and the development of corresponding infrastructure (such as the Southern Gas Corridor and liquid gas hubs in central and eastern Europe, as well as the Mediterranean area). It also pleaded to increase LNG trade and develop transport infrastructure linking LNG access points with the internal market. It emphasised solidarity in case of potential gas supply disruption, maintaining adequate oil stocks and developing domestic energy such as renewables.
The 2022 State of the Energy Union report presents an overview of EU actions in the energy security field, including energy supply diversification (e.g. the Baltic Pipe and the Greece-Bulgaria interconnector), the creation of the EU Energy Platform, as well as the synchronisation of Ukraine and Moldova with the EU electricity network to enhance grid stability and electricity trade. The overview of the internal energy market dimension mainly focuses on electricity market integration and market coupling (i.e. optimising cross-border electricity capacities between countries and harmonising cross-border electricity exchanges) in the context of the energy crisis.

National energy and climate plans

Under the Regulation on the Governance of the Energy Union and Climate Action (EU)2018/1999 each Member State is required to prepare a ten-year national energy and climate plan (NECP). The current NECPs cover 2021 to 2030. The NECPs must refer to each of the five dimensions of the Energy Union. This includes sections on energy security and internal energy market, which contain for instance information on increasing the flexibility and resilience of national energy systems, key electricity and gas transmission infrastructure projects, modernisation projects, market integration and coupling, and increasing the tradeable capacity of existing interconnectors.

In addition to the NECPs, Member States are required to prepare national long-term strategies with a perspective of at least 30 years. These strategies focus mainly on GHG emissions reduction and decarbonisation measures, energy efficiency, demand-side flexibility, energy consumption and building a renewables-based energy system. The long-term strategies must be consistent with the NECPs and submitted every ten years.

Electricity interconnection target

The Regulation on the Governance of the Energy Union and Climate Action also establishes a 15% electricity interconnection target by 2030 (Article 4). This means that each Member State should aim to have electricity networks allowing for 15% of the electricity produced on its territory to be transported cross-border to neighbouring countries. Member States are required to track progress towards this goal as part of their reporting on NECP implementation.

REPowerEU

The REPowerEU plan was adopted in May 2022 to increase the EU’s energy security and reduce its dependence on Russian energy. The main measures included energy supply diversification, boosting renewables and saving energy. The plan also proposed developing energy infrastructure, to focus primarily on gas, hydrogen, oil and electricity. Proposed adjustments to oil infrastructure were minimal and mainly concerned addressing the bottlenecks in supply to countries almost fully dependent on pipeline oil from Russia. In terms of gas infrastructure, the plan called for LNG and pipeline gas import diversification, as well as for investment in LNG import terminals, pipelines and reverse flow capacities. Moreover, it set increased ambitions in terms of biomethane production (35 billion m³ by 2030) and renewable hydrogen production and imports (20 million tonnes by 2030).

Annex 3 to the REPowerEU communication provides a detailed assessment of EU infrastructure needs for gas and takes stock of the achievements of the TEN-E framework to establish resilient European electricity and gas networks. The assessment highlights the possibility to fully compensate for the equivalent of Russian gas imports through a combination of demand reduction, increasing the production of biogas/biomethane and fossil-free hydrogen, and limited additions of gas infrastructure beyond what is already included in the 5th PCI list. It identified the most significant infrastructure needs in central and eastern Europe and northern Germany, as well as in terms of reinforcing the Southern Gas Corridor.

One of the legislative proposals under the REPowerEU plan was to include REPowerEU chapters in the national recovery and resilience plans under the Recovery and Resilience Facility (Regulation adopted in February 2023). These chapters have to be submitted as updates to the national plans.
They may include, for instance, measures concerning energy infrastructure to ensure the security of supply of gas and oil, address internal and cross-border energy transmission and distribution bottlenecks, to accelerate the integration of renewables and in support of increased electricity storage. RRF funding can be used to finance energy infrastructure projects.

EU strategy for energy system integration

In July 2020, the European Commission published a communication outlining an EU strategy for energy system integration in the context of the EU’s efforts towards a climate-neutral economy. Energy system integration is defined as the ‘coordinated planning and operation of the energy system as a whole, across multiple energy carriers, infrastructures and consumption sectors’. It is seen as a pathway towards an effective and affordable decarbonisation of the European economy in line with the European Green Deal. The strategy calls for accelerated electrification of energy demand, building on a largely renewables-based power system, boosted deployment of offshore renewable electricity, promotion of renewable and low-carbon fuels (including biofuels, biogas, biomethane and hydrogen) and measures to advance carbon capture, utilisation and storage. In terms of a more integrated energy infrastructure, the strategy proposes more physical links between energy carriers and a holistic approach to both large-scale and local infrastructure planning, including the protection and resilience of critical infrastructures. It highlights the need to integrate renewable and low-carbon gases into the existing gas networks and to repurpose the gas network for hydrogen applications, as well as finding solutions to transport renewable hydrogen from offshore renewable electricity parks. The strategy acknowledges the possibility of using gas networks to enable hydrogen blending, but suggests exploring dedicated infrastructure for large-scale storage and transportation of pure hydrogen, and the expansion of hydrogen refuelling stations. It also highlights the importance of a digitalised energy system and a supportive innovation framework. Lastly, the strategy calls for a more integrated and cross-sectoral approach to future network planning, by aligning TYNDYPs, NECPs and other network plans.

Legislation on gas, hydrogen and electricity

The revised gas and hydrogen package (procedures ongoing) includes provisions on creating conditions for more decarbonised infrastructure, facilitating the integration of renewable and low-carbon gases into the existing gas networks. It proposes a more integrated network planning between electricity, gas and hydrogen networks. It also aims to enable natural gas infrastructure to be reused for hydrogen and to remove barriers to a cross-border hydrogen infrastructure.

The Electricity Regulation, revised as part of the Clean Energy Package (CEP) in 2019, set a 70% target for electricity transmission capacity to be available for cross-zonal trading (known as the CEP70 target). This means the possibility of sending electricity to a neighbouring electricity zone, including in another Member State. This goal is to be gradually achieved by the end of 2025. ACER issues an annual monitoring report on progress towards the 70% target.

Legislation on critical infrastructure and supply risk management

The EU also has a number of laws that help manage risks in the energy infrastructure field. Directive 2022/2557 on the resilience of critical entities (which replaced the previous Critical Infrastructures Directive of 2008), aims to reduce vulnerabilities and strengthen the physical resilience of critical entities in the EU, to ensure uninterrupted provision of various essential services. In the energy field, the directive concerns electricity, district heating, oil, gas and hydrogen operators. The directive obliges Member States to carry out regular risk assessments and adopt a national strategy to enhance their resilience. Moreover, in the aftermath of the hybrid attacks on the Nord Stream pipelines, the Commission proposed a Critical Infrastructure Blueprint to improve the EU’s response to disruptive cross-border incidents.

The Security of Gas Supply Regulation 2017/1938 aims to enhance EU energy security by helping prevent potential supply and infrastructure disruptions and respond to them when they occur. It
enhances coordination between regional groups of Member States to assess supply risks and develop joint preventive and emergency measures. It also introduces a solidarity mechanism, whereby Member States must help each other to guarantee gas supply to the most vulnerable consumers. In addition, the [Gas Storage Regulation](https://eur-lex.europa.eu) 2022/1032 requires gas storage to be 90% full ahead of winter periods. It also provides for storage arrangements whereby Member States without storage facilities should store at least 15% of their average annual gas consumption in another Member State with storage facilities. Moreover, Directive 2009/119/EC on emergency [oil stocks](https://ec.europa.eu) sets targets for maintaining stocks of crude oil and/or petroleum products and obliges EU countries to have them readily available in the event of a crisis. Regulation (EU) 2019/941 on [risk-preparedness in the electricity sector](https://ec.europa.eu) establishes rules for cooperation between EU countries in electricity crises and obliges Member States to establish risk-preparedness plans.

**Energy networks**

**Gas and LNG**

According to the [European Commission report](https://ec.europa.eu) of May 2023 entitled ‘REPowerEU: One year on’, the EU’s dependence on Russian gas has fallen at a faster pace than expected. The EU’s gas imports from Russia fell from 39% in 2021 to 13% by mid-2023 (this includes a slight increase in Russian LNG imports). The EU intensified its pipeline gas imports from Norway, the United Kingdom, Algeria and Azerbaijan, and LNG imports from the United States and Qatar. In terms of infrastructure development, a number of new projects were created and new ones are planned (see Figure 1).

The main projects to diversify importing routes of natural gas and enhance cross-border interconnections include:

- the development of the Southern Gas Corridor;
- new sources of LNG in the Mediterranean area (LNG terminals in Cyprus and Alexandroupolis in Greece);
- expanding the LNG terminal in Gdańsk, Poland;
- opening the Baltic Pipe (connecting Norway and Poland via Denmark);
- the Interconnector Greece-Bulgaria (IGB);
- the gas interconnector between Poland and Lithuania (the GIPL pipeline);
- upgrading the interconnector between Latvia and Lithuania;
- the Poland-Slovakia interconnector;
- investment to connect LNG import terminals in the Iberian Peninsula and the EU network through hydrogen-ready infrastructure;
- several storage projects in south-eastern Europe (Greece, Romania, Bulgaria);
- and a gas interconnector between Poland and Slovakia.
The European Commission estimates that around 15 new LNG terminal projects have been either commissioned or are planned between 2022 and 2024 in France, Italy, the Netherlands, Germany, Finland and Greece (for instance, the La Havre terminal in France, the Eemshaven terminal in the Netherlands and six floating storage and regasification units (FSRUs) in Germany).

These projects are changing the network of gas interconnections in the EU (see Figure 2 showing the EU gas interconnections map used by ENTSOG for the system assessment serving as a basis for the latest TYNDYP).

Figure 2 – Gas interconnections, gas storage capacities and LNG capacities in the EU, 2023

The 2022 TYNDYP for gas proposes a number of new projects, which may be chosen for the upcoming 6th PCI list. Overall, 358 investments have been submitted to TYNDP 2022, by more than 60 different project promoters, including both TSOs and third-party promoters.

Hydrogen

The REPowerEU plan considers renewable hydrogen as key to replacing natural gas, especially in hard-to-decarbonise industries and transport. Given that cross-border hydrogen infrastructure is still in its infancy, in addition to setting a target of 20 million tonnes of hydrogen production and imports, the plan calls for a regulatory framework for hydrogen to remove existing obstacles. It also envisages the development of three major hydrogen import corridors via the Mediterranean, the North Sea area and with Ukraine (see Figure 3).

While gas infrastructure has different levels of maturity, hydrogen infrastructure can only be defined in terms of planned projects, as there is no existing infrastructure in place. The 2022 TYNDYP proposes a dual gas system model, based on natural gas and hydrogen. The TYNDYP considers onshore or offshore hydrogen transmission pipelines (including pipelines enabling hydrogen imports from non-EU countries), liquefied hydrogen terminals and storage facilities. Projects can be newly constructed or repurposed existing natural gas infrastructure. Of the total projects submitted as part of the TYNDYP exercise, 45 % propose new or repurposed infrastructure to carry hydrogen or retrofitting infrastructure to further integrate hydrogen.
Oil imports from Russia are partially covered by EU sanctions since December 2022 (crude oil) and February 2023 (refined oil products). This ban concerns oil transported by sea alone, while pipeline oil was exempted, to ensure continued access for landlocked countries such as Czechia, Slovakia and Hungary via the Druzhba pipeline. In the majority of cases, EU countries managed to find a replacement for Russian oil on the world markets, strengthening cooperation with partners such as Angola, Brazil, Iraq, Norway Saudi Arabia and the United States. According to the REPowerEU plan, adjustments to oil infrastructure were only needed to a small extent compared with gas infrastructure. The biggest needs were identified in terms of expanding the capacity of ports such as Gdańsk, Rostock, Trieste and Omisalj, given the additional import pressure, and addressing bottlenecks in the Transalpine (TAL), Adria and Société du Pipeline Sud-Européen (SPSE) oil pipelines. The plan also recommended reconfiguring and upgrading petroleum product refineries, as replacing Urals crude oil with alternative oil grades requires technological changes.

Electricity

The development of electricity networks in the EU has to take account of the increasing demand for electrification, the growing share of renewables and the need to ensure cross-border interconnections and stable supply and prices. Investments in the electricity infrastructure identified in the REPowerEU plan included the Biscay Bay electricity interconnector between France
and Spain, the Celtic interconnector between France and Ireland, and the EuroAsia interconnector between Greece and Cyprus. These help increase interconnection capacity with the Iberian peninsula and connect Ireland and Cyprus to the Union’s electricity grid. In addition, the synchronisation of the Baltic States’ electricity grids, the last Member States with electricity systems still dependent on third countries, is scheduled for completion by 2025 at the latest. The emergency synchronisation of Ukraine and Moldova’s electricity grids with Europe’s grid was completed in mid-March 2022, to improve their interconnection with the EU’s power grid and enable electricity trade.

Further investment in transmission and storage, included in the 2022 TYNDYP for electricity, is planned as part of the TEN-E corridors, including: the North Sea Offshore Grid, North-South Interconnections West (NSI West), North-South Interconnections East (NSI East) and the Baltic Energy Market Interconnection Plan (BEMIP). Most of the planned projects are cross-border.

**European Parliament**

The European Parliament’s May 2022 resolution on ‘The social and economic consequences for the EU of the Russian war in Ukraine – reinforcing the EU’s capacity to act’ highlighted the importance of ensuring energy sovereignty and independence from Russian supplies. It also called for more strategic autonomy and energy security, by upgrading and ensuring major investment in EU energy infrastructure, including on interconnections and cross-border infrastructure. It also called for the establishment of a new dedicated European fund (a Strategic Autonomy Fund for Europe) to finance cross-border energy infrastructure, avoiding lock-in effects on fossil fuels, and supporting renewable energy production and energy efficiency.

In an October 2022 resolution on the EU’s response to the increase in energy prices in Europe, Parliament expressed concern about the sabotage of Nord Stream infrastructure. It also underlined that the creation of a fully integrated single market for energy, providing for a truly resilient European energy network, including the construction of new interconnectors, would alleviate the price pressure on businesses and consumers in the short term, and establish energy independence and resilience in the long term.

**Outlook**

The climate and energy crises have changed EU energy infrastructure needs. The EU energy system is undergoing a structural change to achieve decarbonisation and address energy security concerns through a sharp increase in renewables, import diversification and expanded interconnections. Significant investment will be needed, particularly as regards the development of renewable electricity, repurposing gas networks for hydrogen applications and integrating biogases such as biomethane. The future energy system will also need improved flexibility solutions, such as demand response or energy storage. Expanding EU energy infrastructure requires significant funding, which is only partially covered by existing EU financial mechanisms. Financing the necessary investment thus continues to be a challenge. Furthermore, questions remain regarding possible future EU interconnection targets and their monitoring. While the EU managed to weather the immediate energy supply risks linked to the energy crisis, long-term strategic planning to boost energy security is also needed.
MAIN REFERENCES
Boehm L. and Wilson A., EU gas storage and LNG capacity as responses to the war in Ukraine, EPRS, European Parliament, April 2022.

DISCLAIMER AND COPYRIGHT
This document is prepared for, and addressed to, the Members and staff of the European Parliament as background material to assist them in their parliamentary work. The content of the document is the sole responsibility of its author(s) and any opinions expressed herein should not be taken to represent an official position of the Parliament.
Reproduction and translation for non-commercial purposes are authorised, provided the source is acknowledged and the European Parliament is given prior notice and sent a copy.
Photo credits: © Filippo Carlot / Adobe Stock.
eprs@ep.europa.eu (contact)
www.eprs.ep.parl.union.eu (intranet)
www.europarl.europa.eu/thinktank (internet)
http://epthinktank.eu (blog)