A system approach to energy security

EUGINE-EUTurbines paper on energy security and competitiveness

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The past years have put energy security high up on the European agenda and, in the coming months, the European Commission could review its energy security legislative framework to adapt it to present and future challenges.

In this paper, the European gas power plant industry argues for an integrated approach to energy security, which considers the energy system as a whole and, particularly, responds to the evolutions induced by the decarbonisation and electrification on the energy system.

Our recommendations

1. **Focus on the essentials and adapt to a decarbonising energy system**
2. **Take an integrated approach to energy security**
3. **Extend the gas security of supply to all (decarbonised) gases and fuels**
4. **Take a broad approach to flexibility and storage**
5. **Integrate new threats linked to electrification**
6. **Combine wholesale price signals with reliable investment signals**

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Reliable electricity requires flexible, dispatchable power plants

A reliable electricity supply requires that the system can, at any time, match supply and demand but it also implies the availability of essential system services that ensure a smooth system operation. Gas power generation is one of the few technologies that can provide both essential system services and seasonal balancing and it will therefore continue playing an important part in a secure, affordable energy system.

In 2024, gas power generation represented 17% of installed power plant capacity and covered around 15% of power needs in the EU.[1] With the increasing shares of electricity produced from wind and solar energy, the running hours of gas will further reduce. There is, however, a need to differentiate between capacity and energy produced. From 2021 to 2024 the installed capacity of gas power plants in Europe increased from 181 GW to 189 GW, which underlines the growing importance of gas power plants as dispatchable generators in a context where the installed capacity of other reliable power generation sources as coal and nuclear is diminishing.

In the years to come, gas power plants fuelled with renewable gas and hydrogen can provide an essential seasonal and inter-annual contribution together with other long-term energy storage solutions. This has a double effect. While the running hours of gas power plants decrease over the year, there will still be longer periods of continuous operating hours to cover seasonal supply gaps (mostly in winter).

Gas power will not only continue to play a key role in balancing a renewables-based system but also in stabilising the grid. Flexibility needs will increase in all timeframes and so will the provision of certain new ancillary services that can be provided by synchronous generators, e.g. inertia.

Indeed, with some technical adaptations,[2] gas power plants are able to provide the same grid service as standalone synchronous condensers. If adequately equipped, turbine and engine power plants can operate in synchronous condenser mode and thus reduce the need for new and costly, dedicated stand-alone solutions, while maximising the value of Europe's power plant fleet.

Making the policy framework ready for the future — our recommendations

1. Focus on the essentials, adapt to a decarbonising energy system

Energy security is understood to be "the ability of an economy to ensure the balance between energy supply and energy needs across different timeframes and the ability of the system to react to sudden shocks (resilience) supported by the underlying energy infrastructure" (European Commission consultation: Fitness check evaluating EU energy security architecture).

In 2022, the issues with Russian energy imports, coupled with a spike in prices and other weather events such as drought, showed the need to consider the consequences of a lack of diversification of energy sources, suppliers and routes and of multiple risks converging. It did, nevertheless, also show the resilience of the European energy system and the importance of markets and of European action to preserve that resilience.

With this in mind, the European energy security framework should continue to focus on preserving the ability to balance supply and demand in all scenarios, both in the electricity and gas sectors -while adapting it to a decarbonising energy system, especially in the heating sector. This means that increased focus should be put on electricity security and decarbonised gases. It should also preserve the system's ability to react to sudden shocks, be they geopolitical, weather events, or other. For that, the ever-growing complexity of the energy system will need to be better factored in.

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[1] Own calculation with data from Eurelectric. Does not include biomass. Data available at: https://electricity-data.eurelectric.org/

[2] For more information, see: https://www.euturbines.eu/spotlight-on/spotlight-on-using-power-plants-for-grid-stabilisation/

2. Take an integrated approach to energy security

With growing electrification levels, energy system integration will become even more essential to maintain a resilient and secure system. Gas power plants play an essential role in balancing supply and demand in different timeframes, and this reality should continue to be considered were the security of supply frameworks to be revised.

Since 2022, the electricity adequacy outlooks have incorporated a Critical Gas Volume (CGV) analysis, which should be maintained in the future. A review of the seasonal adequacy methodology could also be considered to include a cross-sectoral approach. On the gas side, the gas storage targets should be maintained and adapted to include the decarbonisation of the energy system.

As the energy system evolves, the role of gas power plants shifts from providing year-round flexibility to covering demand in more critical periods of the year. The IEA WEO 2024 estimates that, in 2050, gas-fired power plants in Europe will operate below a 25% capacity factor for most of the year but will operate above 60% of their capacity three times more often as they do today.

A critical cross-sectoral risk can therefore occur whenever electricity demand is high, and both (variable) electricity and gas or hydrogen supply are scarce. In those periods, gas storage will be essential to cover any uncompressible demand, and especially demand that cannot be shifted over several weeks.

A reliable integrated energy system requires networks that adequately connect generators with energy consumers but also their supply chain. In that sense the critical infrastructure for electricity and gas needs to be adapted and improved, but also investments in new networks for hydrogen and the transport of carbon need to be set up.

3. Extend the gas security of supply to all (decarbonised) gases and fuels

In the years to come, gas demand will decrease, and supply is expected to decarbonise via hydrogen, biomethane and other gases and fuels such as synthetic natural gas and hydrogen derivates. While most of the energy supply should come from must-run renewables, renewable fuels will play a key role in covering seasonal imbalances, especially those caused by heating and cooling needs.

Decarbonisation targets require that the security of gas supply regulation shall be adapted to include a wider scope of gases, not just natural gas. Indeed, incorporating various types of gases in the storage equation will secure seasonal imbalances in the most efficient way, especially by using the well-functioning existing gas infrastructure, which includes over 200,000 km of transmission pipelines and over 2 million km of distribution network (Gas Factsheet, ACER).

In addition, storage filling targets could be extended to other renewable gases and fuels, including hydrogen and its derivatives. Towards 2050, hydrogen-to-power will be a key role in covering electricity demand that cannot be reduced or shifted over longer periods of time. While estimates vary, the EU Joint Research Centre,[3] for example, calculates that, in 2050, seasonal flexibility needs of the electricity system will amount to over 300 TWh – often squeezed in only some weeks. Similarly, a report from Frontier Economics and Artelys[4] estimates that, in 2050, 270 TWh of hydrogen storage would be needed. It could be expected that most of those hydrogen and other gas storage capacities will serve seasonal and inter-annual needs, especially in the years after 2040.

4. Take a broad approach to flexibility and storage

In the years to come, flexibility needs will grow considerably in all timeframes. Flexibility is now defined as “the ability of an electricity system to adjust to the variability of generation and consumption patterns and to grid availability, across relevant market timeframes”. Following the last electricity

[3] Koolen, D., De Felice, M. and Busch, S., Flexibility requirements and the role of storage in future European power systems, available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC130519

[4] Frontier Economics and Artelys, Why European underground hydrogen storage needs should be fulfilled, available at: https://www.gie.eu/wp-content/uploads/filr/9697/RPT-EU_Underground_Hydrogen_Storage_Targets-090424-CLEAN.pdf

market review, Member States will need to measure future flexibility needs and set up dedicated support schemes if those are not met. Such schemes nevertheless have a relatively narrow focus, and do not tackle the long-term storage needs required to cover seasonal and inter-annual demand and supply variations.

We therefore very much welcome that the Commission considers strengthening the use of all energy storage technologies (electricity, gas, liquid fuels, heat) as one of the possible revised objectives of the energy security framework.

Storage is already considered in the electricity short-term and Seasonal Adequacy Assessments methodology, but only as part of the electricity system. A reviewed approach should also include molecules and heat in the storage equation.

5. Integrate new threats linked to electrification

In the past years, energy security was mostly associated with securing the supply of primary energy such as oil, coal and gas, via global trade. With the electrification of the European energy system, this is set to change. Growing electricity consumption coupled with increasingly weather- and seasonal-dependent generation and a context of increasing extreme weather events will shift the energy security focus further on electricity supply and the challenges associated to it. Among those challenges, two stand out: cybersecurity threats and an increased dependency on extreme weather events.

The digitalisation and smartening of the energy network is a must-have to optimise operations and increase the uptake of demand-side management and microgrids, but it will also increase risks such as cyberattacks that can paralyse entire businesses or even larger geographical areas. Many of the new solutions that are enabling smarter balancing (balancing markets moving to shorter periods, demand side management, algorithmic power trading…) are all dependent on complex digital technologies.

Implementing defensive barriers should be an essential element in proactive cybersecurity management and EU law is already catering for that. Going forward, common standards and guidelines for companies are required to create a system that withstands attacks but is also able to operate in case of a successful cyber-attack. On a system level, any significant disruption to software-based technology will increase the immediate demand for flexible, dispatchable sources located within individual TSO zones and, for critical services, emergency power located on-site.

Next to the need to be better prepared in the face of cybersecurity threats, there is also a need to better adapt to the changing climate. We observe that climate models are still generally based on historical data, while climate change will introduce new risks that are more difficult to forecast. In the future, what we call “extreme events” (floods, droughts, dark doldrums, etc.) will unfortunately become the “new normal” and will need to be integrated in the modelling and in the preparedness of energy infrastructure.

6. Combine wholesale price signals with reliable investment signals

A reliable, balanced electricity wholesale market requires price signals for motivating market participants to adapt and technological solutions to compete. An imbalance of demand and supply leads to both upward and downward price spikes.

Price signals are essential for an efficient clearing of the market, and they ensure open competition of already available resources. However, only if sufficient capacities for generation and storage are available at any given moment, these resources can be activated and wholesale prices for electricity stay an acceptable level.

The overall amount of available capacities that can react to price changes on the wholesale electricity market is defined by long-term investment decisions. Fluctuating day-ahead prices depending on weather conditions and even limited by political interventions are not sufficient to trigger such long-term investments. These investments require at least partially predictable long-term income streams.

For investments in renewable capacity, long-term contracts such as PPAs provide predictable income. For dispatchable generation and storage, the same can be achieved by Capacity Remuneration Mechanisms (CRMs). Even if not directly tackled through the security of supply framework, long-term instruments are needed for all types of generation[5] to help to incentivise investments leading to a secure and reliable energy system.

EUTurbines represents the leading European gas and steam turbine manufacturers.

EUTurbines advocates an economic and legislative environment for European turbine manufacturers to develop and grow R&I and manufacturing in Europe and promotes the role of turbine-based power generation in a sustainable, decarbonised European and global energy mix.

For more information please see www.euturbines.eu

EUGINE is the voice of Europe's engine power plant industry. Our members are the leading European manufacturers of engine power plants and their key components.

Engine power plants are a flexible, efficient, reliable and sustainable technology, helping to ensure security of electricity supply and providing (renewable) electricity and heat.

For more information please see www.eugine.eu

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[5] On investment security for peak-load power, see also:
https://www.eurelectric.org/wp-content/uploads/2024/11/M-EC-consultation-on-Energy-Security-fitness-check.pdf