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Liquefied natural gas and global energy security: the need for operational excellence in sustainable production

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1 Introduction

Liquefied natural gas has emerged as a pivotal component in the global energy landscape, playing a crucial role in enhancing energy security for nations around the world.

As countries strive to diversify their energy sources, reduce greenhouse gas emissions, and transition to cleaner fuels, liquefied natural gas offers a viable solution that aligns with these objectives. This white paper discusses the significance of liquefied natural gas in global energy security and explores how operational excellence can ensure reliable and sustainable liquefied natural gas production amid evolving energy dynamics.

The consequences of the Russian invasion of Ukraine in 2022 have once again highlighted fragilities in the global supply of energy, particularly for Europe. To make up for the loss of Russian gas, Germany had to swiftly establish floating terminals to import liquefied natural gas. This will become the new normal for Continental Europe, after Russian gas exports via Soviet-era pipelines came to a halt on January 1, 2025, following Ukraine's refusal to renew a transit agreement. The Russian invasion drove gas prices to a record high in Asia and Europe contributing to what the International Energy Agency described as, "the first energy crisis that is truly global."

The sharp increase in gas prices in 2022 has resulted in an unprecedented surge in new liquefied natural gas projects. Currently, projects that have either commenced construction or reached a final investment decision are poised to significantly increase the current global liquefied natural gas supply by 2030. In addition, US President Donald Trump signed an executive order on January 20, 2025, for the US to resume processing export permit applications for new liquefied natural gas projects which may add to the potential future oversupply.

The strong increase in liquefied natural gas production capacity is expected to ease prices and gas supply concerns in the medium to long term. However, it also raises questions regarding the long-term profitability of projects and future operating economics.

Historically, liquefied natural gas was primarily supplied through "term deals" to power producers, which provided the liquefied natural gas producer with a guaranteed margin. This arrangement facilitated significant investments in operational excellence to ensure plant reliability and a continuous supply for power producers. In the future, the economics are less certain, which could exert pressure on operating margins. Liquefied natural gas producers will need to adopt "nimble" operational excellence strategies, similar to those previously employed in the global refining industry.

2 Current reality

Prior to 2022, Russia supplied nearly 40% of the EU's natural gas. This gas was transported through four pipeline systems: one under the Baltic Sea, one through Belarus and Poland, one through Ukraine, and one under the Black Sea via Turkey to Bulgaria.

Following the onset of the war, Russia halted most supplies through the Baltic and Belarus-Poland pipelines, citing disputes over a demand for payment in rubles. The Baltic pipeline was ultimately destroyed. In addition, as of January 1, 2025, the Ukraine pipeline was shut down as the supply contract expired.

The Russian cutoff triggered an energy crisis in Europe. Germany had to quickly invest billions of euros to establish floating terminals for importing liquefied natural gas by ship, rather than through pipelines. As prices skyrocketed, consumers reduced their usage. Norway and the US stepped in to fill the void, becoming the two largest suppliers of liquefied natural gas to Europe.

Similar to oil, the patterns of natural gas trade have undergone significant changes since 2022. A notable indicator of a transformed global gas market is that liquefied natural gas has now emerged as a primary source of gas supply for Europe, with its share of total demand in the EU increasing from an average of 12% during the 2010s to nearly 35% in 2022, akin to the contribution from previously piped gas from Russia. This shift has had far-reaching implications for all facets of natural gas markets and for how countries collaborate to ensure gas security.

It can be concluded that the current state of natural gas supply in Europe is unlikely to change for some time, and Russian pipeline natural gas will no longer be available to Europe in the foreseeable future. The resulting deficit will be compensated by liquefied natural gas imports.

3 Future liquefied natural gas capacity growth

Starting in 2025, an unprecedented surge in new liquefied natural gas projects is set to tip the balance of markets and increase concerns about natural gas supply.

Market balances remain precarious in the immediate future, but that will change towards the end of the decade. Projects that have started construction or have taken final investment decisions are set to produce 250 billion cubic meters of liquefied natural gas by 2030, equal to almost half of today's global liquefied natural gas supply. Announced timelines suggest a particularly significant increase between 2025 and 2027. In addition, on January 20, 2025, US President Donald Trump signed an executive order, for the US to resume processing export permit applications for new liquefied natural gas projects which could contribute to the potential future oversupply.

4 Future liquefied natural gas demand

This additional liquefied natural gas capacity arrives at an uncertain time for natural gas demand, creating significant challenges for Russia's diversification strategy towards Asia. The strong increase in liquefied natural gas production capacity eases prices and gas supply concerns in the medium term.

However, it enters the market at a moment when global gas demand growth has slowed considerably since its "golden age" in the 2010s, primarily driven by Japan's decision to reduce its nuclear power generating capacity in the wake of the Fukushima disaster.

Alongside gas contracted on a longer-term basis to end-users, the International Energy Agency in its *World Energy Outlook 2023* estimates that more than one-third of the new gas will seek buyers in the short-term market. Nevertheless, some mature markets — particularly in Europe — are experiencing a pronounced structural decline, and emerging markets may lack the necessary infrastructure to absorb significantly larger volumes if gas demand in China diminishes.

Gas markets have become increasingly open in recent years, a development that has underpinned investor confidence. However, this also raises the possibility of looser market fundamentals, lower prices, and a reduction in gas supply security concerns from the second half of the 2030s. These developments could increase demand if they enhance confidence in gas among price-sensitive emerging markets and developing economies. Nonetheless, it prompts questions about the long-term profitability of projects. The *World Energy Outlook 2023* states that, "a good deal of gas would probably end up being sold in an over-supplied market at close to short-run marginal costs, although the degree of exposure to volume and price risk between suppliers and off-takers would depend on contractual arrangements."

5 Liquefied natural gas and operational excellence

History

Historically, liquefied natural gas was primarily supplied to power-generating companies in various regions around the world on "term deals." Each plant's capacity was measured in "cargoes per annum." Given the limited liquefied natural gas storage capacity at many of these power-generating plants, "missing a cargo" due to an incident or breakdown was a serious event, especially in the absence of a liquefied natural gas spot market. Suppliers were unwilling to risk the reputational damage of power supply disruptions in major cities, and hence, substantial investments were made in hardware, staff training, and operating and maintenance budgets. This resulted in high levels of reliability, low levels of losses, and the preservation of the companies' reputational integrity.

Industry performance benchmarking of liquefied natural gas plants versus oil refineries indicated that the liquefied natural gas plants spent more than twice as much on maintenance for an equivalent equipment count. This approach ensured that a high level of reliability was maintained.

Texas incident in June 2022

In June 2022, an incident occurred at the liquefied natural gas liquefaction plant in Texas, releasing liquefied natural gas. This led to the formation and ignition of a natural gas vapor cloud and a subsequent fire at the facility. The loss from this incident, which was primarily due to business interruption, represents one of the largest claims in the market in 2022.

The direct cause of the incident was:

- Thermal expansion within a liquefied natural gas line with an isolated pressure relief valve resulted in a boiling liquid expanding vapor explosion and loss of primary containment.
- The flammable vapor (methane) then met an ignition source resulting in a vapor cloud explosion, a fireball, a small secondary pool fire, and a short-term release of vaporizing liquefied natural gas from damaged piping.

Regarding the root cause of the incident, the report of the US Pipeline and Hazardous Materials Safety Administration stated the following:

- A lack of pressure safety valve testing procedure and car seal program.
- A lack of safeguards to warn operators of increasing vacuum-insulated piping temperature and/or pressure for lines routinely isolated by procedure.

Prior to this event, there had been few major incidents at liquefied natural gas plants. This incident highlights the benefits of a comprehensive system for operational excellence, encompassing a permit-to-work process, inspections, maintenance execution, and robust operating procedures.

6 Future challenges for liquefied natural gas operators

Reduction in operating budgets

With the unprecedented increase in liquefied natural gas supply anticipated in the coming years, a long-term glut is likely to exert pressure on operating margins. If operating and maintenance budgets are reduced, this could lead to lower reliability and, consequently, an increased potential for losses.

Liquefied natural gas operators should adopt nimble operational excellence tactics that have been successfully implemented in the global refining sector, including:

- Risk-based inspection.
- Bad actor and defect elimination.
- Reliability-centered maintenance.
- Optimization of safety instrumented functions.
- Turnaround management.
- Proactive technical monitoring across all disciplines.
- Digitalization, including operator rounds.

Aging assets

Older liquefied natural gas plants, some of which are over 50 years old, will require increased focus on maintenance and inspection. If not managed properly, aging assets can lead to decreased reliability and potential losses.

Addressing aging assets requires the following:

- Maintaining the operation of existing equipment while performing all the mandatory regulatory requirements.
- Evaluating operations and maintaining the facility beyond the regulatory requirements to identify techniques to extend equipment life.
- Planning for the replacement of components and major machinery as they become obsolete, inefficient, unreliable, or pose increased risk.

Diversity of operating companies

In the past, liquefied natural gas processing facilities were generally set up as independent operating companies with minority shareholdings from international energy companies. These companies provided design standards and technical support to the sites that included staff seconded to work directly in the plants. While such projects continue in collaboration with international energy companies, there are now a number of newer operators that may not have access to the same standards and may lack the historical knowledge regarding plant design and operation.

Availability of skilled staff in the US Gulf Coast

A large proportion of future projects for liquefied natural gas plants will be in the US Gulf Coast. This concentration of projects will put pressure on the availability of skilled staff to meet future operations and maintenance requirements.

7 Conclusion

The evolving landscape of the liquefied natural gas industry presents several challenges.

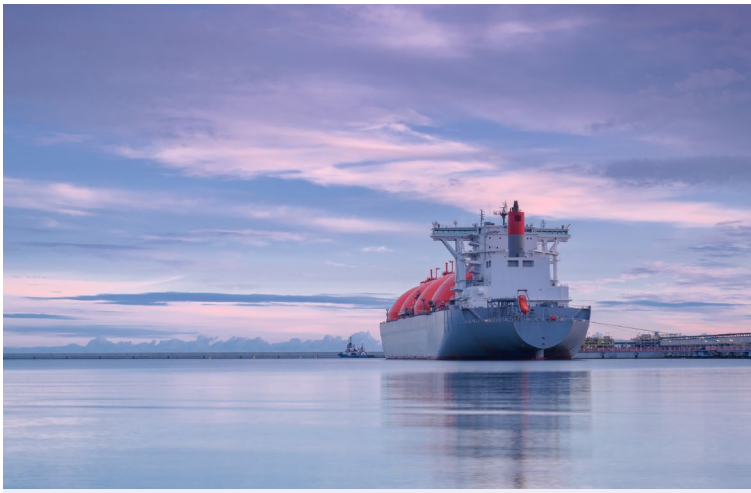
The current state of natural gas supply in Europe is unlikely to change any time soon, and Russian natural gas is not expected to be accessible to Europe in the near future. The resulting deficit will be compensated by liquefied natural gas imports with the main suppliers being the US and Qatar.

As the legacy plants age, diligent maintenance and rigorous inspection will be required to ensure reliability and mitigate potential losses.

Additionally, the shift towards increased liquefied natural gas supply may impact operating margins and market dynamics. Benchmarking can help newer sites understand median operating and maintenance budgets, but sustained low margins can pose severe strain on costs and subsequent plant integrity.

As new projects emerge, particularly in the US Gulf Coast, the demand for skilled personnel will intensify, necessitating a renewed focus on training and development.

Stakeholders must navigate these complexities to maintain operational excellence and uphold the integrity of the liquefied natural gas sector, ultimately contributing to global energy security and sustainability.



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