Energy supply security

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Abstract

This report examines the meaning of energy supply security in the context of the ongoing energy transition and increasing geopolitical, economic, and environmental uncertainty. It reviews how energy supply security is defined in policy and research, highlighting its core dimensions of availability, affordability, accessibility, sustainability, and resilience. The report first considers the Finnish context, where security of supply is supported through diversified energy production, reserve stocks, preparedness planning, and cooperation between public authorities and industry. It then broadens the discussion to the European Union and global level, where legislative frameworks, import dependence, market volatility, cyber risks, and climate-related disruptions increasingly shape energy security. Overall, the report argues that energy supply security should be understood as a multidimensional and evolving concept that must integrate technical reliability, economic stability, sustainability, and strategic resilience across local, national, and international energy systems.

Keywords

Energy supply security, security of supply, resilience, energy transition, Finland, European Union

Contents

1. Introduction: Energy supply security definitions

Energy supply security is defined as the availability of adequate supply of energy at a reasonable cost (EU-1, 2024). It refers to the ability of a system to withstand disruptions or crises. It is ensured in advance through preventive actions such as risk management and assessing the likelihood and impact of potential disturbances (FI-1, 2026). The goal of energy supply security is to ensure that major disruptions can be managed nationally, supported by a stable economy, diverse production, competitive markets, and reliable international trade. Once focused on material availability, supply security now centres on protecting critical infrastructure such as electricity, water, transport, and secure digital and financial systems. Growing global interdependence makes international cooperation essential, alongside strong collaboration between government, industry, and civil society. The most serious risks include interruptions in essential imports, failures in digital and financial systems, energy shortages, and large-scale natural disasters. Dulian (2024) displayed a classification of security of energy supply as shown in Figure 1.

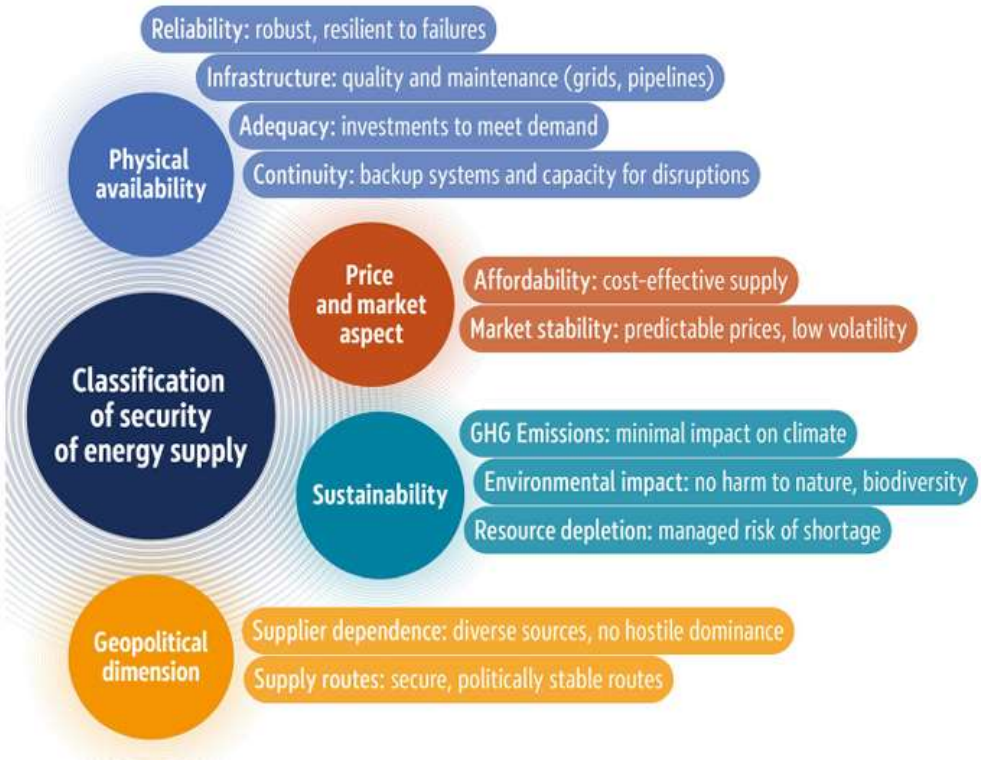

Figure 1. Classification of security of energy supply (Dulian, 2024)

Figure 1 shows that security of energy supply includes physical availability, price and market aspects, sustainability and geopolitical dimensions. In today's energy transition, sustainability and geopolitical

risks have become central. Energy security also varies by source (fossil fuels, nuclear, renewables and emerging options like hydrogen) and includes electricity security and storage.

2. Securing energy supply in Finland

In Finland, continuity management is developed collaboratively through the National Emergency Supply Organisation's sectoral pools, where companies and organisations share best practices and conduct joint exercises to strengthen overall preparedness. According to FI-2 (2025). Finland ensures its energy supply security through decentralised, diverse, and efficient production methods. The country maintains imported fuel reserves alongside thorough contingency plans that support the transfer, distribution, and transport of energy during disruptions. State reserves are designed to meet both domestic needs and Finland's international obligations, containing coal, crude oil, and petroleum products under the management of the National Emergency Supply Agency. This Agency works closely with permanent committees made up of industry representatives, known as sectors and pools. The Energy Supply Sector is responsible for planning emergency responses to major disruptions. Within it, the Power Supply Pool focuses on securing electricity and district heating during emergencies, while the Oil Pool handles company-level planning for oil and natural gas, including arranging transport for petroleum products in emergencies. During crises, both pools manage and execute energy supply operations. To ensure enough peat is available, reserve stocks are kept to cover six months' consumption at the start of every production season. Nuclear power plants stockpile nuclear fuel sufficient to generate electricity for several months or up to a year. The Finnish Energy Department within the Ministry of Economic Affairs and Employment drafts legislation related to energy security, such as acts and decrees governing fuel and peat stockpiling obligations. Security of supply requirements are also outlined in the Electricity Market Act and Natural Gas Market Act, which regulate and guide energy provision. On an international level, the EU mandates that each Member State keeps minimum supplies of crude oil or petroleum products, while International Energy Agency (IEA) members must hold oil reserves equivalent to 90 days of net imports. In case of oil supply interruptions, IEA countries can coordinate joint actions to stabilise markets. In the Nordic region, a shared electricity market has fostered collaboration in preparedness planning and supply security, with public authorities, sector organisations, and transmission system operators working together via the NordBER Forum. NordBER is a dedicated platform for Nordic energy and electricity authorities, along with TSOs, to discuss emergency preparedness.

3. EU energy supply security

The EU has a legislative framework to safeguard energy security. Electricity rules require Member States to prepare for and manage crises together. The Oil Stocks Directive obliges them to maintain minimum reserves, and the Gas Supply Regulation sets solidarity rules and guarantees supply for protected customers (Dulian, 2023). Dulian (2023) states that a planned 2025 revision could update the framework to reflect decarbonisation, new import patterns, and the growing importance of domestic energy production, including renewables. The report postulate that energy security will remain a long-term challenge, requiring stronger coordination and further legislative action across the EU.

On 5th of October 2025 the Commission launched a four-week call for evidence on the EU's energy security framework ahead of its planned revision. A proposal for the updated framework is expected in early 2026 (COM-1, 2025). On 5th of January 2026 the Commission released a report (COM-2, 2026) revealing that existing regulations have helped maintain stable and secure energy supplies and protected vulnerable consumers. It also states that the upcoming revision of the energy security framework aims to strengthen the EU's resilience in a rapidly changing energy and geopolitical environment, addressing new risks such as infrastructure protection, cyber threats, climate impacts and geopolitical shifts.

4. Global energy security

Global energy challenges, limited resources, rising demand, and price volatility, make secure energy supply essential for modern societies, yet rising demand, fossil-fuel dependence, and climate impacts have increased energy insecurity. Global energy use grew from 86 Exajoule (EJ) in 1950 to 503 EJ in 2010 and may reach 1000 EJ by 2050 (Zhu et al., 2020). Heavy reliance on fossil fuels accelerates CO_2 emissions, environmental damage, and vulnerability to supply disruptions. Energy security depends on **availability**, **affordability**, **accessibility**, and **acceptability** (APERC, 2007). Countries strengthen it by improving energy efficiency, reducing import dependence, diversifying energy sources, and expanding renewable energy. Renewables, solar, wind, hydro, geothermal, and bioenergy, enhance security by improving availability, affordability, and sustainability and because they are domestic, clean, and sustainable. Figure 1 shows a conceptual framework of energy security

Zhu et al. (2020) reviewed Japan's energy supply system, emphasizing diversification, efficiency improvements, and renewable energy expansion. They also examined government policies supporting renewables and highlighted the need to reduce CO_2 emissions from fossil-fuel use. Japan, one of the world's largest energy consumers and importers, relies on imports for about **96%** of its primary energy.

After decades of supply shocks, Japan shifted its strategy toward energy diversification, renewable energy expansion, higher efficiency, and reduced import dependence. The study of Zhu et al. (2020) examines government policies promoting renewables, the role of technologies such as biofuels, hydropower, solar, geothermal, and wind, and the need to cut CO_2 emissions from fossil-fuel use. Japan's energy system, heavily dependent on imports, increasingly relies on domestic renewable sources, with biofuel and waste energy as the largest contributors, followed by hydropower and geothermal. The findings show that renewables will play a key role in Japan's future primary energy supply and energy security. Among them, biofuels and waste (2.6%), hydropower (1.7%), and geothermal (0.5%) are currently the top three contributors to Japan's total primary energy supply.

Nazlioglu et al., (2025) argue that energy supply security is increasingly important because of volatile oil prices, geopolitical tensions, and sustainability concerns. Growing urbanization and industrialization in emerging economies make stable, affordable energy essential for economic growth. Historical crises, from the 1973 oil shock to recent conflicts, demonstrate how energy disruptions impact global markets. Energy and financial market relations can shift both suddenly and gradually, so understanding how energy-supply security influences these links is crucial. Countries reliant on imported energy face financial uncertainty and risk due to unstable costs and supplier volatility. The IEA (2025) defines energy security as reliable and affordable access to all energy sources, which is essential because rising energy consumption is closely tied to economic performance.

Boute (2025) emphasizes that the energy transition is reshaping long-standing ideas of supply security in the EU and globally. As countries push for clean-technology and seek to localize and diversify supply chains, new trade-restrictive measures create uncertainties to the international trade. Analysts warn these measures may raise costs and slow decarbonization.

Rajabzadeh & Wiens (2024) highlight that the global energy supply chain is vital for meeting energy demand. As environmental concerns grow, renewable sources such as solar, wind, hydro, and biomass have become cleaner, more sustainable alternatives to fossil fuels. Renewables help cut greenhouse gas emissions and reduce dependence on finite fossil fuels. Solar PV and wind have grown at unprecedented rates and are now cost-competitive with fossil fuels, making continued rapid expansion likely.

Lowe & Drummond (2022) examined whether solar PV and wind electricity generation capacity could dominate global primary energy supply by 2050. For their examination they used global trend extrapolation and logistic substitution models. They conclude that even under conservative assumptions, no fundamental constraints stop such growth. They also argue that if current trends persist, solar and wind could replace fossil fuels in most markets between 2050 and 2070.

Conclusion

In conclusion, energy supply security is no longer a narrow question of securing sufficient fuel or electricity, but a broader and evolving challenge that combines technical reliability, economic affordability, environmental sustainability, and resilience to geopolitical, climatic, and cyber-related risks. The report has shown that Finland's model of reserve stocks, preparedness planning, and strong cooperation between public authorities and industry provides an important foundation for managing disruptions, while the European Union continues to strengthen its legislative framework in response to changing import patterns, market volatility, and new systemic threats. At the global level, growing demand, supply-chain dependencies, and the transition away from fossil fuels further underline the need for diversification, renewable energy expansion, flexibility, storage, and international coordination. Taken together, these findings suggest that future energy supply security must be approached as a multidimensional policy and system challenge, requiring long-term investment, adaptive governance, and closer integration of resilience and sustainability across all levels of the energy system.

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