

GIE Position paper on the GIE Study by Artelys and Compass Lexecon *"Securing Future Supply: Quantifying Gas Storage Needs for a Resilient and Integrated European Energy System"*

Takeaway messages

1. **Gas storage is essential for both gas and electricity well-functioning markets and SoS through 2030–2040.** No alternative offers seasonal and peak deliverability at comparable scale.
2. **Peak withdrawals from UGS are found to increase despite decreasing consumption peaks,** since import contribution at peak decreases due to lower annual methane demand.
3. Under a supply shock, **deliverability margins may prove insufficient if the shock materialises late in the winter season,** several shocks are compounded, or the initial storage filling level is below 90%.
4. **Current EU filling behaviour and market incentives will not ensure adequate filling,** creating major SoS risks.
5. **A reformed EU SoS framework is urgently needed,** integrating gas-power-hydrogen, adopting longer-term planning horizons, and strengthening cross-border coordination.
6. **Mandatory or incentivised filling measures beyond 2027 are indispensable,** including the Toolbox of Storage Mechanisms Capturing the Insurance Value.
7. **Cost sharing must be redesigned by Member States** to reflect the EU-wide value of gas storages during crises.

Underground Gas Storages provide irreplaceable resilience value. Without regulatory action ensuring high filling levels and long-term economic viability of storage, the EU energy system would face unacceptable SoS risks, particularly under harsh winters or supply shocks.

Introduction

Europe's energy transition must advance with equal attention to **sustainability, affordability and security**. Persisting geopolitical tensions, intensifying climate-related risks, rapid expansion of renewable energy, deeper electrification, and the growth of electricity uses (such as data centres and EVs) are profoundly reshaping the architecture of Europe's energy system. These transformations heighten the need for **system flexibility** and reveal **new interdependencies across energy vectors**. Ensuring Europe's long-term resilience therefore requires a regulatory framework capable of anticipating these structural shifts and supporting a **coherent, integrated approach to Security of Supply (SoS)**.

From the perspective of **gas storage operators**, a key starting point of this debate lies in the **evolution of market spreads**. In recent years, increasingly compressed or inverted seasonal spreads have tended to **weaken the link between market outcomes and the insurance function provided by gas storage**, even as systemic risks affecting the energy system have increased. This observation led storage operators, within GIE, to seek a **robust, independent quantitative assessment** of the physical role of gas storage in a rapidly changing energy landscape.

Against this backdrop, **GIE commissioned a study** entitled "*Securing Future Supply: Quantifying Gas Storage Needs for a Resilient and Integrated European Energy System*", conducted by **Artelys** and **Compass Lexecon**. The purpose of this study was to inform GIE's reflection on the future role of gas storage in the evolution of Europe's SoS framework.



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Based on the **modelling results produced by Artelys**, the study shows that **European system resilience increasingly depend on deliverability**, defined as the **ability of gas storage facilities to provide high withdrawal rates during stress events**, and not solely on annual gas volumes. Artelys' high-resolution, cross-sectoral modelling demonstrates how interactions between gas, electricity and hydrogen systems shape overall energy SoS, and identifies the physical capabilities required to ensure resilience under a wide range of scenarios.

In parallel, **Compass Lexecon's regulatory analysis**, conducted in the context of the ongoing revision of the Security of Supply Regulation, examines how the existing framework interacts with the evolving characteristics of the European energy system and market conditions. Building on a review of the current regulatory framework, the analysis takes into account recent developments (including changes in demand patterns, market dynamics and cross-sector interactions) and considers how these evolutions may, over time, inform further reflections on the framework's development.

Within this analytical scope, and beyond refining existing standards, the study examines the relevance of internalising the insurance value, recognising its contribution beyond what is reflected by markets signals alone. The analysis highlights that ensuring that sufficient physical storage capacity exists is not, in itself, sufficient. and explores the importance of regulatory arrangements in supporting the appropriate filling levels ahead of the winter season. The analysis further considers the importance of anchoring a more sustainable, long-term approach within the SoS framework beyond 2027.

To support this evolution, the study introduces a **"Toolbox of Storage Mechanisms capturing the insurance value"** designed to complement market-based arrangements and reinforce a coherent, future-proof European approach to security of supply.

1. Evidence for Action: Quantifying Gas Storage Needs in a Changing Energy Landscape

Within this context, the **quantitative analysis conducted by Artelys** provides a **critical, evidence-based assessment** of future system needs. The study demonstrates that, **even as annual gas demand is projected to decline**, the **underlying need for gas storage from a system-resilience perspective remains high** and, in several dimensions, **increases over time**. These findings form the analytical foundation upon which GIE and storage operators base their reflections.

1.1. Methodological approach led by Artelys

The study relies on a state-of-the-art **cross-sectoral modelling framework developed by Artelys**, integrating **gas, electricity, and hydrogen systems at detailed temporal (hourly), and spatial resolution**. This approach appears to reflect the reality of today's energy system, where security of gas supply and security of electricity supply are deeply interdependent, and where stress in one vector rapidly propagates to others.

The analysis places particular emphasis on **deliverability, timing and storage filling levels**, which the study identifies as **decisive parameters for security of supply under stress conditions**. This modelling approach enables a **robust assessment of system flexibility and resilience** across multiple transition pathways and stress scenarios, including:

- **Multi-energy, hourly modelling** capturing cross-sector flexibility and stress propagation.
- **Scenario-based stress testing** including harsh weather, LNG and Norwegian supply shocks, and delayed decarbonisation trajectories.



- **Quantitative outputs** providing system-level insights into storage capacity, filling requirements and deliverability needs.

1.2. Key findings emerging from the quantitative analysis led by Artelys

➤ UGS contribution during peak demand and stress events

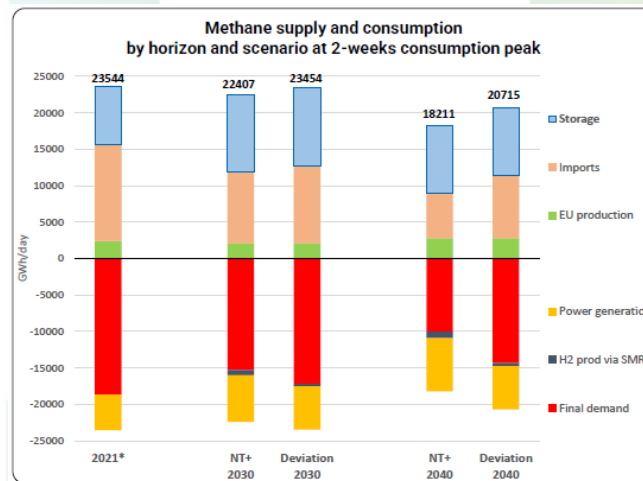
The study’s results show that UGS is indispensable for resilience across all scenarios, not only for seasonal balancing but also for providing short-term flexibility during cold spells, low renewable output or supply shocks.

During peak demand and stress events, the study finds that UGS supplies more than half of daily needs in 2040, making withdrawal (peak deliverability) capacity, alongside stored volumes, a decisive system factor.

In quantitative terms, by 2040, UGS is projected to supply:

- 58% of gas during peak days (up from 44% in 2024)
- 51% during two-week peak periods (up from 34% in 2021)

☞ GIE therefore considers that, even in a transitioning energy system, storage remains indispensable to cover peak demand, underscoring its strategic importance for the entire energy system rather than for the gas market alone.



Source: GIE-Artelys-Compass Lexecon 2026 study

➤ Deliverability as the central system parameter

Peak demand remains a defining challenge despite declining gas consumption. The study shows that Europe’s future gas system will continue to be shaped by **short-term peak demand**, even as annual methane consumption declines significantly.

In the **NT+ 2040 scenario**, compared with 2023–2024 (“today”s) levels, the modelling results show that annual methane consumption declines significantly, reaching approximately 2600 TWh by 2040 (–23%), reflecting a strong volume effect.¹

¹ The study identifies two opposing drivers shaping future methane peak demand.

- On the one hand, residential and tertiary methane demand for heating declines sharply, falling to 11.1 TWh/day in 2040 (vs 20 TWh/day in 2021) of daily peaks.
- On the other hand, methane demand for power generation increases markedly during cold periods coinciding with low renewable generation (Dunkelflaute period). These stress event, characterised by higher electricity demand, the widespread deployment of heat pumps, and low wind and solar output, lead to a sharp rise in gas-fired power generation needs. As a result, peak methane

Peak methane demand, however, remains structurally high, particularly under stress conditions:

- **Peak daily demand** reaches **21.4 TWh/day** in 2040, -12% below today's peak of 24.5 TWh/day.
- **Two-weeks peak demand** remains at **18.2 TWh/day**, -16% compared to 21.6 TWh/day today.

➤ **Implications for underground gas storage (UGS)**

The study also shows that UGS plays a central role in meeting peak methane demand. As annual demand declines, **import volumes are structurally reduced**, limiting their contribution during peak periods and increasing reliance on storage withdrawals, despite slightly lower consumption peaks.

In NT+ 2040 scenario, **peak storage withdrawals remain high at 12.5 TWh/day (+15%)**, compared with 10.9 TWh/day today.

➤ **Sensitivity to storage filling levels**

The study also shows a strong sensitivity to storage filling levels, with low inventories significantly reducing withdrawal capability and increasing security-of-supply risks, particularly towards the end of winter or under shocks.

➤ **Short-term flexibility and electricity-gas link**

Electricity market tensions are shown to transmit directly to the gas system, positioning storage as a key reliable source of flexibility.² Rising daily peak demand for gas-fired generation (doubling by 2040) reinforces the need for strong deliverability.

➤ **Narrow deliverability margins under supply shock**

Under supply shock conditions, the study finds that **deliverability margins become very limited, falling to around 2 TWh/day**. In these situations, UGS plays a dominant role, **covering up to 61% of deliverability**, acting as a critical safety net for both gas and electricity security of supply.

☞ GIE therefore considers that high storage filling levels and strong deliverability must be preserved as core elements of Europe's energy security framework.

➤ **Robustness across transition pathways**

According to the study, the deviation scenario reflects a slower transition, with later deployment of hydrogen and heat pumps. As a result, gas demand declines less quickly than in the NT+ scenario.

- **By 2040**, the study finds that
 - Total gas demand is only 19% lower than in 2019 (vs -36% in NT+).
 - This leads to higher demand peaks across all timeframes (about +2.5 to +2.8 TWh/day).
- **On the peak day in 2040, the study shows that:**
 - Final gas demand is **much higher (+45% compared to NT+)**.
 - Gas use for power generation is **lower (-21%)**, because electrification and electrolysis develop more slowly.

demand for power generation rises from 5 TWh/day in 2021 to 10.7 TWh/day in 2040, more than doubling over the period. This increase partially offsets the decline in heating-related methane demand during peak periods.

Peak demand decreases far less than annual consumption : When these two effects are combined, the study finds that while annual methane consumption declines substantially, peak demand remains structurally high, with peak daily demand reaching around 21.4 TWh/day and two-week peak demand around 18.2 TWh/day in 2040. These results confirm that the future energy system remains exposed to high-intensity stress events despite declining gas use.

² This is not applicable for the Iberian Peninsula where the demand patterns are different, and LNG stocks play also an important role.

The study also finds that, because annual gas demand remains higher, import volumes are higher and more stable, which helps absorb these higher peaks. As a result, overall UGS needs remain similar to those in the NT+ scenario. Storage therefore continues to play an essential role in managing peak demand, although the balance between imports and storage differs.

2. Aligning Regulation with System Needs

2.1. Insights from the study

The study part conducted by **Compass Lexecon** assesses whether the current European security-of-supply framework is adequate to reflect the evolving physical needs of the energy system. This assessment is carried out in the context of the ongoing revision of the Security of Supply Regulation.


➤ Context and Drivers

According to the study, Europe's existing storage and security-of-supply rules were largely designed **before the escalation of geopolitical tensions** and **prior to the structural transformation of energy demand patterns**, including deeper electrification, stronger electricity–gas interdependencies and increased exposure to global LNG markets. While temporary crisis measures adopted since 2022 have helped mitigate short-term risks, these measures **do not provide a durable, structural solution** aligned with long-term system needs.

➤ Key Challenges

The study further concludes that **market signals alone may not adequately remunerate the system-wide insurance value of gas storage**. The insurance value, *defined as gas storage's fundamental contribution to security of supply*, is defined as a positive externality that is not fully captured by market mechanisms. Insufficient price signals may undermine the economic sustainability of storage facilities, putting at risk the resilience of the energy system. Since the full value of storage is not fully reflected in market signals, the economic viability and availability of storage to provide security of supply is threatened.

The study recommends that the European regulatory framework must ensure, over the long term, the necessary economic conditions for the sustainable operation of storage facilities by enabling the internalisation of their strategic value for security of supply.

 Building on these findings, **GIE considers that the situation may lead to storage site closures putting at risk Security of Supply.**

2.2 Directions identified in the study for Enhancing the Framework

2.2.1 Strengthen EU-Wide SoS Assessments

Against this background, the study indicates that to ensure a resilient energy system, EU-level assessments should evolve to better reflect the deepening interdependence between gas and electricity, the increasing complexity of risk and market scenarios, and the profound transformation of energy infrastructures.

The study identifies several areas where the security-of-supply framework could evolve to better reflect system needs, including:

- **Strengthen the analytical bridge between gas and electricity** by integrating cross-sector interactions more systematically into security of supply and flexibility evaluations.
- **Identify the storage capacity needs and inventory levels required** to safeguard supply, taking careful account of withdrawal constraints and deliverability dynamics.

- **Broaden the shock scenario framework** (traditionally centered on cold spells) to also encompass periods of low renewable generation, potential geopolitical or supply disruptions (e.g. pipeline or LNG flow interruptions).
- **Extend the analytical horizon to ten years** and embed anticipated infrastructure developments, including the progressive repurposing of assets for hydrogen transport and storage.

2.2.2 Key regulatory implications of the study

➤ **Updating SoS Standards for a more Integrated Energy System and Interdependent Europe**

Given shifting demand patterns, regional specificities, and the evolving needs of European industry, the study suggests that national SoS standards must be redesigned to remain fit-for-purpose in a rapidly changing energy landscape:

- Update infrastructure standards to incorporate **volume-based adequacy assessments**, forward-looking demand trajectories, storage filling requirements, and regional perspectives, as well as **new drivers of peak demand-based** adequacy assessments.
- Revise supply standards to better reflect **cross-sectoral demand determinants**, the economic significance of uninterrupted supply for SMEs and industry, the allocation of responsibilities within the market model, and more consistent compliance mechanisms across Member States. Supply standards should ensure that gas supply contracts to final customers are **backed by firm physical instruments**.
- Member States should establish **measures that will, in an effective and proportionate manner, ensure that natural gas undertakings comply with such a supply standard**, including the obligation to establish penalties on suppliers or the withdrawal of a commercial supply license. A common and higher supply standard across Member States should be considered at EU level, duly reflecting regional specificities and differences in national energy systems and infrastructure configurations.³
- Storage obligations currently available only to “**protected customers**” **should be extended EU-wide to include all customers benefitting from SoS**, including small or medium-sized enterprises, or industrial installations that are not able to switch to alternative fuels, gas-fired power plants and district heating companies to the extent that it delivers heating to household customers.⁴

➤ **Establish a Long-Term Framework Beyond 2027**

A durable and coherent framework beyond 2027 is essential to ensure predictability for market participants while preserving market compatible tools and avoiding cross-border distortions. According to the study:

- **Define clear conditions and requirements for the activation of the Toolbox of Storage Mechanisms capturing the insurance value.**
- **Address the EU-wide implications of national measures** and acknowledge the significant variation in storage capacities across Member States.
- **Design any new interventions using market-compatible approaches** that minimise distortions and preserve efficient price signals.
- **Consider reinforcing incentives for storage booking and filling.**

➤ **A Dedicated Toolbox of Storage Mechanisms capturing the insurance value**

Emergency interventions in 2022–2024 exposed the limitations of ad-hoc rules. Recognising the system-wide **insurance value** of gas storage requires instruments that operate alongside, but distinctly from, commercial

³ GIE acknowledges the specificities of the Iberian Peninsula in terms of seasonal demand patterns, level of interconnection, and complementary SoS measures.

⁴ Against this background, GIE recommends that any consideration of extending storage obligations be subject to further in-depth analysis, fully reflecting Member State-specific energy mixes, infrastructure portfolios and existing security-of-supply arrangements, in order to avoid unintended consequences

markets. These mechanisms define the level of capacity that must be maintained and filled to meet additional demand during stress-test conditions.

The objective is to acknowledge, over the long-term, the strategic value of physical back-up resources, **assets that can be mobilised very quickly, and delivered in large volumes** compared to other energy storage means alternative technologies, precisely the type of flexibility that is increasingly scarce and highly valued in the electricity system.

To address this challenge, the study presents a new **Toolbox of complementary Strategic Storage Mechanisms** has been developed to capture system-wide insurance value, *i.e. the level of storage capacity that must be available and filled in order to meet the additional demand that appears under stress-test conditions.*

The Toolbox, as referred in the Study provides a set of complementary options that can be tailored to national market specificities and aligned with Emergency Plans.

Looking ahead, the study recognises that the segmentation of customers under the *protected customers* definition interacts directly with the allocation of responsibilities within the Toolbox and ultimately influences the design of **cost-sharing mechanisms**.

➤ **Cost-Sharing Mechanisms**

Compass Lexecon indicates that the principles and mechanisms for the cost sharing should be reassessed. This recalibration must reflect Europe's structural asymmetries: storage capacities are unevenly distributed across Member States, and so are the benefits they provide.

➡ **GIE considers that any adjustment to cost-sharing arrangements should take account of differences in the national infrastructure configuration**, notably with respect to different levels of interconnection, storage and LNG capabilities, and also considering the demand patterns and the different portfolios of SoS measures applied by Member States. Thus, a credible mechanism must acknowledge both the physical location of assets and who relies on them, whether directly or indirectly, for stability.

The framework should also recognise the full value of gas storage in its ability to underpin electricity system adequacy, its stabilising influence beyond crisis moments, and its inherent insurance function. Only by acknowledging this continuum of benefits can financial contributions accurately reflect storage's strategic significance for Europe's energy security.

Conclusion

➤ **From Crisis Response to Structural Resilience**

The study demonstrates that Europe must move from reactive crisis management to a proactive and structural resilience planning.

According to the study, a long-term, market-compatible regulatory framework (supported by strengthened assessments, updated standards, strategic mechanisms, and fair cost-sharing) is essential to safeguard the insurance value of gas storage.

➤ **A Call for Long-term Vision in Europe's Energy Security Architecture**

The study indicates that by implementing incentive-based schemes with measures ensuring physical storage levels, and integrating storage measures from the **Toolbox of Storage Mechanisms capturing the insurance value** alongside commercial capacities, the EU can align its security goals with the realities of a rapidly evolving energy system, reinforcing the indispensable role of underground gas storage in delivering a resilient, sustainable, and affordable energy transition.

About GIE

Gas Infrastructure Europe (GIE) is the association representing the interests of European gas infrastructure operators. Our members are active in transmission, storage and regasification via LNG terminals. They work and innovate with renewable and low-carbon molecules, including hydrogen, natural gas and biogases.

Gathering more than 70 industry entities from 25 EU countries, we hear out and embody the multiple decarbonisation pathways of the different regions of Europe.

We believe that by 2050, the gas infrastructure will be the new innovative energy system's backbone, allowing EU citizens and industries to benefit from a secure, cost-effective, and sustainable energy supply.

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