GAS IN TRANSITION

BY THE INTERNATIONAL GAS UNION IGU

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DIGITAL TRANSFORMATION

ACROSS THE GLOBAL GAS VALUE CHAIN

Natural gas in an era of *poly-weiji*

Driving multi-energy digital acceleration

Cutting energy use and emissions with foundational AI

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From the Secretary General

As our March 2026 edition reaches your desks, the hostilities in the Strait of Hormuz have significantly escalated, including the targeting of energy facilities in the region. Since March 2, 2026, the Strait of Hormuz, a vital artery not only for the world's oil and gas but also for petrochemicals, fertilisers, and regional food, has been effectively closed.

LNG production at Qatar's Ras Laffan LNG plant, the world's largest, was halted earlier this month and subsequently sustained damage. As a result, approximately 20% of the global LNG supply has been impacted.

Many questions from journalists have arisen regarding this situation, with the two most common being "Who can cover the LNG shortfall and how quickly?" The brief answer is that, in the short term, the total shortfall cannot be fully compensated. Some additional supply capacity can be generated from LNG plants worldwide by increasing output to full nameplate capacity and delaying maintenance schedules. New liquefaction facilities currently under construction and commissioning could assist in alleviating the situation, but they are not expected to be operational until late in the year.

At the start of February this year, QatarEnergy hosted the 21st edition of the International Conference and Exhibition on Liquefied Natural Gas, a global triennial event organised by the International Gas Union, GTI Energy, and the International Institute of Refrigeration. Meanwhile, in 2026, Qatar will celebrate the 30th anniversary of its first LNG cargo, which was shipped to Japan. Over these 30 years, Qatar has maintained an impeccable delivery record.

As we have recently stated, the International Gas Union remains deeply concerned about the targeting of energy infrastructure. This infrastructure is vital not only to public safety and security but also to regional and global economic activities. Continued investments in energy infrastructure and diversification of energy supplies are crucial to mitigate market shocks and ensure security of supplies.

It is undeniable that energy demand continues to rise. We live in an environment where, despite all investments in renewables, additional supplies of hydrocarbons remain necessary to meet global energy needs. Gas is not "just a support" for renewables or "just another fossil fuel," as some have recently claimed, but a crucial pillar of global energy security, sustainability, and affordability. We cannot, and should not, apologise for it; instead, let us use the facts and data to support our core argument: that Gas is vital to human progress and global growth, as recent events in the Middle East are demonstrating.

Menelaos (Mel) Ydreos
Secretary General, *International Gas Union*

From the editorial team

There can be no human progress or global growth without Gas in all its forms: fuelling economies, powering houses and businesses, supporting the agricultural industries, reducing CO_2 emissions, stabilising the power grid in terms of peak demand and when renewables can no longer cope, providing a stable baseload for data centres and so much more. The global Gas industry, and its entire value chain, are constantly innovating: from the world's largest companies to the most agile start-ups, the race to innovate more and use digitalisation for optimum customer serviceability are probably at their highest today, despite all the regulatory and geopolitical pressures and hurdles.

The latest edition of our magazine provides a snapshot of what our sector is doing to integrate artificial intelligence with human decision-making, and predictability and risk mitigation with the latest developments in digitalisation. The debate is shifting from "human versus machine" to "human together with the machine".

Enjoy this edition whose articles have been carefully curated by our editorial team and, as ever, we look forward to hearing from you!

Ella Minty
Director, Communications
Senior Adviser to the Secretary General
International Gas Union

New Member Focus

HUNT OIL COMPANY

Hunt Oil Company is a privately held company founded in 1934 in Dallas, Texas, with a solid track record in oil and gas exploration and production. Its presence extends across North America, South America, Europe, and the Middle East, with strategic liquefied natural gas (LNG) projects in Peru and Yemen. The company operates with excellence, safety and sustainability, guided by the values of respect, humility, community, teamwork and creativity. Its purpose is **to impact humanity for the better with energy**, creating lasting value for the industry, its partners, and the communities where it operates globally, in a sustainable and responsible manner.

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JTA INTERNATIONAL INVESTMENT HOLDING

JTA International Investment Holding was established in 2010 with the aim of delivering distinctive and forward-looking financing and investment solutions to businesses and landmark projects worldwide. Over the years, the group has evolved into an active investor, building strong partnerships with aligned companies and experienced individuals across multiple markets.

JTA's international footprint supported by offices in several countries and an extensive global partner network, forms the foundation of its investment platform, which continuously identifies, evaluates, and develops investment opportunities. Through its subsidiaries, the group operates across a diversified range of sectors, including Energy, Civil Development, Innovation and Technology, Tourism and Transportation, Health, and Agriculture and Food Security.

The group's corporate structure, established in Qatar and the United Kingdom, provides centralised oversight of investments, strategic direction, and a robust governance framework to ensure consistency, transparency, and long-term value creation across all operations.

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OMCo (ONHYM MIDSTREAM CO)

OMCo is a Moroccan company specialised in the transportation of natural gas by pipelines. Its activities cover the management, construction, and development of natural gas transmission networks, as well as the maintenance, repair, and construction of related infrastructures in Morocco. In addition to its core mission, OMCo is also engaged in projects related to gas storage and hydrogen transportation in Morocco.

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XINJIANG HONGTONG GAS CO., LTD

Xinjiang Hongtong Gas Co., Ltd. (hereinafter referred to as "HONGTONG GAS") is an important integrated service provider of clean transportation energy in northwest China. Headquartered in Korla City, Bayingolin Mongol Autonomous Prefecture, Xinjiang, China, the company is currently a listed company on the Main Board of the Shanghai Stock Exchange (Stock Code: 605169), a member of the International Gas Union (IGU), and the chairman unit of the Xinjiang Gas Industry Association.

HONGTONG GAS is mainly engaged in the production, processing, storage & transportation, and sales of Liquefied Natural Gas (LNG) and Compressed Natural Gas (CNG). It currently has approximately 40 subsidiaries and branch companies, with an annual LNG production capacity of 500,000 tons and a storage capacity of 50,000 cubic meters. The company is equipped with over 100 integrated energy stations and operates more than 300 hazardous goods transportation vehicles. Relying on its digital and intelligent platform, it deeply cultivates the full-industry-chain services of LNG and CNG, boasting strong comprehensive service capabilities for clean transportation energy.

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New Member Focus

TENEO HOLDINGS LLC

Teneo is the global CEO advisory firm. We partner with our clients globally to do great things for a better future. Drawing upon our global team and expansive network of senior advisors, we provide advisory services across our five business segments on a stand-alone or fully integrated basis to help our clients solve complex business challenges. Our clients include a significant number of the Fortune 100 and FTSE 100, as well as other corporations, financial institutions and organisations.

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FLOENE ENERGIAS

Floene Energias is the largest Gas distribution network operator in Portugal, ensuring a safe, efficient, and reliable energy supply to more than one million customers across 106 municipalities, from the north to the south of the country. Committed to the energy transition, Floene is strongly focused on integrating renewable gases – such as biomethane and hydrogen – into its infrastructure, helping to promote a more sustainable and decarbonised energy system. By placing its network, expertise, and commitment at the service of a fair and sustainable energy transition, Floene's forward-looking vision consolidates its position as a strategic partner and a driving force for decarbonisation.

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Events

LNG2026

Firstly, I would like to congratulate QatarEnergy on staging one of the largest, most well attended LNG series conferences IGU has ever held. My thanks go to the National Organising Committee and to their dedicated team. Aside from the unrivalled hospitality, two things stood out from the attendees' objectives in participating at the event:

1. It was the place where industry stakeholders go to discover, listen to and explore new Gas technologies. In addition, the new Technical Delegate programme enabled even more stakeholders to engage, learn, network and collaborate in the quest to making Gas more sustainable, available and affordable.
2. It was also the forum for doing business at a global level, and to network with new and existing customers, suppliers and partners. My sincere thanks also go to all the exhibitors, sponsors, speakers, delegates and attendees that made this event so successful.

Preparations have already started for LNG2029 that will be held in Brisbane, Australia, and hosted by our Australian Charter Member – the Australian Gas Industry Trust – and the Australian Energy Producers. The event will take place April 17-20, 2029, so do mark your calendars and, to be kept abreast of the latest news, register your interest here: www.lng2029.com

IGRC2027

The International Gas Research Conference (IGRC2027) will follow IGU's core mission of showcasing the role of Gas in enabling more prosperous and sustainable societies. The IGU's Research, Development and Innovation Committee (RD&I), acting as the Technical Programme body for the conference, places a particular focus on the development and impacts of new technologies in the Gas industry.

At a time when many IGU members and economies are concerned about affordable energy supply, it has never been more important to develop and integrate technology to help realise these goals.

The conference is positioned to accelerate the deployment of zero and low-emission gases, such as biomethane, hydrogen and e-methane, as well as the sustained deployment of decarbonisation technologies, especially carbon capture, utilisation and storage.

The Call for Abstracts for the IGRC2027 Technical Programme is now open and details can be found at www.igrc2027.com . To us, IGRC2027 is a rallying call to the global Gas industry to support the rapid development of new Gas technologies to enable a cleaner, more secure and affordable energy future.

If your organisation is an IGU member and you would like more information on joining the IGU's RD&I Committee or any other IGU Committee, more details can be found here https://www.igu.org/advocacy/working-groups-task-forces?page=2.

If your organisation is not a member of the IGU and you would like to know more about the committees and joining the largest and oldest Gas membership organisation in the world, please email our Membership & Governance Director Joao Salviano Carmo at Joao.Salviano@igu.org

WGC2028

Since 1931, the IGU's World Gas Conference has been the vital global platform for dialogue, collaboration, and commercial activity for the global Gas industry. I am truly delighted that the 30th edition will return to London in 2028!!

Marcus Gurske has been appointed the Executive Director of WGC2028 as he has been involved in the last five major IGU flagship events in a variety of management capacities, and I can think of no one better to steer this event forward. His welcome message and vision for 2028 is simple, clear and unequivocal:

WGC2028 will bring together thousands of energy leaders, policymakers, and innovators at ExCeL London for four days of critical dialogue, breakthrough innovation, and strategic partnerships that will define the future of our industry!

London's position as a global energy and financial hub provides the ideal backdrop for addressing the challenges and opportunities ahead. Here and together, we will chart the course for delivering secure, sustainable, and affordable energy worldwide and for showcasing the role of Gas in driving human progress and global growth!

This Conference will deliver an exceptional technical content, highlight our industry's thought leadership, and provide you with meaningful business connections. Whether you're a returning delegate or joining us for the first time, the 30th edition of the World Gas Conference will mark a defining moment for the global Gas industry.

Join us in London as we continue to Shape the future of the Gas Industry!

For more information, and to join the mailing list to be kept updated, please go to https://www.wgc2028.com/

Simon Polledri
Flagship Event Director, *International Gas Union*

GAS IN TRANSITION.MARCH 2026

Natural gas in an era of *Poly-Weiji:* Opportunity, danger, and the race for relevance

KEVIN JIANJUN TU
Senior Visiting Research Fellow, Oxford Institutes for Energy Studies

Natural gas has entered an era of *poly-weiji* – multiple overlapping crises that embody both danger and opportunity. Drawing from the Chinese concept of *weiji*, this framing captures a defining paradox: every major opportunity, from Gas' transition-fuel role to rising electricity demand driven by digitalisation, carries embedded risks, while each challenge also presents pathways for strategic adaptation.

This article examines six key *weijis* shaping the global natural gas sector, drawing on insights from the International Energy Agency's World Energy Outlook 2025 (WEO 2025), its Gas 2025 medium-term report, and broader market trends. It adopts a politically neutral lens, focusing on observable developments rather than ideology. The central message is straightforward: the Gas industry must seize the opportunities created by today's poly-*weiji* environment, but its long-term relevance will depend on whether it can manage environmental and geopolitical liabilities credibly.

Weiji One: The Transition Fuel Narrative – Bridge or Bottleneck?

Natural gas is often characterised as a transition fuel: it emits less CO_2 than coal, is scalable, and can provide flexible generation that complements variable renewables. This remains a tangible opportunity, particularly in regions where electricity and industrial demand are rising quickly and coal remains dominant.

The IEA's Gas 2025 outlook suggests global natural gas demand will continue its structural growth into the late 2020s, supported by new LNG capacity and expanding infrastructure – especially across Asia and the Middle East. Even if annual growth rates moderate after 2024, global consumption is likely to remain at historically high levels, with LNG trade expanding and new liquefaction capacity entering the market.

However, the transition narrative contains a structural risk: infrastructure lock-in. Gas assets – pipelines, liquefaction terminals, LNG carriers, and combined-cycle power plants – are long-lived. Without credible decarbonisation pathways, they risk becoming stranded as regulations tighten and alternative technologies mature.

Europe's experience after 2022 illustrates this duality: LNG imports surged to maintain supply security, but policy momentum simultaneously accelerated renewables, electrification and efficiency targets that aim to cut natural gas demand significantly by 2030.

The underlying question is whether Gas systems are designed for flexibility or permanence. Treating "bridge fuel" as a justification for delay can turn natural gas into a bottleneck. Designing infrastructure to accommodate biomethane, hydrogen blending, carbon capture, and demand-side efficiency can preserve value while mitigating long-term risk.

Weiji Two: AI-driven Demand Surge – Boon or Burden?

The rapid expansion of artificial intelligence (AI) and data centres is reshaping electricity demand patterns. These facilities require continuous, high-reliability power, and in many markets grid expansion is not keeping pace. Natural gas-fired generation is emerging as a near-term option, particularly in the US, where a significant share of planned on-site capacity for data centres is natural gas-based.

This creates a structural opportunity for natural gas: deeper integration into power systems and a new source of reliable demand that could stabilise markets across the value chain – from upstream production to midstream infrastructure and generation. In regions where renewables alone cannot yet meet baseload and flexibility requirements, natural gas may play a critical role in preventing power shortages that could otherwise constrain economic growth.

Yet risks accompany this surge. Unabated natural gas use could elevate emissions and intensify regulatory scrutiny. Some jurisdictions, particularly in Europe, are exploring sustainability standards for data centres that could limit the role of natural gas in future power procurement. Moreover, the pace of technological change – including improvements in storage, advanced nuclear deployment, renewable integration, and AI efficiency – could reduce long-term natural gas dependence, leaving some investments vulnerable to oversupply.

To seize the opportunity without entrenching risk, natural gas can be positioned as part of hybrid solutions – paired with renewables, high-efficiency generation, carbon capture, and stringent methane standards – so that its role in powering digital growth remains compatible with evolving climate expectations.

Weiji Three: Geopolitical Realignments – Diversification or Division?

Geopolitics has profoundly reshaped global natural gas markets. Since the Russia-Ukraine War in 2022, reliance on single-source pipeline imports has declined, while LNG trade has expanded, with the US and Qatar emerging as leading suppliers. IEA analysis in Gas 2025 highlights that a major increase in LNG capacity is expected by 2030, strengthening supply flexibility for importers across Asia, Europe, and beyond.

This shift creates opportunity. A more diversified →

NATURAL GAS SHARE OF GLOBAL CO_2 EMISSIONS (IEA WEO 2025 STEPS)

Year	Total fuel combustion CO_2 ($GtCO_2$)	Gas ($GtCO_2$)	Gas share
1990	20.5	3.7	17.9%
2000	23.2	4.6	19.6%
2010	30.4	6.1	20.0%
2024	34.9	7.8	22.3%
2035	32.0	8.6	26.9%
2040	29.5	8.5	29.0%
2050	26.4	8.3	31.5%

Source: Adapted from IEA WEO 2025 STEPS emissions outlook; shares calculated as gas CO_2 divided by total fuel combustion CO_2.

LNG market can reduce reliance on any single supplier, improve resilience, and strengthen energy security for importing countries. It can also deepen global trade linkages, delivering economic benefits for both exporters and importers.

At the same time, geopolitical tensions introduce risks of fragmentation. Military confrontations and regional instability – particularly in strategically vital energy corridors – can heighten price volatility and disrupt supply flows, as recent US-Israeli strikes on Iran illustrate. For economies reliant on spot LNG markets, sudden price surges may trigger short-term fuel switching, as seen during parts of 2022 and 2023 when elevated LNG prices contributed to temporary increases in coal and oil use.

Climate geopolitics adds another layer of complexity. As governments refine emissions frameworks and border adjustment mechanisms, importers may increasingly prioritise emissions transparency and low-carbon standards for Gas supply. In the absence of coordinated multilateral frameworks for emissions accounting and long-term contracting stability, diversification strategies could inadvertently harden into market segmentation.

This *weiji* underscores the urgent need for stronger international coordination and trust-building in the global Gas market: transparent emissions accounting, stable and reliable contract mechanisms, credible methane emission standards, and proactive political derisking measures. Without these foundational elements, the push for diversification risks devolving into deeper market division and fragmentation.

Weiji Four: Rising Share of Global CO_2 Emissions – Accountability or Advantage?

Perhaps the most consequential *weiji* is natural gas' evolving emissions profile. While natural gas emits less CO_2 than coal per unit of energy, its continued expansion means it may account for a rising share of global emissions even as total fuel combustion emissions decline through mid-century.

In the IEA's WEO 2025 Stated Policies Scenario, natural gas' share of global fuel combustion CO_2 emissions rises from about 22% in 2024 to near one-third by 2050, even as total fuel combustion emissions decline from around 35 Gt to approximately 26 Gt. This reflects coal's gradual decline and natural gas' sustained role across power and industrial systems.

Methane further intensifies this *weiji*. The IEA estimates total energy-sector methane emissions at roughly 145 Mt in 2024, with gas operations contributing about 35 Mt. Approximately 70% of methane emissions from fossil energy operations could be avoided using existing technologies, and about 30% could be eliminated at no net cost. As regulatory frameworks evolve, methane performance is likely to become a defining market metric.

This trend increases accountability pressures on natural gas. If natural gas becomes the primary large-scale fossil fuel persisting into mid-century, it may also become the central focus of climate policy. Yet this also creates opportunity: natural gas value chains are technically compatible with carbon capture, low-carbon hydrogen pathways, and methane abatement, potentially allowing leading producers to retain market access under tightening standards.

Weiji Five: Technological Disruption – Innovation or Obsolescence?

Technological change is rapidly reshaping energy systems. Renewables are scaling quickly, storage costs are falling, and electrification is advancing in transport, heating, and industrial processes. These trends threaten natural gas demand in mature markets and may accelerate peak-demand timelines.

At the same time, technology also creates new roles for natural gas. As renewable penetration rises, flexibility and balancing services become more valuable. Natural gas remains well-suited for dispatchable generation and for high-temperature industrial heat, where electrification may be slow or costly. Existing Gas infrastructure may also play a future role in transporting hydrogen or storing decarbonised molecules, depending on regional transition strategies.

The risk is obsolescence if the industry fails to adapt. The opportunity is innovation: deploying advanced methane detection, improving liquefaction efficiency, investing in hydrogen-ready systems, retrofitting CCUS, and integrating digital tools across the value chain.

Technology will not eliminate gas demand overnight – but it raises the bar. The sector will increasingly be judged by how quickly it can reduce emissions intensity and demonstrate alignment with climate mitigation pathways.

Weiji Six: Climate Governance Shifts- Momentum or Retraction?

Recent developments in international climate governance highlight another structural *weiji*. The US not only withdrew from the Paris Agreement again, but also from the overarching United Nations Framework Convention on Climate Change (UNFCCC), signalling a step back from multilateral climate engagement. While such moves do not automatically determine global outcomes, they can influence the pace of international coordination, the consistency of emissions reporting frameworks, and the credibility of collective commitments.

Reduced policy alignment among major economies may lengthen the global mitigation pathway by weakening coordinated pressure for emissions reductions. At the same time, many governments, subnational authorities, and private-sector actors continue to pursue decarbonisation strategies, and technical cooperation on clean energy remains active through multiple channels.

For the natural gas sector, the implication is uncertainty. If climate policy momentum slows in some jurisdictions, near-term natural gas demand and emissions trajectories could remain higher than I expected, particularly where energy security and affordability concerns dominate. However, uneven policy implementation could also increase market complexity, creating a fragmented environment where natural gas suppliers must meet very different regulatory and emissions standards across importing regions.

In this sense, shifting climate governance can simultaneously reinforce near-term natural gas demand while increasing long-term uncertainty about the durability of global market access.

Conclusion: Don't Waste a Good Poly-Weiji

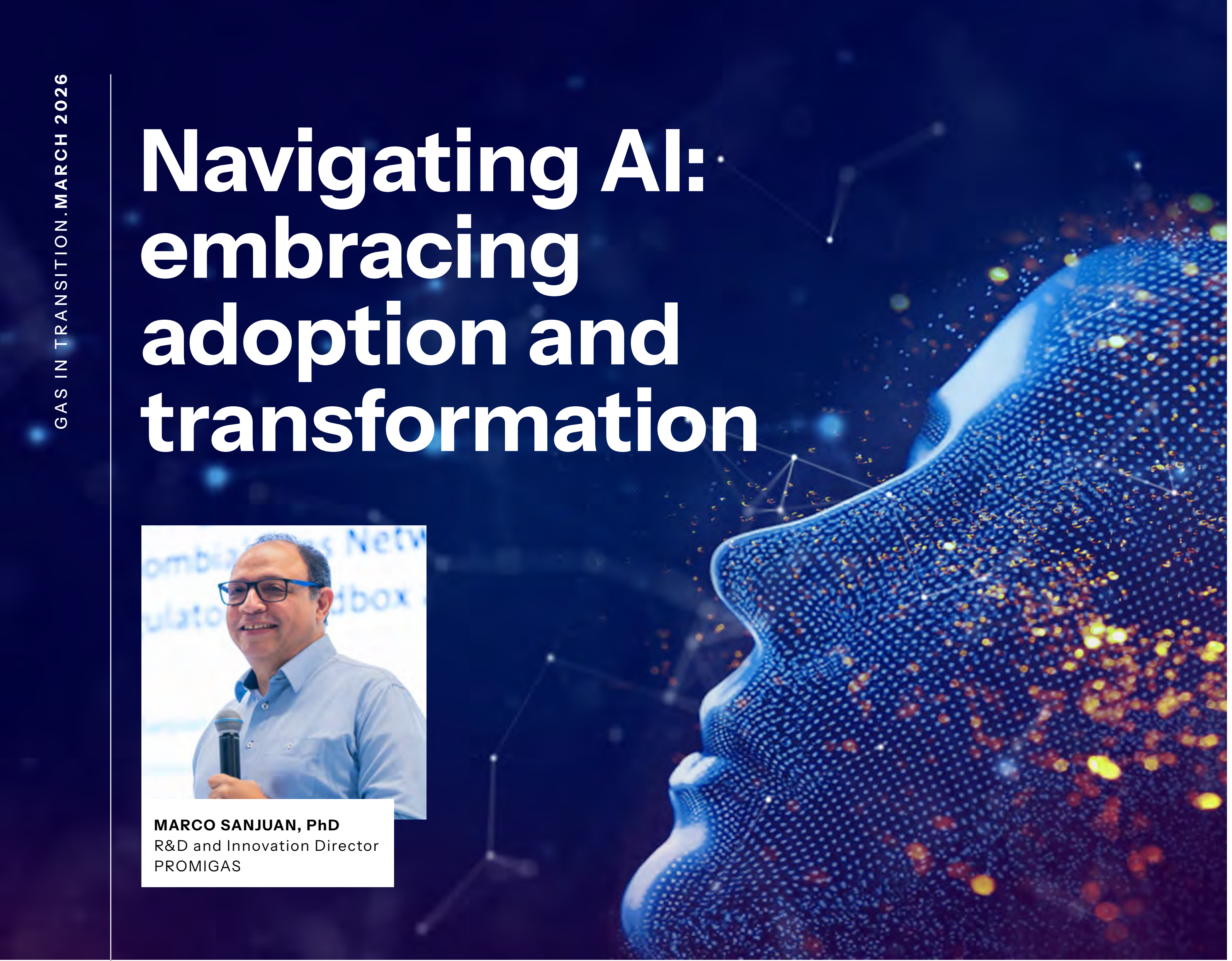
The natural gas sector sits at the confluence of structural pressures: climate imperatives, geopolitical realignments, technological disruption, and shifting demand shaped by electrification and digital growth. These are not transient shocks. They are defining conditions of the next decade and beyond.

Natural gas can no longer rely primarily on the argument that it is simply cleaner than coal. While that remains technically accurate, it is increasingly insufficient. Future viability will depend on natural gas systems demonstrating credible compatibility with decarbonisation pathways, measurable methane performance, and transparent emissions accounting.

Opportunities remain substantial: LNG expansion, coal displacement in emerging markets, rising energy access needs across the Global South, and reliable power supply for digital economies. Yet these opportunities narrow if methane remains unmanaged, carbon capture is not scaled, and emissions transparency lags behind policy expectations.

The core strategic imperative is therefore straightforward: don't waste a good *poly-weiji*. Disruption creates rare windows when market structures, investment flows, and policy priorities can shift rapidly. If the natural gas sector uses this moment to reduce methane leakage, scale credible mitigation pathways, and align infrastructure with lower-carbon systems, it can remain a durable component of evolving energy systems.

If it does not, the *poly-weiji* will resolve more toward danger than opportunity – leaving natural gas increasingly exposed to regulatory risk, investment retreat, and declining social licence. The race for relevance is underway. Whether natural gas finishes strong will depend on performance, not narrative. ●



Navigating AI: embracing adoption and transformation

MARCO SANJUAN, PhD
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PROMIGAS

Just as Jules Verne flooded the minds of readers in the 1800s with mechanical devices beyond his age, Isaac Asimov challenged the boundaries of reality in the 1900s with a world where intelligent machines coexisted with humans. Not surprisingly, you can always count on literature to depict humankind's greatest dreams, ambitions, and even fears. Just as well, you can always count on science to bring those farfetched dreams – and nightmares – to the doorsteps of today.

Making machines think

In the Dartmouth Workshop in the 1950s – before the era of silicon and microchips – the term "artificial intelligence" was coined by John McCarthy to make reference to the "thinking machines" described by Alan Turing as those capable of sustaining a conversation indistinguishable from one of a human. In 1957, Frank Rosenblatt created the "Perceptron" the first artificial neural network, a classifier trained with automated learning. Today, neural networks are the core learning mechanism used to train LLMs (large language models) supporting generative AI interfaces used by us daily. Since the "perceptron", and until 10 years ago, many artificial intelligence techniques have been developed, deeply studied, implemented, and deployed in niche applications, following these same stages in most cases.

From search to genetic algorithms, from fuzzy logic to reinforcement learning, there had always been a slow adoption curve – most of the time with great efforts – of AI-based solutions. One of the most relevant roadblocks for faster adoption was the fact that the effectiveness of the implementation was highly correlated with the depth of understanding of the given technique. AI experts were not an optionality; they were one of the foundational pieces of the projects.

And these AI techniques made it to our homes, factories, and refineries. Digital communication with neural networks, video cameras and washing machines with fuzzy logic, and major industrial automation providers adding AI tools to their DCS platforms. Included AI capabilities were mostly expert systems, fuzzy logic, and neural networks, which started being implemented in the late 1990s, making our lives better and generating profits for our companies.

In all these times, from the 1950s to the 2010s, evolving AI applications were believed to have a role, and perform better than humans in segmentation, forecasting, pattern recognition, natural language processing, search, and machine vision, always with one "unreachable" human feat of intelligence: creation, human-like content generation.

The age of generative AI

All this started to change – without most of us realising it – when the team from Google Brain and Google Research published in 2017 a new technique – the transformer architecture – adding a feature called "self-attention" to the training process of neural networks that greatly increased the model's ability to understand complex relationships and large volumes of data, and produce human-like content, leading to what is called Generative AI.

How powerful was this change? Well, let's just say that for decades the discussion of ethics in science was centered on whether cloning of cells was acceptable or what type of compounds should be tested on animals. Now, we are witnessing disagreements about the use of AI in autonomous weapons or mass surveillance, and governments are starting to discuss protections from mass automation and embedded bias in AI systems. One could say that this is a new AI "phase", but the size of the expected impact can be better characterised by saying that we are transitioning to a new AI world.

Navigating this AI world requires us to face challenges and opportunities as individuals and company leaders. The search for the "recipe for success" in this journey is a massive quest, and predicting what the final destination will look like may require Verne's and Azimov's creativity. So instead of trying to split the good from the bad, we could guide our journey with four key elements of this new reality.

People first: Individual adoption is moving faster than corporate plans: employees started using GenAI at work before companies regulated them, and without company-led training. This is creating AI-first individuals, those whose go-to mode is to use AI at every turn, and AI-last workers, who pursue AI as a last resource. The same could be said about companies and competitors. The expected outcome could be a major performance gap with social and economic impacts. A people-first approach means that developing AI understanding, competencies, and adoption among our workforce should be an intentional, high-priority effort, because companies will move at the speed of their people, and the economy is merciless when picking winners and losers.

Universal AI: AI will soon be embedded in most devices and systems, which will lead companies to reassess their network of suppliers and products. Getting the "AI advantage" means understanding not only current pros and cons in commercial solutions but learning about the AI strategy and future pathways of suppliers and partners of critical technology. How well-prepared companies are to buy smart beyond the simplistic cost and time analysis will determine their ability to acquire the AI-edge.

Value-driven: Advancing in the AI world is not a choice between chaos or inaction. While two years ago experimenting with GenAI in everything was a reasonable learning path – and could still be the case in the AI productivity assistants' sphere – industry scale solutions such as end-to-end processes, customer service functions, or AI-native new products, require disciplined investment with a clear value-driven proposition. As centralising all AI-related decisions is impractical, a company's ability to establish a framework for idea-to-development-to-value of AI solutions will be essential for the efficient use of the critical resources of this new world: employees' time, computing cost, and data usage.

Specialise and conquer: Not all AI is created equal, and we may not need to choose, rather have alternatives. Just as we use several LLMs for different tasks, the trend is to have a "platoon" of general models for AI solutions and SLMs (small language models) that cannot tell you how many threads are in a bolt but know your customer data by heart – while using much less power than LLMs. Similarly, in the world of agentic AI, digital units making decisions or performing tasks, a company's ability to differentiate, govern, and deploy micro-agents to support an employee, scalable function-oriented agents for a broader population, and AI digital workers that collaborate with humans and other agents, will determine how much true transformation can be achieved.

Just as the old AI was used and enhanced to create the new AI, the successful companies of the future will leverage their existing knowledge and experience, embrace the challenge of AI adoption and transformation, and create a new piece of the future for all of us to thrive. ●

Driving multi-energy digital acceleration: an interview with TotalEnergies

For the French major, AI and data products must be deployed as part of a well-thought-out digitalisation strategy.

ANNA KACHKOVA

CATALINA SAÉNZ
Digital Transformation Officer, Gas, Renewables & Power Branch, TotalEnergies

ALEXANDRA LAMOUROUX
Chief Information Officer for Trading, TotalEnergies

Oil and gas companies are embracing AI and other digital tools in an effort to boost performance, increase efficiencies and reduce emissions, among other goals. In order to do this effectively, they need to identify where digitalisation brings the most value to their organisations and co-ordinate the roll-out of digital tools across multiple divisions. The larger the company, the more complex this task becomes, and while AI and data products can help navigate this complexity, having a well-thought-out digitalisation strategy in place is essential. For supermajors, it is a particularly significant undertaking.

France's TotalEnergies, with a presence in roughly 120 countries, says it has been leveraging data and AI since the 1990s to help increase oilfield production and improve maintenance at its facilities. These tools have since evolved considerably, particularly in recent years. Now, TotalEnergies says they play a "critical" role in optimising its industrial operations and reducing the environmental footprint of those operations while also providing new ways of meeting customer needs.

In order to support these efforts, TotalEnergies has partnered with various companies in recent months, including with Mistral AI on the acceleration of AI innovation and with Emerson's Aspen Technology business on large-scale industrial data collection across its operational sites.

In addition, TotalEnergies has established OneTech, a technical, digital and scientific global centre, set up in 2021 to support all of the major's business units and drive technological innovation across its entire energy mix.

GRP's digital acceleration

TotalEnergies' Gas, Renewables & Power (GRP) Branch Digital Transformation Officer, Catalina Saénz, a member of the OneTech Digital Line at the service of GRP, says her role is carried out in close collaboration with all the teams in OneTech.

"My role is to drive the company's multi-energy digital acceleration into the GRP Branch – spanning data strategy, industrial digitalisation, AI deployment and workforce adoption of new technologies," Saénz tells *Gas in Transition (GiT)*. "This includes steering, in line with GRP Business strategy, our Digital Factory, Integrated Power Modelling [IPM] platforms, partnerships ecosystem, industrial data platforms and the strategic use of AI to improve performance, safety, sustainability and operational efficiency."

GRP's strategy is to industrialise data and software across the power value chain, Saénz says, adding that the branch prioritises business outcomes such as operational safety, asset design and performance, portfolio optimisation, and customer operations while converging technological building blocks including data foundations, AI, and the Internet of Things (IoT).

"Our north star is a differentiating roadmap of products – data and software – that sustainably scales across different power markets enabling GRP to capture value," Saénz says.

Progress to date includes the launch of TotalEnergies' digital and data transformation programme for the electricity business, known as eSpark, in 2024. The programme aims to connect and modernise the entire electricity value chain – from renewable generation to market trading – by using harmonised, high-quality data, Saénz explains.

"With eSpark we move from siloed information to real-time, actionable insights – unlocking value in operations, trading and strategy," Saénz says. She goes on to describe eSpark as a "cultural shift" to small multidisciplinary squads, agile ways of working, and a shared digital language across GRP.

The shift away from siloed information is one of the key changes to TotalEnergies' approach that have been brought about by new technologies, Saénz says, "The organisation of our data into data products makes data trusted, resusable and ready-to-use."

The other changes highlighted by Saénz include the use of differentiating models to capture value from the power value chain more competitively. As part of this, AI now plays a significant role in the IPM programme, which develops advanced design, simulation, forecasting and optimisation tools to support the company's growth in electricity. And the use of agentic AI is another significant change, shifting TotalEnergies' focus from "assistive analytics" to workflow orchestration and decision execution.

Saénz and TotalEnergies' Chief Information Officer for Trading (OneSI), Alexandra Lamouroux, cite a number of specific digital tools adopted by TotalEnergies as having a measurable impact on performance. These include a 36-hour renewable power forecast digital tool that helps traders and operators to optimise maintenance scheduling, limiting value and power loss.

The company also deploys the D+1 CCGT production capacity forecast digital tool, which uses machine learning to analyse how assets behave in the field, highlighting performance gaps and enabling operators and traders to make better-informed decisions, and reduce imbalance costs, according to Saénz and Lamouroux.

Meanwhile, SmartBrokerCurves is an AI-based tool that aggregates content from exchanges →

between traders and their counterparts to more easily identify opportunities for over the counter (OTC) deals at the best price. And OMAHA is an AI-based tool that monitors news to allow a real-time analysis of the credit risk of TotalEnergies' counterparties, Lamouroux tells *GiT*.

TotalEnergies uses a prioritisation model to decide the rolling out of digital technologies, pre-framing ideas to account for aspects such as value creation, scalability, data/IT readiness, cyber and run costs, as well as cross-country reusability. Depending on the effort involved and the type of technology required, an idea will pass through different decision gates before being approved for development, according to Saénz.

"As part of the continuous improvement, we currently see this prioritisation model evolving thanks to the democratisation of the development tool," Lamouroux says. "Increasingly, our business comes with citizen development as they implement to test their ideas and assess more concretely the value before we move to an industrialisation cycle in the digital and IT teams. This process was applied for SmartBroker Curve and OMAHA."

Bringing value to Gas

Digital tools can help companies with the functioning of highly complex, integrated models and businesses. TotalEnergies' integrated power business model combines renewables, flexible assets, storage, trading and customers in an integrated value chain.

"Natural gas – especially via CCGTs [combined cycle gas turbines] and LNG value chains – plays a strategic, risk-mitigating and flexibility-providing role in this model," Saénz says. "Digital is central in making this technically, economically and operationally feasible by synchronising dozens of inputs," she continues, adding that these can include weather, prices, asset constraints, grid data, contracts and forecasts, among others.

TotalEnergies' iPower data platform, built with eSpark, is seen as the backbone, aggregating renewables, flexible assets, trading, weather, markets and contract data into one validated place.

"This is complemented by advanced models developed by TotalEnergies' Integrated Power Modelling platforms and digital tools that accelerate data flows and decision-taking between operating assets (renewables or flexible), trading and the portfolio optimisation teams," Saénz says. This extends to areas such as planned maintenance, real time production, imbalance risks and price signals, among others.

"As a company, TotalEnergies has positioned itself as a **key energy partner in the decarbonisation of the data centre sector, providing tailored, low-carbon and reliable power solutions to major hyperscalers."**

CATALINA SAÉNZ, DIGITAL TRANSFORMATION OFFICER, GAS, RENEWABLES & POWER BRANCH, TOTALENERGIES

Overcoming obstacles

There are various obstacles that need to be overcome during the implementation of a digital strategy. For a company of TotalEnergies' size, achieving the necessary scale and harmonisation represents one of the key challenges, according to Lamouroux.

"We run similar businesses in diverse countries with diverse tools and maturity," Lamouroux says. "Harmonisation while keeping local (country) specificities (and careful budget arbitrage) is essential."

Data and product readiness represent another key challenge.

"Many use cases now require data with clear purpose, scope, access paths and change management," says Saénz. "We're standardising these via eSpark adoption patterns."

In addition, there are challenges such as making vendor or architecture choices, with Lamouroux noting that TotalEnergies enforces an "agnostic approach" and compares the options available to it. And, perhaps unsurprisingly, cyber and compliance is another key area of challenges to navigate, with new AI components having to undergo risk analysis.

The biggest challenge, however, is navigating change and technology adoption, says Saénz. This area requires important resource allocation,

"As part of the continuous improvement, we currently see this prioritisation model evolving thanks to the democratisation of the development tool"

ALEXANDRA LAMOUROUX, CHIEF INFORMATION OFFICER FOR TRADING, TOTALENERGIES

she notes.

"We invest in UX 'quick wins', run adoption squads, and institutionalise recurrent forums (e.g., lunch and learn) to foster awareness, understanding and adoption and unlock the value expected," Saénz says. "It also requires the development of digital skills in each one of the collaborators."

There has been concern over the impact that the increased adoption of AI and other digital products could have on the workforce, not just in the energy industry but more broadly. However, Saénz takes an optimistic view, saying that while she expects this shift to have an impact on the nature of work being done, she anticipates that jobs will change rather than disappear.

"The trajectory is role evolution rather than reduction," she says. "Our roadmap explicitly emphasises skills adaptation, talent pools and acculturation, while our operating model expands roles such as Digital Business Leads, Product and Data Owners and citizen developers."

Bigger picture

While the digital transformation of energy companies is playing out, the growing uptake of AI more broadly is underpinning the boom in power demand from data centres. TotalEnergies estimates in its latest Energy Outlook, published in late 2025, that electricity demand from data centres accounted for nearly 3% of global electricity consumption in 2024 and is projected to rise to 6% to 7% by 2050. This is driven in part by the growing uptake of AI. TotalEnergies also expects that it will push up natural gas demand in the short and medium term.

"As a company, TotalEnergies has positioned itself as a key energy partner in the decarbonisation of the data centre sector, providing tailored, low-carbon and reliable power solutions to major hyperscalers such as Google, Amazon, Microsoft and Data4," says Saénz. "At the same time, AI is enhancing the efficiency of [natural] gas systems – from LNG scheduling to optimising CCGT operations and managing emissions. During the energy transition, [natural] gas continues to serve as a flexible complement to renewables, while AI helps reduce its environmental footprint, particularly through improved flaring and methane reduction pathways. Together, these dynamics strengthen Gas' role as a bridging energy source as TotalEnergies continues to scale low-carbon solutions." ●

How can foundational AI cut energy use and emissions in oil and natural gas?

DAN JEAVONS
President, Applied Computing

For more than two decades, oil and natural gas have invested heavily in digitalisation with the promise of greater efficiency and lower emissions. Too often, the results have been underwhelming. Many executives can point to expensive platforms, dashboards and pilot projects that never translated into sustained operational change.

That history matters. It explains why many leaders remain sceptical when AI is presented as the next solution to the sector's emissions challenge. Yet the reality on the ground is shifting. Not because oil and natural gas suddenly have more data, or because climate pressure has intensified – both have been true for years – but because the nature of industrial AI has changed.

We are moving from narrow, use-case tools to systems capable of reasoning across the physical and digital worlds. That shift makes a measurable reduction in energy use and emissions far more achievable than it was even five years ago.

The case for AI in oil and natural gas today is not about experimentation. It is about operational efficiency at scale.

Emissions are driven by how assets are run

Most methane emissions in oil and natural gas come from normal operations: equipment running slightly off design, energy systems drifting from optimal conditions, avoidable flaring during upsets, heat losses that accumulate over time, and leaks that persist unnoticed for months.

These losses are rarely visible in headline metrics. They are embedded in day-to-day decision-making – in how set points are chosen, how maintenance is prioritised, and how operators respond to early warning signs.

This is why traditional emissions reporting has limited impact. Looking backward tells us what happened, but not how to prevent it happening again. Cutting emissions at pace requires continuous operational insight – and the ability to act on it.

AI-enabled optimisation allows operators to balance production, energy use and emissions simultaneously, rather than treating them as competing priorities.

Why previous digitisation efforts fell short

Past digital programmes struggled for three reasons. First, they optimised for data availability rather than operational outcomes. Creating centralised data platforms did not change how engineers and operators worked. In safety-critical environments, tools only create value when they are embedded directly into operational workflows.

Second, digital initiatives mirrored organisational silos. Reliability, maintenance, process engineering and safety each deployed their own tools, drawing on a fraction of the available data. Emissions, which cut across all of these functions, were treated as a reporting problem rather than a systems problem.

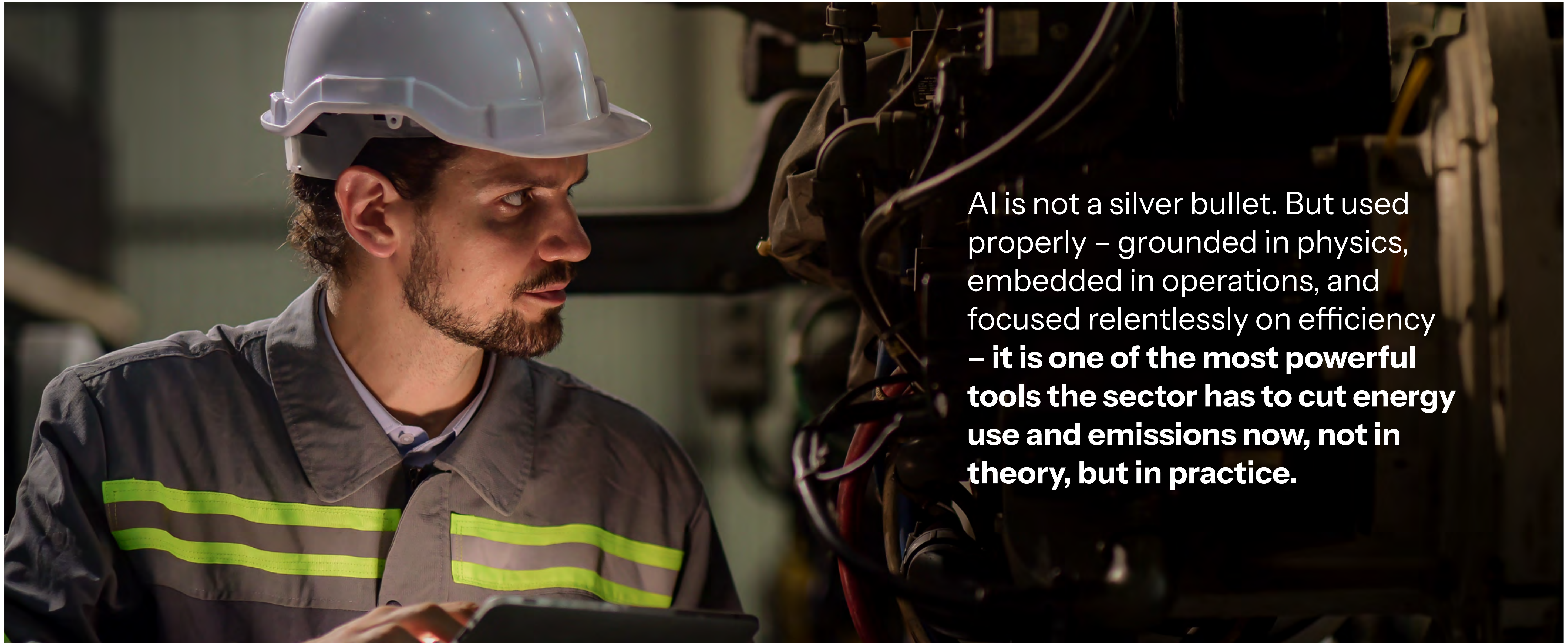
Third, the AI itself was limited. Statistical models delivered predictions but lacked explainability; physics-based models offered insight but were costly to build, brittle to maintain and time consuming to run. None of which was well suited to complex, evolving operations where trust is essential.

As a result, many programmes stalled at pilot stage – interesting, but not transformative.

Why AI can now cut energy use and emissions

The difference today is not incremental improvement. It is a structural shift. Modern industrial AI is increasingly built on foundation-style models that can reason across three domains at once: time-series behaviour, physical constraints, and engineering language. This matters because energy use and emissions are not single-variable problems. They emerge from interactions between processes, equipment, and human decisions.

By understanding these interactions, AI can identify inefficiencies that were previously invisible: subtle process drift that increases energy intensity, early indicators of equipment degradation that lead to methane leakage, or operating regimes that trade short-term throughput for long-term emissions penalties. →



Crucially, these systems do not sit outside operations. When designed properly, they work alongside control systems, maintenance planning and engineering workflows – supporting decisions rather than issuing abstract recommendations.

This is the point at which AI stops being an analytics tool and becomes an operational one.

Methane illustrates the opportunity

Methane offers a clear example of how AI and digitalisation can deliver rapid emissions reductions.

As a greenhouse gas, methane is around 28 to 30 times more potent than CO_2 over a 100-year period, making even small leaks highly consequential. At the same time, natural gas plays a critical role in lowering emissions when displacing more carbon-intensive fuels, generating around 50% to 60% fewer emissions than coal in power generation. This dual dynamic – high impact if released, but lower emissions when used efficiently – makes methane both an urgent problem and a powerful opportunity for targeted intervention.

Detection technologies have improved dramatically, from continuous sensors to aerial and satellite monitoring. But detection alone does not cut emissions. What matters is what happens next: prioritising repairs, understanding root causes, and preventing recurrence.

AI enables this by correlating emissions events with equipment history, operating conditions and maintenance activity. Crucially, much of the challenge lies in so-called "fugitive" emissions – small, often intermittent methane leaks that are individually minor but collectively significant. These leaks are typically straightforward and low-cost to fix when identified early. By distinguishing persistent issues from one-off anomalies and forecasting where leaks are most likely to occur next, AI helps operators prioritise limited resources and intervene early, where remediation is simplest and impact is greatest.

Given methane's disproportionate warming effect in the near term, these capabilities represent one of the fastest ways for the sector to deliver meaningful climate gains – often at low or even negative cost.

Energy efficiency and resilience go hand in hand

Reducing energy use is not just a climate objective, it is a resilience strategy. Lower energy intensity reduces exposure to fuel price volatility, improves profitability, extends asset life and improves reliability. In an era of geopolitical uncertainty and tightening margins, these benefits matter.

AI-enabled optimisation allows operators to balance production, energy use and emissions simultaneously, rather than treating them as competing priorities. Over time, small efficiency gains compound, delivering structural reductions in both operating cost and emissions.

The leadership question

The remaining barrier is not technology. It is execution.

Leaders should be clear-eyed about what to demand from AI initiatives. The right question is not "does this use AI?" but "does this change how our assets are run?" and "how will I use this to rethink my operations?"

If digital systems do not integrate across operational silos, respect industrial change control, and deliver explainable insight that engineers trust, they will repeat the mistakes of the past. If they do, the upside is substantial.

Oil and natural gas will remain part of the global energy system for decades. How efficiently and cleanly it operates during that time will shape both its climate impact and its social licence.

AI is not a silver bullet. But used properly – grounded in physics, embedded in operations, and focused relentlessly on efficiency – it is one of the most powerful tools the sector has to cut energy use and emissions now, not in theory, but in practice. ●

Regional Update

Europe

Gerald Linke PhD
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Germany

A winter of stress tests: low natural gas storage, record LNG, and rising pressure for revised RFNBO (Renewable Fuels of Non-Biological Origin) rules

Europe's energy system in 2025/26 reflects a market in transition: more diversified and fundamentally reshaped, yet still operating with limited safety margins. A colder-than-expected winter puts natural gas storage resilience to the test, while record LNG imports underscored the continent's shift away from Russian pipeline gas. At the same time, renewable molecules are moving closer to commercial scale. But rising costs and regulatory bottlenecks have reignited debate over Europe's hydrogen and e-fuel framework, highlighting the complexity of balancing climate ambition with market realities.

1. Low gas storage levels amid cold winter

As Europe moves into the final stretch of winter, natural gas storage levels are running noticeably low. Two main factors are driving this trend: to begin with, Europe entered the winter with lower storage levels of roughly 82%, compared to about 94% the previous year. This drop reflects the EU's decision to lower the mandatory storage requirement from 90% to a minimum of 75%.

Adding to the pressure, an unusually cold winter has led to higher natural gas consumption. If low temperatures persist, storage sites could finish the season at historically low levels. While supply security remains stable for this winter, the central challenge will be refilling storage ahead of next winter. Starting from a much lower baseline than in previous years, Europe will need to inject significantly larger volumes of natural gas over the summer to return to high storage levels next autumn.

2. LNG remains Europe's main backup

The year 2025 confirmed a long-term structural change in Europe's natural gas supply. With Russian pipeline deliveries sharply reduced, LNG became the main flexible supply source for the region. This led to Europe recording its highest ever LNG import volumes during 2025.

Since the beginning of 2022, Europe's LNG regasification capacity has increased significantly. While usage varies across region, with some terminals heavily used and others less so, the system as a whole now offers far greater flexibility and diversification than in the past.

Looking ahead, a global wave of new LNG liquefaction capacity expected between 2025 and 2030 will further strengthen Europe's position. This additional supply should make it easier to attract cargoes during periods of tight demand, even if competition from other regions continues to shape pricing and market dynamics.

3. Renewable molecules gain momentum

While LNG strengthens short-term supply security, renewable molecules are increasingly defining Europe's long-term energy strategy. Across the continent, projects are moving from pilot stage to industrial scale, showing that low-carbon fuels are steadily gaining ground in key energy and industrial sectors.

E-methanol: a Nordic step forward

In Denmark, the Kassø facility, Europe's first large-scale commercial e-methanol plant, continued ramping up production through late 2025. It supplies synthetic methanol produced from renewable hydrogen and biogenic CO_2 to the shipping sector and chemical industry. Sweden added further momentum, when Liquid Wind secured funding for a 100,000-tons/year e-methanol facility.

A further development arrived in October 2025 with the introduction of electric steam methane reforming (e-SMR), an innovative production process for e-methanol. Unlike conventional methods that rely on burning fossil fuels to generate high temperatures, e-SMR uses renewable electricity to heat the catalyst bed directly inside the reactor. This approach significantly reduces the energy required to convert biogas into methanol compared with traditional production routes. The first commercial 10 MW unit is expected to become operational in 2026.

Biomethane: continued investment, moderate growth

Biomethane continues to attract significant investment. By mid-2025, more than €28bn (billion) had been committed, projected to deliver 7.3bn m^3/year of biomethane capacity to Europe by 2030. Current national climate plans forecast biogas and biomethane production to reach 30-32bn m^3 by 2030. However, this still falls short of the 35bn m^3/year target set by REPowerEU. Bridging this gap will require stronger policy support and faster infrastructure expansion.

Hydrogen and ammonia: building import infrastructure

Europe is also advancing plans to import green hydrogen in the form of ammonia. Several major infrastructure projects progressed:

- Rotterdam's ACE Terminal continued preparations for receiving green ammonia and converting it into hydrogen for the Dutch Gas network.
- Antwerp's Fluxys-Advario advanced its ammonia terminal project toward the next engineering phase. It is recognised as a Project of Common Interest by the European Union.
- VTTI's Amplifhy concept continued planning ammonia import and cracking facilities in both Rotterdam and Antwerp.

At the same time, electrolyser deployment slowed. By July 2025, 571 MW was operational and 2.84 GW under construction. However, fewer new investment decisions were taken than expected.

4. RFNBO rules: requests for adjustment

Industry and policymakers have focused on Europe's rules for renewable hydrogen and e-fuels. In December 2025, Members of the European Parliament called for a review by mid-2026, warning that strict requirements such as hourly matching could delay or even stop projects before they start. At the same time, a report by the European Commission Joint Research Centre concluded that synthetic fuels including e-methanol, e-ammonia, and e-kerosene are largely technologically ready. The main obstacle is no longer technology, but cost: high hydrogen prices continue to limit their competitiveness in the market.

5. Outlook for 2026 and beyond

Overall, Europe's energy system has proven resilient through the winter, but the months ahead will be critical. An early and decisive summer storage refilling strategy will be essential to ensure supply security for the next winter. At the same time, LNG capacity must be managed strategically amid ongoing global competition, and clearer RFNBO rules are needed to unlock hydrogen and e-fuel investment at scale. ●

"Overall, Europe's energy system has proven resilient through the winter, but the months ahead will be critical."

GAS IN TRANSITION.MARCH 2026

Data centres, electricity growth and the potential next wave of natural gas and LNG demand

Surging data centre loads are tightening grid constraints and underpinning potential long-term growth in natural gas and LNG demand.

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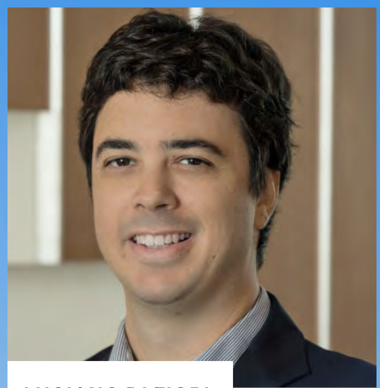
Partner, McKinsey & Company



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As the world embraces artificial intelligence, data centres are becoming a major source of electricity demand. By 2030, global data centre electricity demand could more than double compared to current rates, with installed generation capacity reaching around 220 GW, growing at roughly 22% each year *(Exhibit 1)*.

Solutions for growing power demand

Data centres are big, fast growing and require firm electricity supply. This places a premium on assured capacity and system resilience – at a time when renewable energy sources are becoming more prevalent in many regions globally, and the need for energy security has never been more pressing.

While new data centre capacity is often added in increments, it can create sudden surges in local demand that outpace network reinforcement. Grid constraints are becoming a critical factor as a result, extending time-to-power for many data centre developments. Even in Tier-1 markets, time-to-power can now be as long as two to five years.

With renewables increasingly expected to supply a growing share of new electricity demand, their inherently intermittent nature may not satisfy the around-the-clock consumption that data centres require. Where renewables build-out or grid connections lag, firm dispatchable capacity is needed.

Some developers are now assessing behind-the-meter solutions, including natural gas turbines, LNG-to-power or hybrid microgrids, alongside staged ramp-up arrangements. Storage and demand response solutions can help too, especially for short-duration balancing, but are not always enough where grids are constrained and the system needs multi-hour to multi-day firmness.

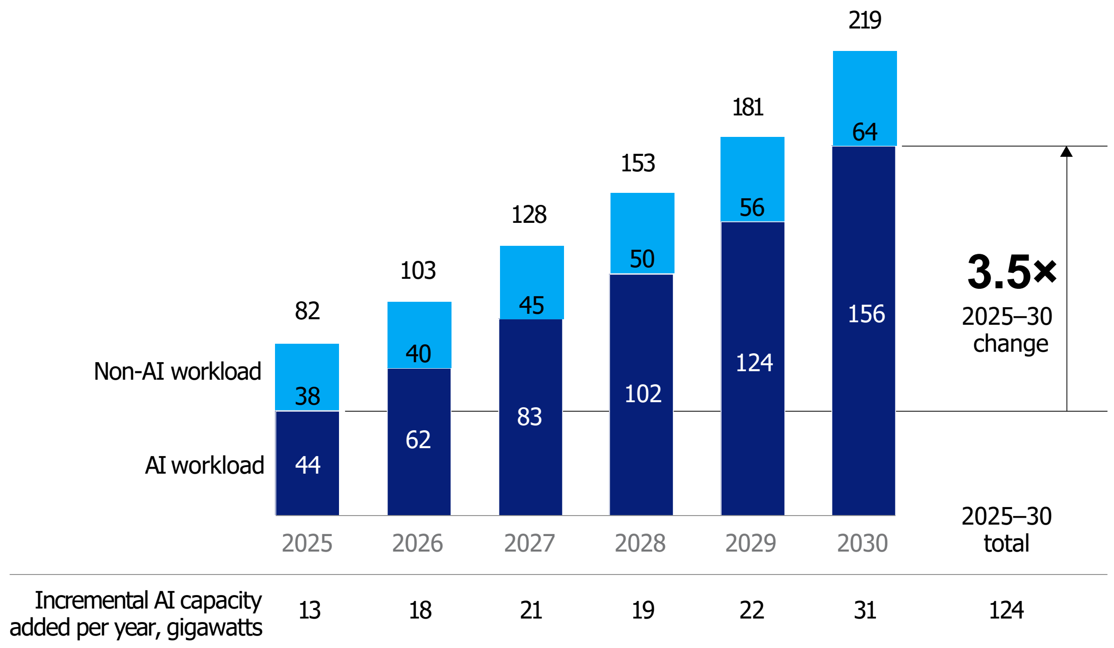
In many markets, natural gas could be a practical, flexible and reliable option to consider. It can provide dispatchable firm supply, ramping capability and grid support, while complementing renewables as they scale. For example, in the US, demand for roughly 3bn ft³/day – more than half of the additional natural gas demand for power – is expected to come from data centres.

Global natural gas demand is set to rise

According to McKinsey's *Global Energy Perspective 2025*, global natural gas demand is expected to increase by 10% by 2050 in the Continued Momentum scenario. Power generation is expected to be the largest contributor to this demand, accounting for 38% to 44% of total demand between 2030 and →

Exhibit 1. Both AI and non-AI workloads will be key drivers of global data centre capacity demand growth through 2030.

Estimated global data centre capacity demand, 'continued momentum' scenario, gigawatts

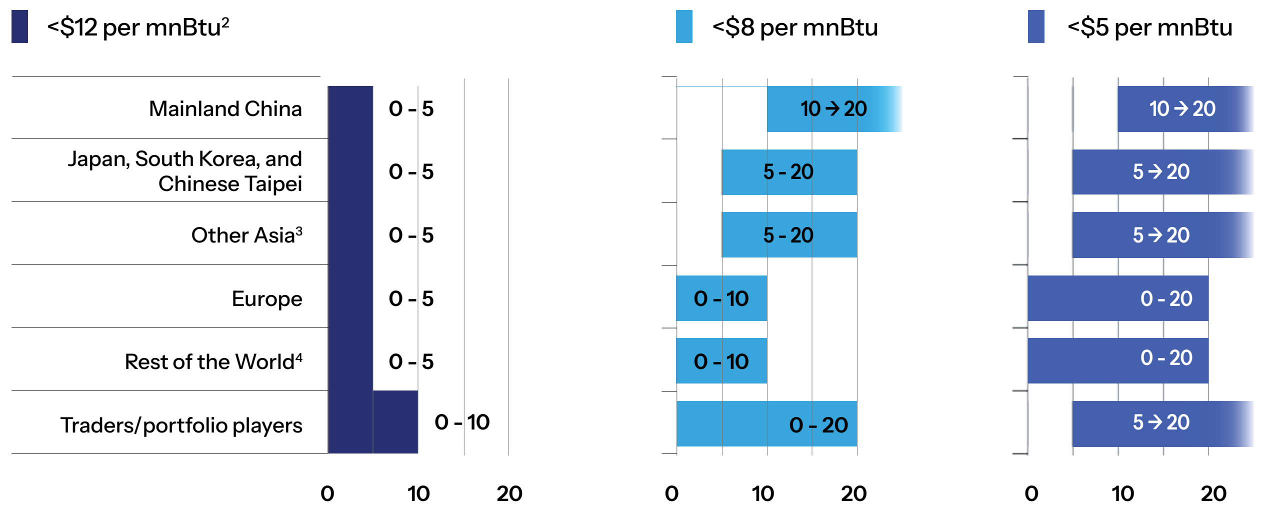


Note: Figures may not sum to totals, because of rounding.

Source: McKinsey Data Center Demand Model; Gartner reports; IDC reports; Nvidia capital markets reports

Exhibit 2. Liquified natural gas buyers expect softening prices to stimulate significant latent demand.

Additional liquified natural gas (LNG) demand expected, by LNG price threshold, 1 million tons per annum



1. Question: How much additional LNG demand could be unlocked in your region without major investments if prices fell?
2. Million British thermal units.
3. Australia, Bangladesh, Cambodia, India, Indonesia, Malaysia, New Zealand, Pakistan, Philippines, Singapore, Thailand, and Vietnam.
4. Brazil, Qatar, US, and other importing or producing countries in Africa, Middle East, and Latin America.

Source: McKinsey Energy Solutions LNG Buyers Survey 2025 (conducted in July 2025 with 41 participants)

2050, across all scenarios.

Regionally, natural gas demand is expected to grow fastest in Asia, driven by coal-to-gas switching and rising power needs, particularly in China, India and Southeast Asian markets. North American natural gas demand is also expected to grow significantly to 2040 and beyond, with additional demand from industrial users and data centres, even as renewables expand.

In Europe, the impacts of data centre growth on power demand are already being felt. The load from these centres is projected to increase from around 19 GW in 2023 to about 74 GW by 2030, creating concentrated pockets of demand for firm capacity in key hubs. However, this growing demand is expected to be relatively short lived, with European natural gas demand projected to trend downward after 2030 as decarbonisation accelerates, electrification expands and low-carbon alternatives scale.

Buyers are planning for continued LNG demand

Because much of the world's incremental natural gas demand is expected in Asian markets – which have constrained pipeline and domestic supply – additional power demand is likely to translate into higher LNG imports.

In our Continued Momentum scenario, LNG demand is projected to grow by about 65% through 2040 and potentially by up to 75% by 2050. Our analysis indicates that Asia is expected to remain the centre of gravity for LNG demand, with South and Southeast Asian markets standing out as major demand drivers, across all scenarios.

Buyer sentiment and procurement plans broadly align with this outlook. In our *2025 LNG Buyers' Survey*, conducted in July 2025, about 70% of the 41 buyers surveyed across 17 countries signalled an intention to secure both short- and long-term contracts in the next two to three years.

While the share of buyers considering long-term contracts is similar to our 2023 survey findings, interest in short-term contracts has risen by nearly 20 percentage points. In the Asia–Pacific region, that trend is even more pronounced, with 77% of respondents now intending to pursue short-term

contracts, an increase of nearly 40 percentage points since 2023.

Buyers also appear to see the period to 2030 as a favourable window for procurement. As additional projected supply capacity comes online, LNG buyers expect market tightness to ease, putting downward pressure on spot prices. Around 60% of survey respondents expect both TTF and JKM to stabilise in the $7/mnBtu to $10/mnBtu range by 2030. Only 15% to 18% expect prices below $7/mnBtu, while roughly 21% to 25% anticipate prices to exceed $10/mnBtu. Overall, expectations of a price collapse are limited, suggesting that latent demand could materialise should prices move below the $7/mnBtu threshold.

In line with this, buyers indicate that lower prices could unlock additional LNG demand, particularly in Asia. Chinese buyers, who show the greatest price sensitivity, report that coal-to-LNG switching becomes attractive at around $8/mnBtu *(Exhibit 2)*.

Buyers in other major Asian markets, including Japan and South Korea, anticipate potential demand upside in response to lower prices, too, though the wider ranges of reported volumes suggest greater uncertainty. Meanwhile, buyers in the rest of the world, including Europe, expect LNG demand to be less sensitive to lower prices – consistent with the expectations of declining long-term LNG demand in Europe.

What this means for powering data centres

A softer LNG market around 2030 could have wider implications beyond fuel switching. More competitive LNG prices and greater confidence in supply availability can support investment decisions for new power-intensive loads, especially in LNG-importing markets.

For data centres, where reliability and cost are critical, access to competitively priced gas could strengthen the case for natural gas-backed power solutions that provide firm capacity alongside renewables, including hybrid configurations where needed.

Over time, if data centre deployment accelerates in these regions, it could further reinforce natural gas and LNG demand in the power sector, underscoring the need to align infrastructure and contracting strategies with emerging sources of electricity load growth. ●

The rising call on natural gas to power the tech boom

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DANIEL MYERS
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A generational growth opportunity

The US power grid is experiencing a generational growth opportunity. AI-driven data centre developments, electrification trends in transportation and residential heating, and other large industrial loads – reshoring of semiconductor fabs, solar PV manufacturers and the like – are all contributing to steadily rising US power load growth for the first time in over a decade. Even as renewable generation sources experience significant growth in the power stack, the call for new baseload generation sources, particularly from natural gas, is clear.

Natural gas-fired power demand has seen steady growth over the last 15 years and is now the leading source of electricity generation in the US at between 40% and 45% of the power stack. Historically, natural gas has competed with coal for electricity market share amid relatively stagnant total generation demand. Since overtaking coal generation in 2016, natural gas' superior cost and emissions profile has allowed for accelerated coal-to-gas adoption as aging coal plants are retired and combined cycle gas turbines take their place.

Going forward, this dynamic persists but is importantly supercharged by the expectation of overall power load growth. Current proposals for over 500 data centre projects underpin Wood Mackenzie's substantial power generation growth expectations, even if many projects fail to move forward. As the largest driver of domestic natural gas demand growth in our long-term forecasts, Wood Mackenzie projects US natural gas-fired power demand to expand by over 25% by 2035.

Given the scale of expected natural gas demand growth in just 5 to 10 years, it requires concert between all areas of the natural gas value chain, from exploration and production to midstream pipeline operators to eventual end-users, to enable market growth while keeping costs competitive relative to alternative fuels. So, what is required for this new phase of natural gas demand growth?

For US LNG export developers, funding new pipelines is nothing new. Most of the first wave of LNG export projects developed or repurposed their own header pipelines to transport natural gas around the Gulf Coast.

Supply shifting to meet rising demand

Between 2010 and 2025, the US gas market nearly doubled in size due to the shale gas revolution and the corresponding adoption of horizontal drilling and fracking techniques. The market size went from 66bn ft^3/day to 113bn ft^3/day over 15 years, yet Henry Hub prices nearly halved from US$6.40/mnBtu (2025 real US$/mnBtu) to US$3.50/mnBtu.

Over this period, supply growth rotated between production basins, mostly driven by which regions had lower costs and pipeline access. At various times, the Bakken in North Dakota, Appalachian Basin in the Northeast, Permian Basin in West Texas, and Haynesville in East Texas and North Louisiana all took turns carrying the mantle for US production growth.

Now, with core shale plays well-known and existing infrastructure largely utilised, Lower 48 States exploration is making a comeback to satisfy the market's rapidly expanding demand requirements. Producers have recently stepped out into the nascent Western Haynesville in East Central Texas, and there are signs that activity in dry gas regions of the Permian and Eagle Ford of South Texas is becoming increasingly attractive.

These resources are being tapped largely to support nearby LNG export projects on the US Gulf Coast, but large power loads have started to compete for the same supply, such as Chevron's proposed 2.5 GW power plant in the Permian. Meanwhile, US independent Gas producers like PureWest and EQT have signed natural gas supply contracts specifically to power data centres outside the Gulf Coast, as geographically disparate power demand growth enables natural gas production growth in the Rockies, Northeast, and elsewhere.

Furthermore, new players are getting involved. JERA, Japan's top power generator, and major Japanese conglomerate Mitsubishi have both taken large stakes in the Haynesville to hedge their LNG supply offtake but have extended their value chain exposure with power generation assets in the US to support data centre growth.

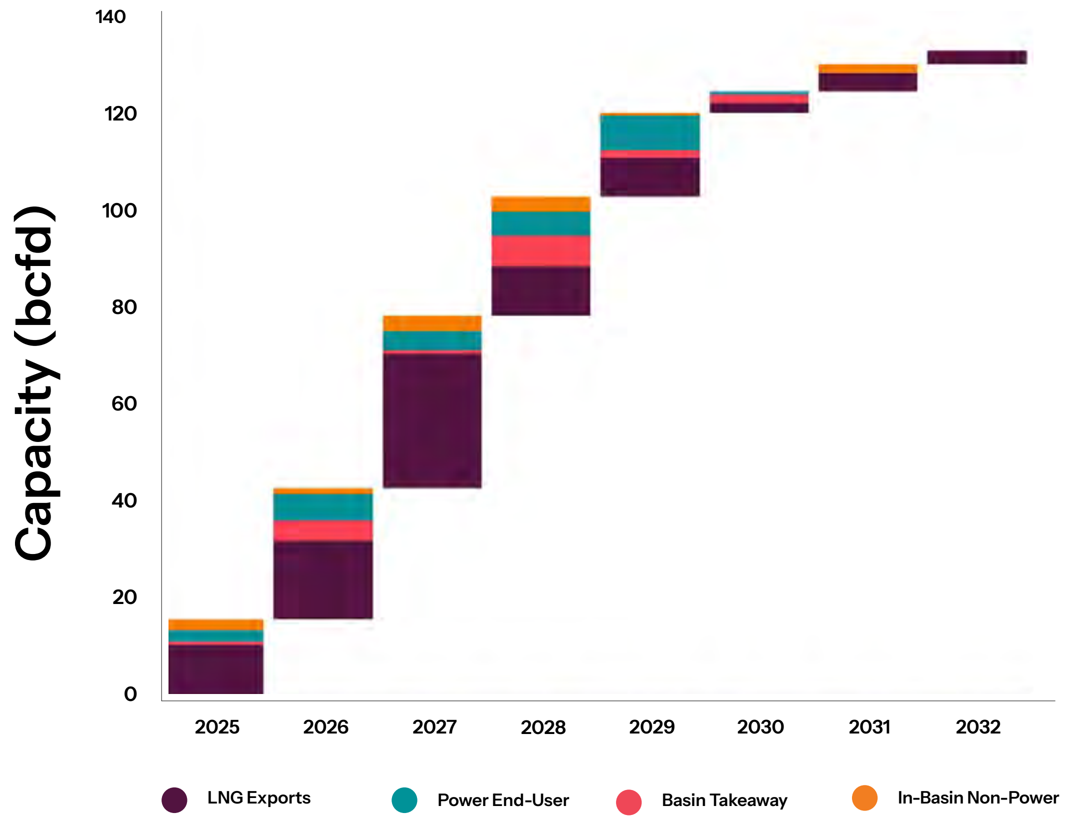
Demand-pull shaping midstream development

While natural gas output has surged over the last 15 years, natural gas pipeline development has been the unsung hero in keeping prices stable. During that time, midstream operators largely followed upstream development to connect low-cost resources to markets: Midcontinent and Rockies in the late 2000s, the Northeast in the 2010s, or Haynesville and Permian in the early 2020s.

But it has not always been smooth sailing for the midstream sector. Many pipeline projects faced regulatory and judicial scrutiny – particularly interstate projects in the Northeast – which often led to substantial cost overruns or eventual cancellations. However, more recently, as the magnitude of investment ready to flow into data centres, manufacturing, and LNG exports has become clear, bipartisan support for infrastructure permitting reform is emerging.

Under US President Donald Trump's administration, supportive policy measures are being introduced across various branches of government. The recent Supreme Court decision to limit the scope of the National Environmental Policy Act (NEPA), regulatory changes from the Federal Energy Regulatory Commission (FERC), and proposed →

Figure 1. New US pipeline development announcements by category



Source: Wood Mackenzie

permitting reforms in the US Congress will be critical to unleash more pipeline and power infrastructure buildout in coming years.

Another piece of the puzzle comes in the form of pipeline contracting *(Figure 1)*. Historically, it was largely natural gas producers who committed to long-term firm transportation (FT) agreements and enabled their development. Often, producers sought access to better markets to avoid rock-bottom in-basin prices, while end-users remained reluctant to fund new pipeline capacity. However, this is beginning to turn on its head. For many end-users, having access to low-cost supply and securing year-round firm capacity are top priorities for fuel gas reliability. The US LNG export industry and power utilities now both standout for driving new pipeline proposals.

For US LNG export developers, funding new pipelines is nothing new. Most of the first wave of LNG export projects developed or repurposed their own header pipelines to transport natural gas around the Gulf Coast.

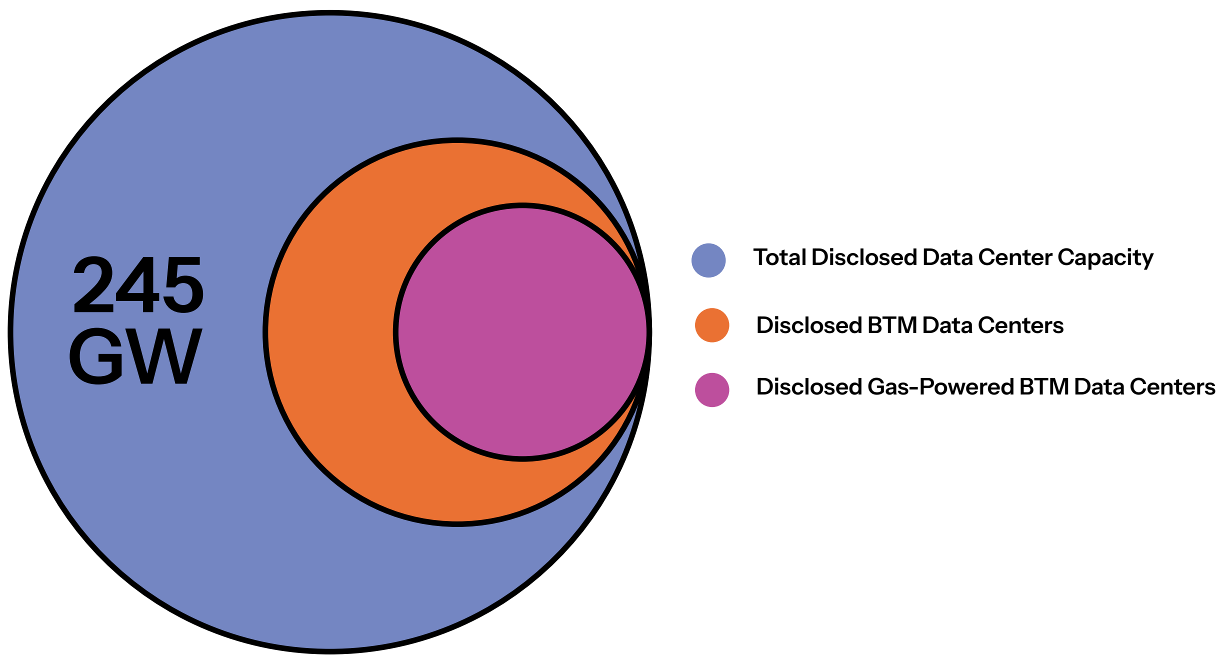
However, for the power industry, it is a different story. Power developers have traditionally struggled with contracting for FT on pipelines, given the high burden of take-or-pay contracts and long-term commitments, which conflict with their short-term power dispatch decisions. But we're starting to see power end-users take pivotal roles in funding pipeline development.

Arizona Public Service and Salt River Project are anchor shippers on the Transwestern Pipeline's Desert Southwest expansion project, and Mountain Valley Pipeline is seeking permits for a potential 0.5bn ft^3/day expansion of its Southgate Extension, which is anchored by Enbridge Gas North Carolina and Duke Energy. This could mark a return to the demand-pull model for midstream development that fell out of favour since the early days of shale gas.

If hyperscalers and other major technology companies start contracting for pipeline capacity to power their own facilities, this would provide midstream developers with even more creditworthy counterparties.

One way this might advance is through behind-the-meter (BTM) generation arrangements. Despite hyperscalers' strong preference for grid power, market bottlenecks, particularly around interconnection, are impacting the pace of development. BTM natural gas power generation *(Figure 2)* has has emerged as a strong contender for data centres in regions with abundant natural gas resources but insufficient pipeline exit capacity or an already congested transmission grid. In these cases, by siting large loads near natural gas production sources – say in the

Figure 2. Data centre disclosures by category



Source: Wood Mackenzie

Appalachian Basin or West Texas – BTM generation can be a reliable generation alternative while accelerating project timelines.

Arrayed against these benefits are challenges regarding natural gas turbine supply chains, onsite operational complexity, hyperscaler Scope 1 emissions, and a constantly evolving regulatory landscape. Even so, Wood Mackenzie expects more BTM projects to become reality in the coming years as the pace of grid connectivity comes into question and federal, state, and Regional Transmission Organization rules begin to align in support of bring-your-own-capacity models.

What does this mean for the natural gas market?

The scope of the opportunity for natural gas market expansion, both for power generation and in industrial and LNG export demand, will require rethinking of the natural gas value chain from top to bottom.

For natural gas producers, efficiency and restrained capital spending will reduce costs and keep resources economic in an aggressively expanding market. For midstream developers, while they are guaranteed to be busy with new opportunities, new types of customers also introduce risks of cost overruns, misdirected investments, or counterparty risk. For end-users like LNG developers, it will be necessary to extend their reach further into supply basins to lock in low-cost feedgas as Gulf Coast demand competition intensifies. And for power producers, utilities, and data centre operators, rethinking long-term pipeline commitments or even direct, off-grid natural gas generation arrangements can provide both long-term supply security and quick-to-market solutions, depending on the situation.

Natural gas power demand growth is not without challenges. Limited natural gas turbine manufacturing capacity and order backlogs stretching three to five years, as well as an exuberance in data centre proposals and uncertain financing for second-tier developments, place into question the timing and eventual magnitude of natural gas-fired power growth expectations. Additionally, power generation will need to compete with other sources of natural gas demand increases, as discussed.

Much about coming power load, and corresponding natural gas generation growth, is uncertain. But in an increasingly interconnected energy system, it is more critical than ever to understand the risks and opportunities across all market segments. More and better intelligence – connected by world-class data and research – is paramount to navigate the changing power and natural gas market landscapes. ●

Natural gas in the Age of AI: Scaling reliable power for data centres at record speed

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Senior Director, Heat & Power, GTI Energy

The accelerated demand for power, including natural gas-fired generation, is reshaping load profiles in ways that are faster, sharper, and more mission-critical than those natural gas systems were previously built to serve. By meeting this moment with modern, flexible, lower-emissions solutions that are fully integrated with storage and controls, natural gas can become not just the bridge to more power, but the backbone of a more reliable and interoperable energy system.

The speed to power accelerates

Demand for natural gas to support AI-related power needs accelerated through 2025. The global expansion of AI infrastructure, particularly in the US, is unprecedented. Market assessments, including National Laboratory of the Rockies' (NLR) Speed to Power geospatial database and the Uptime Institute's tracking, show that projected data centre power demand has doubled since 2023. Electricity required for AI inference has grown nearly tenfold over the same period; and US data centre vacancy rates have dropped to just 2.6%.

For GTI Energy, which is headquartered within a top ten global data centre market, this growth is visible locally. Multiple 20+ MW data centres are complete or underway. Within two miles (3.2 km) of GTI Energy, a colocation facility commissioned by Iron Mountain in 2025 carries a forecasted IT load of 36 MW, comparable to the demand of one of the busiest US airports.

This surge compounds existing power system pressures, including swelling interconnection queues, record power capacity auction prices, rising retail rates, increasingly strict contract structures such as take-or-pay provisions up to 85%, and measurable grid stability events. Generation demand is reflected in equipment markets, where 2025 is likely to be the peak year on record for gas turbine orders, exceeding 100 GW.

What distinguishes this cycle is the operational profile of the load itself, one that positions gas as a balancing resource and a platform for integrated, high-performance energy systems.

Figure 1: Proximity of a New Inference-focused Data Centre to GTI Energy and Major US Airport

A new kind of demand: Critical infrastructure, not incremental growth

Data center load growth represents mission-critical infrastructure with uptime expectations above 99.9%. Of the 50 GW of US behind-the-meter (BtM) data centre projects identified by Cleanview, approximately 75% of disclosed generation capacity (23 GW) is projected to rely on on-site natural gas-based power. That volume is equivalent to the total annual energy consumption of US health care facilities.

Volatility at scale

As the 2024 US NARUC GEAR report noted, deeper natural gas–electric interconnection introduces operating conditions for which the natural gas system was not originally designed. AI clusters intensify this dynamic. Thousands of GPUs can shift states nearly simultaneously, creating rapid megawatt-scale load swings within seconds. These patterns resemble industrial processes more than traditional commercial demand, introducing variability that challenges conventional natural gas planning assumptions.

A different economic calculus

Within this landscape, the scale and complexity of these systems create an opportunity to leverage the reliability, flexibility, and low-emissions profile of modern natural gas generation.

AI developers operate under power thresholds →

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approaching $10,000/MWh, fundamentally altering risk tolerance, procurement strategy, and infrastructure decisions. The speed and capital intensity of this buildout affect every segment of the natural gas value chain: local distribution planning, pressure management, pipeline contracting, storage valuation, trading structures, and risk allocation.

Within this framework, natural gas is positioned less as a marginal supplier and more as an enabling infrastructure layer.

Behind-the-meter natural gas: Beyond backup

In response to interconnection bottlenecks, much of the AI sector has turned to natural gas for behind-the-meter generation, initially as bridge power, but increasingly as primary infrastructure. These systems serve projects awaiting grid interconnection, nuclear colocation, or development in resource-rich regions.

This shift may persist. Grid operators are requiring flexibility; hyperscalers, by contrast prioritise continuous uptime. Data centre operators do not view grid curtailment to mean load curtailment. As one industry representative noted, “demand flexibility from data centres will be inherently limited.”

Today’s BtM systems are materially different from legacy standby generators. Deployments range from multi-MW reciprocating engine fleets to multi-gigawatt campuses, including the 7.65 GW permitted project at GW Ranch in Pecos County, Texas, the largest air permit issued in US history.

Operators cite several drivers: insulation from future electric rate volatility, limited ratepayer exposure, integration with solar and battery electric storage systems (BESS), and reliance on the natural gas grid’s delivery reliability. Natural gas generation also offers a lower-carbon alternative to expanded diesel backup, which remains a regulatory and community concern. With established emissions controls, natural gas systems can meet robust local air quality requirements while maintaining operational redundancy.

Natural gas as an enabler of large-load energy delivery

The unique velocity and character of this demand creates significant opportunities to scale-up emerging technologies, poised to: (1) improve the fuel flexibility, efficiency, and environmental performance of on-site energy technologies; (2) maximise the use of available heat (from engines, turbines, fuel cells) for heat-to-cooling, water recovery and reuse, or for thermal energy networks; and (3) modernise

AI developers operate under power thresholds approaching $10,000/MWh, fundamentally altering risk tolerance, procurement strategy, and infrastructure decisions.

approaches to integrating energy storage, microgrid controls and operation, and system planning. Leveraging this opportunity in power demand, we foresee opportunities to demonstrate the integration of natural gas to:

- Future-proof on-site energy for emissions, including deploying innovations for fuel-flexibility with low carbon fuels, advanced emissions control for local air quality (NO_x, CO, PM) and greenhouse gases (CO_2, CH_4); modernise air quality compliance pathways; and expand the use of lower-emission generators.
- Enable multi-generation, low-emissions solutions combining solar and BESS with the flexibility and long-duration generation enabled through Gas solutions.
- Position natural gas as a preferred backup fuel by expanding innovative, storable fuel pathways that enhance black-start capability and ramp rates for natural gas generation, while enabling seamless integration with BESS. Improve site efficiency with combined cooling, heating and power by improving the ease and effectiveness of valuing generator waste heat to drive cooling applications, water recovery and reuse, advanced emissions controls, and integration with thermal energy networks.
- Drive performance of on-site energy with AI inference loads by demonstrating and deploying integrated solutions to mitigate the “AI Jitter” workloads, defined as rapid megawatt scale load swings of 40% or greater through coordinated deployment within seconds of power and thermal energy storage at multiple physical and temporal scales.

In a landscape where load growth is sharper and more mission-critical than ever, winning energy systems will be the ones that combine speed, reliability, and emissions performance – and integrated Gas solutions are positioned to be the backbone of that new standard. ●

Regional Update

South and Southeast Asia

Abdul Aziz Othman
President, Malaysian Gas Association
Malaysia

Consolidation under strain: grid integration, LNG resilience, and transition sequencing in a volatile global system

ASEAN's energy system in 2025 and early 2026 is advancing its transition within tightening structural and geopolitical constraints. Grid integration is accelerating, natural gas remains embedded in system planning, and renewable ambition continues to expand. These developments, however, are unfolding against the increasingly complex energy industry landscape stemming from global trade disruptions, reassessment of the earlier commitments on energy transition and most recently, the geopolitical turmoil in the Middle East.

In facing all these challenges and uncertainties, South East Asian countries, made up of a regional grouping of all 11 states in Southeast Asia (ASEAN), collectively decided to continue honouring their commitments to decarbonise through strengthened collaboration and cooperation between their member countries.

Energy plays a critical role in ASEAN's economic and social development. This importance is reflected in the annual ASEAN Energy Ministers' Meeting (AMEM), where regional policymakers review emerging energy challenges and coordinate strategic directions for the sector.

The recent AMEM, (hosted by Malaysia as the Chair for ASEAN in 2025) held in Kuala Lumpur in October 2025, confirmed that ASEAN is not retreating from decarbonisation. Instead, the region is recalibrating its transition pathway – prioritising reliability, grid integration, dispatchable capacity, and execution discipline while navigating a more fragmented and volatile global environment.

For the global Gas community, ASEAN illustrates how emerging markets are recalibrating transition under real-time trade disruptions and geopolitical stress. Energy security is increasingly defined not only by supply volumes but by logistical design, portfolio management, financing resilience, and system flexibility.

The renewed instability in the Middle East heightened maritime security risks across key LNG transit corridors and increasingly complex global Gas market dynamics. Recent unrest in the broader Gulf region has reinforced a structural reality for Asian importers: energy security remains exposed to geopolitical risk concentrated at critical chokepoints such as the Strait of Hormuz. While large-scale physical supply disruptions have thus far been avoided, elevated insurance premiums, freight volatility, and risk repricing are already influencing delivered LNG costs. Geopolitical risk has become embedded in LNG economics rather than remaining an external contingency.

Key takeaways from the 2025 AMEM are as follows:

1. Regional power integration gathers momentum

The acceleration of the ASEAN Power Grid remains one of the most significant structural developments. Ministers reaffirmed expanded cross-border electricity trade and deeper multilateral cooperation building on the Laos, Thailand, Malaysia, Singapore Power Integration Project.

Grid interconnection is increasingly framed as resilience infrastructure. As renewable penetration rises, variability must be balanced across a wider geographic footprint. Transmission, therefore, becomes a mechanism for system stability rather than simply capacity expansion.

Electricity demand continues to grow across Southeast Asia, supported by industrial expansion and digital infrastructure development. Reporting on Malaysia's data centre expansion has highlighted increasing firm load requirements and potential grid pressure. This reinforces the importance of dispatchable capacity alongside renewable growth.

The main challenge now lies in implementation. Transmission investment, regulatory harmonisation, and coordinated market rules will determine whether integration can translate into material system flexibility.

Source: ASEAN Centre for Energy

2. Natural gas remains central to system stability

AMEM reaffirmed natural gas as a transition fuel. This position reflects structural system requirements.

Globally, LNG demand is projected to increase from roughly 400mn (million) tonnes today toward 600mn tonnes by 2030, with Asia as a principal driver. Within ASEAN, LNG terminals and pipeline infrastructure continue to anchor power sector stability.

Malaysia's Incentive-Based Regulation framework for 2026 to 2028 includes revised transportation and distribution tariffs, signalling the continued economic relevance of natural gas infrastructure. Natural gas serves three primary functions across the region: coal displacement, renewable integration support, and reserve margin protection.

In markets where demand growth remains robust, dispatchable generation continues to underpin affordability and reliability objectives.

3. LNG markets expand amid uncertainty

ASEAN's LNG strategy must account for shifting global dynamics.

China's expanding domestic natural gas production introduces uncertainty into LNG import growth trajectories. As the largest swing buyer adjusts procurement patterns, price formation becomes less linear.

At the same time, a wave of global liquefaction capacity is expected to enter the market in 2026. Additional supply may ease short-term tightness. However, this supply expansion coincides with renewed geopolitical stress in the Middle East and continued exposure of LNG flows to maritime chokepoints such as the Strait of Hormuz.

Delivered LNG cost increasingly reflects freight rates, insurance premiums, and voyage duration in addition to commodity price.

For ASEAN economies, the priority is portfolio management. Diversified sourcing, calibrated long-term contracts, regasification flexibility, and storage capacity will shape resilience.

Energy security is becoming a logistical design.

4. Renewable expansion and the energy trilemma

ASEAN reaffirmed its commitment to increasing the renewable energy share under the ASEAN Plan of Action for Energy Cooperation.

Solar, offshore wind, hydropower, and hydrogen projects are progressing across member states. Ministers consistently framed transition within the energy trilemma of affordability, reliability, and sustainability.

Regional Update

Rapid renewable deployment without integration planning carries system risks. Commentary on lifecycle challenges associated with solar expansion highlights waste management and recycling considerations that must accompany scale-up.

Renewable expansion in ASEAN is proceeding alongside firm capacity rather than replacing it. The approach reflects cumulative system redesign rather than abrupt substitution.

5. Financing and decarbonisation pathways

Capital mobilisation remains a critical success factor for transition implementation.

Green bonds, blended finance mechanisms, and multilateral development banks are recognised as important instruments. However, project bankability continues to depend on currency stability, regulatory clarity, and long-term offtake certainty.

Carbon capture and storage (CCS) is advancing institutionally in ASEAN.

Indonesia is emerging as a pivotal test case for CCUS deployment in Southeast Asia. Several large-scale developments are advancing, including Pertamina and ExxonMobil's proposed Asri Basin CCS reservoir in offshore Southeast Sumatra, as well as carbon reinjection plans linked to BP's Tangguh LNG expansion and the Inpex-led Abadi LNG project in the Masela Block. Together, these projects illustrate how Gas development and carbon management are increasingly being integrated within major upstream investments.

In Malaysia, PETRONAS has secured the country's first offshore carbon capture assessment permit under the Carbon Capture Utilisation and Storage Act 2025. Industry participants note that clearer carbon pricing signals and incentive structures are required to accelerate deployment.

Global experience indicates that capture performance and cost discipline are critical to credibility.

Alongside carbon capture, methane reduction through biogas in the palm oil sector provides measurable near-term mitigation potential. As the world's largest palm oil-producing region, ASEAN holds substantial potential for biogas development through methane capture from palm oil mill effluent and other agricultural residues.

Grid integration is deepening. Natural gas remains embedded as a stabilising force. Renewable capacity continues to expand.

Currently, Malaysia has developed more than 24 biogas plants capturing methane for renewable electricity generation. International reporting underscores methane reduction as one of the fastest climate levers available. Although the biogas schemes in Malaysia are relatively small in size, they are immediate opportunities that can be harnessed to contribute towards the country's energy security and decarbonisation efforts.

6. Outlook for 2026 and beyond

Against the backdrop of rapidly declining indigenous natural gas production and substantial energy demand growth, ASEAN's energy system is consolidating rather than transforming abruptly. Regulatory clarity and consistent policy implementation are crucial in ensuring stability as the region continues to honour its commitment to decarbonise.

Grid integration is deepening. Natural gas remains embedded as a stabilising force. Renewable capacity continues to expand. LNG markets are entering a new supply phase while geopolitical risk remains elevated.

The coming years will test ASEAN's ability to align infrastructure expansion with financing discipline and regulatory coherence.

Efforts undertaken by ASEAN illustrate how a just and equitable energy transition can be sequenced and implemented responsibly, rather than accelerated indiscriminately. Natural gas retains strategic relevance where it stabilises power systems, supports renewable penetration, and is embedded within coherent market and investment structures.

The central question for 2026 and beyond is not whether transition will proceed, but whether reliability, affordability, and decarbonisation can advance together. ●

Data centre power demand creates challenges, opportunities for energy industry

Characterised by an enormous appetite for power, data centres are not only changing how the oil and natural gas industry works, but how the power sector charts its own future.

ANNA KACHKOVA

THOMAS MULVIHILL
Associate, Enverus Intelligence Research

SUNEIL RAMESH
Senior Vice President, European Asset Finance, Morningstar DBRS

> "Data centres look more like 'critical-infrastructure' than the typical industrial load: **they're large, have high load-factors and are extremely sensitive to power outages."**
>
> THOMAS MULVIHILL, ASSOCIATE, ENVERUS INTELLIGENCE RESEARCH

The energy industry is one of numerous industries embracing AI, but the uptake of the technology is complicated by the infrastructure required to support it and by its growing power needs.

As AI use by industries rises, the construction of the data centres is also booming. According to preliminary data published in January 2026 by UN Trade and Development (UNCTAD), data centres accounted for more than one-fifth of global greenfield project values in 2025, while greenfield investment in data centres rose by $125bn. This, in turn, has led to a rise in electricity consumption by data centres, whose power needs are considerable.

The International Energy Agency (IEA) estimated in 2025 that data centres accounted for around 1.5% of the world's electricity consumption in 2024, at 415 terawatt-hours (TWh). In 2025, this figure will have grown further still. According to the IEA, global data centre electricity consumption has grown by around 12%/year since 2017, which is more than four times faster than the rate of total electricity consumption. The agency projected in 2025 that data centre electricity consumption would more than double to around 945 TWh by 2030. The US accounted for 45% of global data centre electricity consumption in 2024 according to the IEA.

Differences

There are notable differences between data centres and other sources of industrial electricity demand.

"Data centres look more like 'critical-infrastructure' than the typical industrial load: they're large, have high load-factors and are extremely sensitive to power outages," an Enverus Intelligence Research (EIR) associate, Thomas Mulvihill, tells *Gas in Transition (GiT).*

"For grid operators, the question is as much about their ability to deliver electricity when needed as it is about their ability to build the infrastructure needed to do so," he says, citing examples of infrastructure including substations, transformers and transmission lines.

Suneil Ramesh, Senior Vice President of European Asset Finance at Morningstar DBRS, also points to how the location of data centres has an impact.

"With connectivity, end user demand and other factors driving location attractiveness, data centres also tend to be geographically concentrated, which creates greater demands on the grid," Ramesh tells *GiT*. "Workload changes can also cause volatility in marginal demand and impact the local grid."

Challenges

This creates challenges for the energy industry alongside opportunities. On one hand, rising power needs translate into rising demand for fuel including natural gas, providing energy producers with additional incentives to ramp up output and with opportunities to provide power directly to data centre developers.

On the other, energy companies themselves are grappling with rising power requirements as they increasingly use AI for larger, more complex tasks. And rising power demand – both from the energy industry and more broadly – is already starting to act as a constraint on AI deployment.

"In many regions, power availability is already gating timelines for data centres," Mulvihill says. "The binding constraints are interconnection studies, network upgrade costs and supply-chain backlogs."

Meanwhile, Everett Wheeler, Natural Gas Markets Editor at Energy Intelligence, points to an analysis by Data Center Watch, which found that more than $64bn worth of AI projects have been cancelled because of local opposition.

"A substantial driver is concern about the use of resources, including energy," Wheeler tells *GiT*.

In addition, Wheeler points out that energy infrastructure to support data centre development is competing for capital in the same markets as the tech firms building the data centres.

"And we've seen that that's been a challenge for energy companies relative to some of the big tech firms that are flush with cash," he says. "In Texas for example, power generators are relying on subsidised loans to bring new generation to the power grid." →

"With connectivity, end user demand and other factors driving location attractiveness, data centres also tend to be geographically concentrated, which creates greater demands on the grid."

SUNEIL RAMESH, SENIOR VICE PRESIDENT, EUROPEAN ASSET FINANCE, MORNINGSTAR DBRS

With new capacity dependent on power and transmission availability, some entities are having to use alternate – and more costly – sources of power to circumvent current constraints, Ramesh notes. Locating data centres in other regions, which would not have been the first choice otherwise, is also an option.

Mulvihill also sees various options being pursued by those trying to overcome the current constraints on data centre development.

"Some developers are pairing projects with on-site generation or dedicated power supply contracts to improve certainty, while utilities and grid operators are adding collateral/credit requirements to the interconnection process (as a way to reduce speculative queue positions)," he says.

The pushback resulting from concerns over the impact of rising AI use and the accompanying growth of power demand could result in regulations being tightened over time. In the US, Wheeler points to record capacity prices for grid operator PJM Interconnection and to the North American Electric Reliability Corporation (NERC) sounding the alarm about rising risks of power shortages across the US and Canadian power grids as evidence of growing concern.

"This month (March 2026) we are seeing bills introduced in Congress and in several state legislatures aimed at slowing down the build-out of data centres until hyperscalers can guarantee that pull on the grid does not exceed any efficiency gains, which would exacerbate already soaring electricity rates in some markets," Wheeler says.

Slowdown threat

This situation threatens to slow the uptake of AI – or at least make the uptake of the technology more uneven.

"Grid capacity constraints can be a real filter for who is going to deploy their AI at scale," Mulvihill says. "The best-positioned developers are those who can secure their interconnection onto the grid, finance the required grid upgrades, and contract the power delivery. Typically, that tends to benefit large, creditworthy buyers, as well as regions with extra transmission/generation capacity."

This has implications for the energy industry – among others – as companies work to roll out digital technologies across their operations.

"For energy's digital transformation, AI adoption likely continues, but the biggest compute-heavy deployments may concentrate where power is cheapest and most reliable," Mulvihill says.

"Access to grid capacity is increasingly acting as a barrier to entry," agrees Ramesh.

There are steps companies can take to work around this challenge, but how successful these will be remains to be seen. Wheeler cites pipeline operator Williams' Socrates project, which entails the construction of two Gas-fired power generation facilities, as an example.

"You're seeing pipeline companies develop behind-the-meter power generation projects such as Williams' Socrates project in Ohio that attempt to avoid the challenges of interconnecting with the bulk power system," Wheeler says. "Whether those types of workarounds will take enough pressure off the grid remains to be seen; many market analysts are sceptical."

Pipeline companies are not the only ones pursuing new partnerships with AI companies. Various partnerships are being formed in which oil and natural gas firms help to supply on-site power to AI players that, in turn can offer up their digital technologies and services to the oil and natural gas companies.

In the US, majors Chevron and ExxonMobil have both advanced plans to supply natural gas to help power data centres, as has independent natural gas producer EQT. On the oilfield services side, Baker Hughes has increasingly been shifting its focus to serving data centres rather than oilfield customers. Another oilfield services firm, Liberty Energy, has also increasingly turned its attention to data centre services, announcing a partnership with Vantage Data Centers earlier in 2026.

These partnerships are a relatively recent phenomenon, but a growing one, and it is likely that more companies will announce similar agreements over the coming months.

Meanwhile, utilities have a significant role to play in boosting grid capacity and access if the rising power demand stemming from large-scale use of AI is to be accommodated.

"Power producers and utilities can accelerate grid investment, expand flexible generation and have offtake contracts or commercial arrangements for data centres," Ramesh says.

"Utilities can respond on three different fronts: speeding up interconnection and queue discipline, investing earlier in substations/transmission infrastructure in high-growth areas, and creating tariffs that align costs and reliability requirements for large loads," Mulvihill notes. "We're starting to see more hybrid solutions, such as distributed generation (mobile/modular natural gas turbines) and storage, as well as utility partnerships to accelerate power generation," he adds, citing the example of the fuel cell deal between American Electric Power (AEP) and Bloom Energy.

"If power shortages become a common occurrence, expect large-scale adoption of on-site generation at data centre facilities," Mulvihill says. "Grid operators and utilities, in an ideal world, will begin working heavily with data centres and treating it like a joint project so they can work together to find a solution that will allow for data centres to operate without disruption to the local grid."

Given the current pace of AI and data centre expansion, it seems that the challenge will need to **be addressed from multiple angles**

Multiple angles

Given the current pace of AI and data centre expansion, it seems that the challenge will need to be addressed from multiple angles, and that numerous sources will be required to help meet growing power demand needs.

"The rapid growth of data centres is increasing demand for firm, reliable low-carbon power," Ramesh says. "This increases demand for renewables and some nuclear plants are being brought back. Natural gas, and coal in some regions, are also used to support and handle demand spikes. Overall, there is expected to be a hybrid generation mix."

Wheeler and Mulvihill echo a similar view but note that they expect the generation mix to change over time.

"In the short-term it's driving a push for more thermal power – (natural) gas, nuclear, even extending the life of some coal plants that are slated for retirement," Wheeler says. "(Natural) gas is viewed as the short-term fuel for the vast majority of the generation needed to power AI because of its relatively low cost and shorter lead time. But after 2030 renewables and nuclear power are expected to cut into (natural) gas' share."

"In the near-term, the generation mix is likely to tilt toward firm, dispatchable capacity (oftentimes efficient natural gas power plants) paired with renewable build and storage, because data centres value reliability and speed to power," Mulvihill says. "In the long-term, the 'firm and clean' options become important, such as nuclear extensions and new builds, Gas plus CCUS and longer-duration storage. That being said, timelines and permitting will determine how quickly these show up in the actual generation mix." ●

GAS IN TRANSITION.MARCH 2026

Digital twins: Driving operational efficiency and decarbonisation for global Gas

Digital versions of key assets are being deployed to improve efficiencies, with the added benefits of lowering operating costs and reducing emissions.

TOM YOUNG

SHANE MCARDLE
CEO, Kongsberg Digital

DEVAN PILLAY
Global President, Heavy Industries Segment, Schneider Electric

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The advent of cloud computing in the 2010s allowed oil and gas companies to move towards connected, real-time virtual replicas of assets. By the mid-to-late 2010s, major energy companies began deploying these "digital twin" systems for strategic production assets and plant systems, enabled by improved sensor technology.

A digital twin is a digital version of a physical object – it could be a pump, a platform or a compressor. The twin is created with initial data such as 3D CAD models, map data or equipment information and subjected to virtual changes that mirror its real-world counterpart, such as weather, pressure or vibration.

These twins of individual assets are then linked together to form ecosystems that can give firms a digital overview of their entire physical operations. This enables firms to improve efficiency, with the dual benefits of lower operating costs and lower emissions.

"Digital twin ecosystems have long proven their value as one of the fastest, most effective ways for oil and gas operators to cut emissions – this is because they enable teams to optimise every asset, process, and production pathway within a real-time data model," says Devan Pillay, Global President of the Heavy Industries Segment at Schneider Electric, the parent company of Aveva.

Shell's global digital twin ecosystem is built on the Aveva PI System, and Schneider Electric has also implemented systems for ADNOC, Nigeria LNG and Cheniere Energy.

Upstream upsides

In the upstream, the biggest emission sources are typically methane leaks, flaring and maintenance discipline. Most flare emissions come from a small number of abnormal events. Digital twins enable operators to identify these events much earlier, and sometimes before they even happen, Kongsberg Digital CEO Shane McArdle tells *Gas in Transition (GiT).*

"An AI-powered digital twin that recognises precursor conditions – like pressure swings or compressor constraints – can trigger earlier interventions," he says.

Such twins perform most effectively when they draw information from a large number of information sources. Chevron uses ground-level sensors, drones, planes, and satellites to provide a comprehensive view of facility emissions which is then integrated into digital twin technology. BP's Flare.IQ system continuously pulls temperature, pressure, vent gas velocities, and gas composition from its flaring system and then models the data to calculate the ideal amount of assist gas needed to maximise combustion →

LNG Canada site
Source: LNG Canada

efficiency in real time.

Meanwhile, TotalEnergies uses the Aveva PI System for real-time monitoring of Scope 1 greenhouse gas (GHG) emissions, including flaring sources.

"When used in conjunction with advanced digital models, digital twins can connect real-time OT and IT data – everything from energy use and flare activity to compressor performance and rotating equipment health – to deliver actionable insights," Schneider Electric's Pillay says. "Operators can spot anomalies early, tune process setpoints, improve energy efficiency, and significantly reduce methane and flaring-related emissions."

Downstream dividends

In the downstream, midstream and LNG sectors, energy intensity, unplanned events and equipment maintenance tend to be the main sources of emissions. Nigeria LNG – which produces 10% of the world's LNG – deployed a suite of Aveva solutions to create a digital twin of its LNG trains in an effort to increase efficiency and reduce the chance of unplanned outages.

"The company's new cloud-enabled digital twin empowers field operators and executives alike to make better, faster decisions," says Pillay.

Elsewhere, Kongsberg Digital has worked with LNG Canada to embed a digital twin from the commissioning stage to enable real-time visibility, remote collaboration and performance monitoring of

"Digital twin ecosystems have long proven their value as one of the fastest, most effective ways for oil and gas operators to cut emissions."

DEVAN PILLAY , GLOBAL PRESIDENT, HEAVY INDUSTRIES SEGMENT, SCHNEIDER ELECTRIC

the assets and their associated emissions.

"Even before first gas, teams were able to simulate operational scenarios, identify risks early and prepare for more stable startup conditions – which directly impacts energy efficiency and emissions from day one," McArdle says.

The system helps LNG Canada produce LNG at a much lower emissions intensity than the global average.

Emissions reporting

Digital twins can also provide operators with accurate, auditable emissions data that can plug straight into net zero reporting and ESG frameworks. This 'chain of custody' – from the sensor through to the sustainability report – enables complete transparency

in how numbers are calculated.

"Instead of relying on static estimates or annual spreadsheets, digital twins generate a live, validated emissions baseline built on real asset performance," says Pillay.

The system also creates traceability in numbers, enabling operators and regulators to see exactly the factors that contribute to rises or falls in emissions.

"Let's say flare emissions increase – in the twin, you are able to see that this was due to, say, equipment upset on compressor X, or maintenance deferral on equipment Y," says McArdle.

Challenges to deployment

There are several technical and organisational challenges that need to be overcome to enable successful deployment of digital twins. On the technical side, data quality and fragmentation can be major issues. Operators often run on isolated 'data islands' across wells, plants, and pipelines, and also can have inconsistent tag or asset hierarchies for their data.

Organisational challenges are equally significant. Change management, workforce adoption, and unclear ownership or roles often delay digital twin deployment. Research carried out by Schneider Electric indicates that more than half of industry leaders see workforce acceptance as a critical barrier. Rapid roll-outs without adequate governance can introduce operational risks.

"That's why we run Digital Maturity Assessments, remote expert support and structured change-management programmes to build trust in digital insights on the plant floor," says Pillay.

Structured governance, digital maturity assessments, remote expert support, and change-management programmes can build trust in technology and ensure sustainable, scalable implementation across organisations.

Next phase of development

The logical next step for these systems – and one that companies are now starting to evaluate – is to enable systems to make asset adjustments themselves, rather than informing operators to make decisions based on the data they provide.

"We are in a transition where we are gaining more confidence in the models and we are gaining more confidence in the output of the optimisation," Bjarte Pedersen, ABB Energy Industries IMEA Region Senior Vice President, said at the International Gas Union's LNG2026 conference earlier this year in Qatar.

Many simpler processes are already automated in these ways, with critical decisions still left to operators. Improved decision traceability and cyber security will be key to firms taking the next step towards automation. The integration of digital twins into existing risk management and safety procedures ensures that safety protocols evolve in lockstep with technological advancements, reducing downtime and human error.

"We need to have traceability on digital twins. We need to have bounded risks, means we know how far [AI tools] can take us to, but [then they] go no further. And they should be auditable, with logs and everything recorded," Dominique Gadelle, Technip Energies Vice-President of Early Engagement, said at LNG2026. "Nobody is ready to rely on a black box." ●

Regional Update

Northeast Asia and Oceania

Ryota Kuzuki PhD
Senior Research Fellow, The Japan Gas Association
Japan

Australia

In September 2025, Australia announced its 2035 emissions target: 62% to 70% below 2005 levels. Biomethane, renewable hydrogen, and low-carbon liquids are priority decarbonisation pathways. Critics note past reductions relied heavily on land use carbon sinks. The Government launched the A$1.1bn (billion) Cleaner Fuels Program targeting first commercial production by 2029.

CSIRO's December 2025 HyResource database recorded 76 hydrogen projects (17 operating, 11 under-construction, 48 under development), down from 104 in 2023: operating plus under-construction capacity is about 11.5 kt/year (1.4 PJ). Delorean's SA1 biomethane project targets 210 TJ/year with commissioning expected Q3 2026.

In 2025, Australia exported approximately 78 Mt (about 4,100 PJ) at 86% to 90% capacity utilisation. Chevron approved A$3bn Gorgon Stage 3 in December 2025, sustaining 15.6 MTPA of LNG (830 PJ) capacity up to 2070 (with additional wells). Santos announced Barossa's first cargo departure in January 2026, capacity about 3.7 MTPA (about 195 PJ). Woodside's Scarborough remains on schedule for first gas July-December 2026.

The Australian Energy Market Operator (AEMO) forecasts Southern States production will drop 40% from 1,260 TJ/day (2024) to 740 TJ/day (2028), while Queensland-South pipeline capacity is constrained at 512 TJ/day (APA Group announced expansion to 600 TJ/d).

On December 22, 2025, the Government announced a gas reservation scheme requiring LNG exporters to reserve 15% to 25% of new production for domestic consumers, with consultation in 2026 and implementation in 2027. The scheme reportedly replaces previous market interventions while respecting existing contracts. Critics note this may hamper investment without addressing infrastructure constraints.

China

In 2025, China's total natural gas consumption reached 432bn m³, up 3.1% year on year.

On the supply side, domestic natural gas production totaled 263.8bn m³ in 2025, representing a 5.8% year-on-year increase. Total natural gas imports amounted to 176.4bn m³, down 2.9% year on year. Of this total, LNG imports fell by 10.7% to 68.43mn (million) tonnes, while pipeline gas imports increased by 8%, reaching 82bn m³.

From an energy policy perspective, China's 15th Five-Year Plan proposes the development of a new energy system with renewable energy as the mainstay and fossil energy as a backup and safeguard. Measures for the Administration of Natural Gas Utilization designate natural gas peaking plants and distributed energy projects as priority areas for development. Meanwhile, measures for the management of the national special fund for clean energy development clarify that national special funds will continue to support unconventional natural gas development during the 2025-2029 period.

As China accelerates the development of renewable energy, Opinions on Accelerating the Comprehensive Green Transition in Social and Economic Development state that by 2030, renewable energy consumption should increase from the current 1.1bn tonnes to 1.5bn tonnes of standard coal equivalent. Under China's new round of Nationally Determined Contributions, by 2035, renewable energy is expected to account for more than 30% of total energy consumption, while total installed capacity of wind and solar power will exceed six times the 2020 level, with a target of 3.6 TW.

Chinese Taipei

In late 2025, Chinese Taipei's GHG inventory (2025 edition) has been updated, reaffirming methane's role (1.60% of national GHGs) and government efforts aligned with UNFCCC methodologies. The tracking and regulation of methane emissions is an essential prerequisite for scaling e-methane or other low-carbon methane alternatives.

The Carbon-pricing architecture in January 2025 included plans to accelerate the transition from carbon fees to a full ETS (emissions trading system) as early as 2026. Covered entities must calculate and pay carbon fees based on 2025 emissions by May 2026, which is expected to improve demand signals for low-carbon energy carriers.

The Net-Zero Transition Plan 2023-2026 is a transition strategy that focuses on hydrogen energy, smart grids, marine energy, and carbon-reduction technologies – building the enabling environment for synthetic gas fuels such as e-methane.

Regarding offshore natural gas projects, YT2 Offshore Pipeline (between Yong'an and Tongxiao) awarded contracts to Boskalis & Allseas in July 2025. Project spans will be 2026–2028. A €1.2bn contract was also awarded by CPC Corporation to build the second offshore natural gas pipeline.

YT2 is a 232 km, 36-inch pipeline running parallel to the existing YT1 pipeline to increase Gas supply capacity to the northern region. The project includes trenching, installation, 34 infrastructure crossings, backfilling, and two landfalls. Construction is planned to begin in 2026 with completion in 2028.

Japan

In September 2025, Japan co-hosted a ministerial-level meeting on sustainable fuels in Osaka. Ministers from 34 countries attended the meeting and emphasised the importance of hydrogen-based fuels, including e-fuels and e-methane, for accelerating decarbonisation. E-methane was noted in particular for its compatibility with existing natural gas infrastructure and its value for energy security.

At Osaka-Kansai Expo 2025, during "Future of the Planet and Biodiversity Week" (September 17–28, 2025), the first large-scale use of Clean Gas Certificates was successfully implemented. Osaka Gas procured Clean Gas Certificates for the environmental value of e-methane and biogas, which is considered not to increase CO_2 in the atmosphere when combusted. This resulted in net-zero CO_2 emissions from all city Gas used at the venue during the event.

In November 2025, the Japan Oil, Gas and Metals National Corporation (JOGMEC) published its CLEAN Annual Report 2025. Japan is a member of the CLEAN Initiative, which promotes reducing methane emissions and increasing supply chain transparency. Japan is enhancing visualisation of methane emission by utilising satellite data (GOSAT-GW, Methane Sat, etc.).

Japan's GX-ETS will proceed to the phase of →

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Regional Update

being mandatory nationwide in April 2026. It is a system featured by compliance obligations for large emitters, defined price bands, and governance by the GX Agency. This is one of the world's largest new ETS implementations and is attracting attention as a means of achieving Japan's ambitious 2050 climate goals.

New Zealand

The reversal of the moratorium on offshore exploration taking effect in September 2025 was among several significant developments affecting the natural gas and oil sector. This was followed by a new open market application permit process being established which allows operators to apply for new prospecting and exploration permits at any time. In the first signs of the industry reopening, two applications have already been received. Later in October 2025 the Government responded to a comprehensive review of the electricity market. The reforms were measured and included proposals for mechanisms to mitigate sovereign risk and to incentivise new thermal generation.

The momentum of changes to respond to a growing fuel shortage in the energy system continued into the new year. The $200mn Gas Security Fund, initially aimed at getting new natural gas to market, was opened for expressions of interest in January 2026. Its scope has also been widened to support a broader range of projects including investment in existing fields and natural gas storage. Then in early February 2026, the Government announced that it will progress importing LNG as an insurance against the risks that come with dry years in New Zealand. This decision was driven by progressively tightening domestic natural gas supply and growing reliance on intermittent weather-based sources of generation. The intention is to have a contract signed by mid-2026 to build an LNG import facility by 2028. A project is also underway to develop a second natural gas storage facility.

South Korea

In October 2025, the Korean government created the Ministry of Climate, Energy and Environment (MCEE), consolidating responsibilities for climate policy, electricity and grid strategy and energy transition planning.

In November 2025, MCEE announced the 2035 NDC as a reduction of 53% to 61% by 2035 compared to the 2018 net emissions level. As a follow-up to establishing the 2035 NDC, the government plans to finalise, by the first half of next year, the Korea Green Transformation (K-GX), which will include detailed action tasks for fostering green industries such as solar power, wind power, power grids, energy storage systems (ESS), electric vehicles, batteries, and heat pumps, in collaboration with relevant ministries and industry stakeholders.

Despite global order decline, Korean shipbuilders met their 2025 goals, with LNG carriers emerging as a core profitable segment for 2026 orders.

In August 2025, Doosan Enerbility announced that it had been awarded a KRW 560bn contract by Korea Gas Corporation (KOGAS) to construct three LNG storage tanks (270,000 m³, Tanks 5-7) for the Dangjin LNG Terminal Phase 2 project in South Chungcheong Province.

Despite global order decline, Korean shipbuilders met their 2025 goals, with LNG carriers emerging as a core profitable segment for 2026 orders.

HD Korea Shipbuilding & Offshore Engineering's first major 2026 order was an LNG carrier. In September 2025, POSCO International and Korea Southern Power signed a memorandum of understanding to expand domestic LNG bunkering, boosting maritime LNG fuel infrastructure.

GTT received multiple LNG carrier tank-design orders from Hanwha Ocean, including 7 new LNG carriers for a European shipowner and two carriers for the US market.

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AI and the reinvention of subsurface exploration

Machine learning and artificial intelligence have rejuvenated subsurface exploration, even as exploration spending declines.

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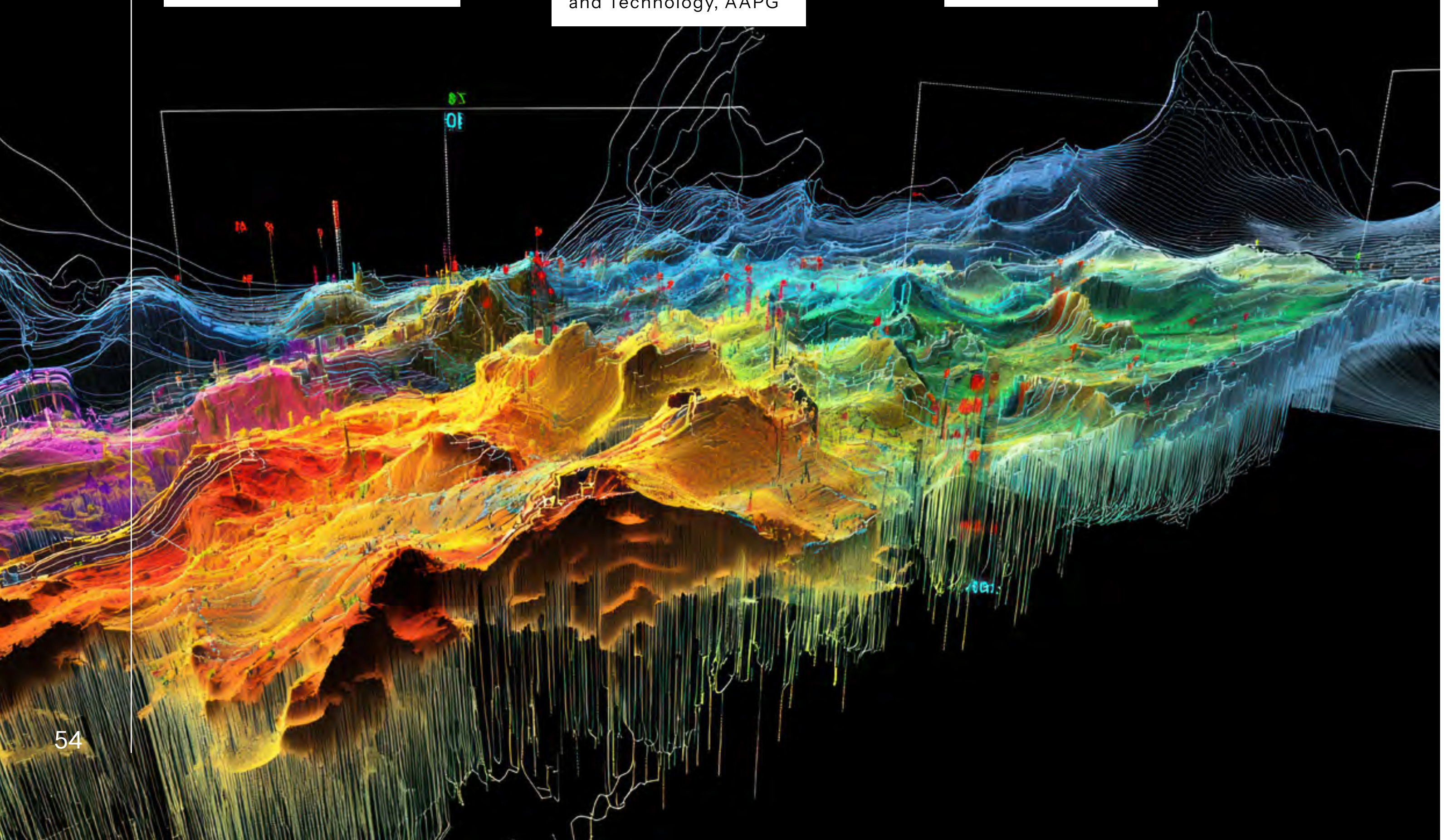


With upstream oil and gas exploration spending declining sharply over the past decade, AI has emerged as a critical enabler of a new exploration model – one focused on extracting more value from existing data, reducing uncertainty, and making faster, better-informed decisions.

Data from S&P Global Energy shows that total exploration spending by integrated oil and natural gas companies has decreased from over $25bn in 2014 to around $10bn in 2025. However, within this trend, these firms have shown a growing interest in seismic and data analytics activities since 2020, whilst continuing to cut spending in more capital-intensive areas such as well construction and recovery.

"The industry is becoming more efficient with its scarce technology development resources," said Carolyn Seto, Director in the Upstream Technology and Innovation practice at S&P Global Energy, presenting the results in December 2025.

Improvements in the abilities of AI tools to analyse seismic data have underpinned a new model of exploration, where companies acquire large amounts of acreage, analyse it, and then drill selectively at optimum locations.

AI and the reinvention of seismic data analysis

Characterising the subsurface through seismic surveying has been a key component in hydrocarbon exploration for many years, requiring the acquisition, processing, and interpretation of vast datasets.

But AI has fundamentally changed the ways in which this data is processed and interpreted. Machine learning techniques – particularly convolutional neural networks (CNNs), U-Nets, generative adversarial networks (GANs), transformers and, more recently, foundation models – have demonstrated dramatic improvements in both the speed and accuracy of interpretation, significantly reducing the time required to reach a 'go/no-go' decision on acreage exploration.

"Generative AI has shifted firms from reactive analytics to proactive scenario generation, significantly reducing the cost of 'frontier' exploration," Susan Nash, Director of Innovation and Emerging Science and Technology at the American Association of Petroleum Geologists (AAPG) tells *Gas in Transition (GiT)*. "Companies are now using it to create synthetic seismic surveys and high-resolution subsurface reconstructions, allowing them to identify 'sweet spots' in data-poor areas and reducing the multimillion-dollar risk of drilling dry wells."

Traditionally, seismic interpretation was the domain of highly specialised geoscientists working with computationally intensive workflows. Fault detection could take two days to run on a 10GB seismic volume. Today, CNN-based models can complete the task in under 20 minutes. And at the basin scale, tasks that once took two weeks to process data volumes from regions like the Gulf of Mexico can now be completed in a fraction of the time.

These gains alter the economics of exploration by enabling companies to evaluate more acreage with fewer staff hours – and simultaneously dramatically improve well selection.

Partnership model

The last few years have seen a growth in partnerships between oil and natural gas players and software firms in the pursuit of better subsurface models. In 2021, Shell partnered with technology startup Low Impact Seismic Sources (LISS) to develop improved marine seismic surveys. And in April 2024, TotalEnergies and Earth Science Analytics (ESA) entered a multi-year, fully integrated partnership to accelerate the adoption of AI in geoscience and reservoir interpretation.

Meanwhile Chevron has a strategic collaboration with Eliis to integrate advanced AI algorithms for automated fault detection and subsurface characterisation. Chevron integrated its automated fault detection algorithms into the Eliis PaleoScan™ interpretation framework, allowing it to accelerate interpretation while preserving consistency and quality control.

"The Chevron collaboration reinforced that AI should be an enabling technology," Phil Hicken, Eliis' Technical Account Manager for UK & Africa tells *GiT*. "Automation improves speed and model detail, but geoscientists remain responsible for validation and final interpretation decisions."

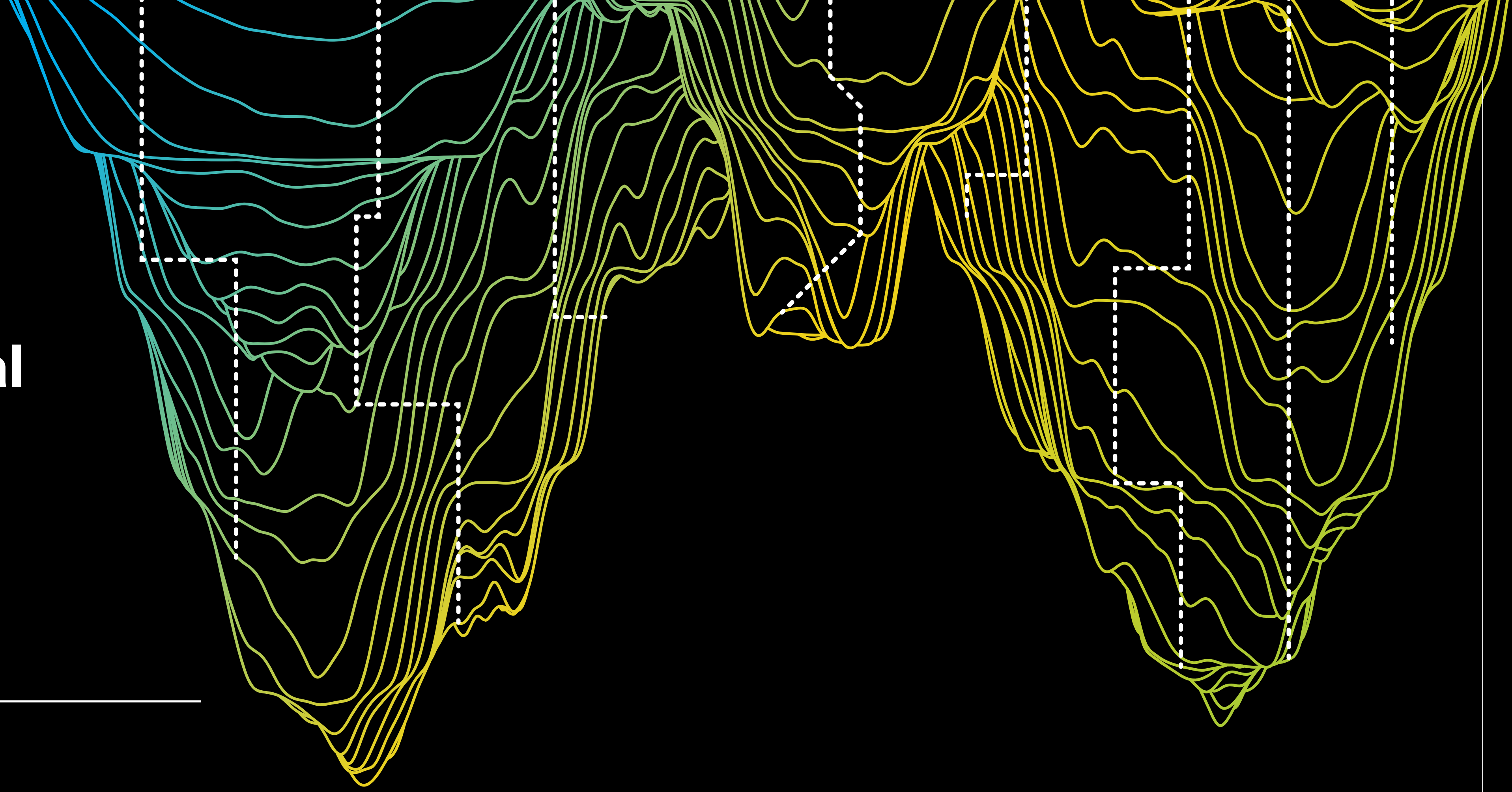
By providing fault likelihood data for every point in the subsurface, PaleoScan enables precise, quantitative mapping of fault networks.

Workflow integration

Subsurface data is inherently noisy and subject to acquisition variability, and no firm wants a 'black box' making crucial drilling decisions – especially without traceability. The prevailing model is therefore one of augmentation, rather than replacement. AI accelerates pattern recognition and proposes candidate structures, while human experts validate and refine interpretations, reducing uncertainty while retaining accountability.

For best results, operatives should compare results against wells and regional understanding, →

Autonomous and semi-autonomous drilling systems **use machine learning models trained on historical well logs, borehole images, and production histories to predict optimal drilling trajectories and anticipate hazards.**



run normal peer review procedures, and be open about uncertainty whenever it feeds into risk and investment decisions, Hicken says.

"It's important to be clear what the tool is meant to do. Don't make it part of the official interpretation without proper checks, and keep track of model versions and edits," he says.

As AI takes over the heavy lifting of data ingestion and seismic processing, the skill sets of geologists and geoscientists are likely to evolve from data processing to model validation. They are also likely to become system architects, as evidenced by TotalEnergies' 'Digital Factory,' which employs over 300 experts to design and manage decision-making ecosystems.

"Future geoscientists will need a hybrid skillset that combines traditional structural geology with computational literacy, acting as the final human-in-the-loop to verify that AI-generated scenarios align with physical laws and environmental safety standards," says the AAPG's Nash.

Well planning

Well planning builds on seismic insights to determine exactly where and how to drill, optimising trajectories, equipment, and operations to efficiently reach the target.

Equinor has developed AI-driven well planning tools that generate thousands of development scenarios, allowing engineers to focus on the most promising options. In the Johan Sverdrup Phase 3 development, AI models identified a novel solution that saved $12mn.

The firm has also developed a chatbot that enables users to interrogate over 50 years of well and borehole data.

"It is designed to help managers, engineers, and analysts quickly gain insights," Olav Landstad, Project Manager for AI at Equinor, said at a company presentation in January 2026. "It can answer questions and help analyse complex operations data in seconds."

Chevron carried out a similar initiative with its ApEX platform, synthesising insights from over a million legacy documents. A major hurdle in such schemes is the geospatial and handwriting discrepancies in old assets.

"These 'stranded' data points often require specialised AI fine-tuning to reconcile disparate naming conventions and diverse document layouts before they become usable," says the AAPG's Nash.

Autonomous drilling

Where seismic AI interpretation maps the subsurface, and AI-driven well planning defines the optimal path, autonomous drilling takes the technology to the physical rig. Once a prospect is identified and sanctioned, companies must decide precisely where and how to drill production wells. Drilling is capital-intensive and operationally risky – improvements in efficiency and targeting can therefore generate substantial value.

Autonomous and semi-autonomous drilling systems use machine learning models trained on historical well logs, borehole images, and production histories to predict optimal drilling trajectories and anticipate hazards.

Furthermore, modern offshore operations generate massive volumes of real-time data at every stage of drilling. When teams rely on manual interpretation, decision latency and uncertainty can arise. Automation and real-time intelligence can remove this uncertainty, supporting faster decisions and more predictable outcomes, according to US-based oil services company Halliburton.

One recent well drilled on the Norwegian Continental Shelf used Halliburton's LOGIX™ Orchestration system to deliver a unified set of drilling and tripping parameters in real time. The system updates subsurface, wellbore fluid, and pressure system data as drilling is taking place, improving safety and accuracy.

"LOGIX is built to address multiple customer needs. From precise well placement, optimised rate-of-penetration (ROP) and tripping, as well as smoother wellbores with better reservoir contact, LOGIX helps improve customer asset value," says Jim Collins, Vice President of Sperry Drilling at Halliburton.

Elsewhere, ExxonMobil has developed a Drilling Advisory System that integrates proprietary modelling with real-time data analytics on the rig floor. By continuously analysing surface conditions and downhole parameters, the system optimises weight-on-bit, rotary speed, and drilling mud properties to maximise penetration rates.

Looking to the future

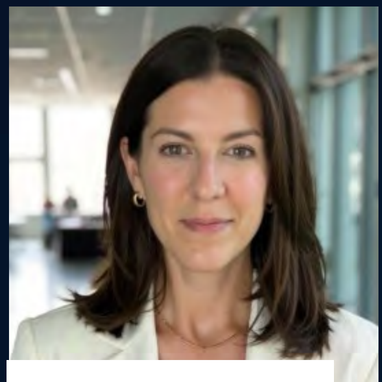
As AI continues to advance across all areas of exploration, the line between digital analysis and on-the-ground operations is becoming increasingly blurred. A new hybrid approach is emerging, where AI tools work hand-in-hand with human expertise. This approach allows companies to unlock more value from existing data, reduce the number of dry wells, and carry out drilling projects with greater accuracy. In this evolving landscape, competitive advantage will come from how well organisations combine advanced analytics with practical experience, strong governance and human judgment. ●

AI to streamline pipeline integrity

Pipeline operators are gaining new insights and control using advanced technologies like machine learning and AI.

JEREMY BOWDEN

GABRIEL GRIFFIN BOOTH
Principal Consultant, Energy Systems, DNV



SHERI BAUCOM
Product Marketing Engineer, Irth Solutions

Advances in technology, led by digitisation, machine learning, and other artificial intelligence tools, are providing pipeline operators with the potential for unprecedented insight and control, promising more efficient and safe pipeline operation in future. The technology is badly needed to address rising regulatory scrutiny, aging infrastructure, increasing ESG pressure, and demands for real-time operational visibility and control.

In pipeline integrity, AI refers to machine learning (ML) and statistical modelling/data science techniques that are able to make sense of large volumes of operational data, including real-time and historical time series data from meters, sensors, and control systems, according to Pipewise, which provides leak detection services for pipeline operators.

The performance of the machine learning systems improves as they process more information – so companies with the most data tend to have the best AI. ML models can recognise patterns invisible to the human eye, while data science ties it all together, extracting actionable insights from large, complex datasets, according to Sheri Baucom, a Product Marketing Engineer at Irth Solutions.

An AI system enables the information extraction

> "In my experience, the organisations making the most progress aren't buying AI. **They're investing in the foundations that will allow AI."**

SHERI BAUCOM, PRODUCT MARKETING ENGINEER, IRTH SOLUTIONS

and fusion from multiple datasets, found within asset and operational systems, to identify information that reveals asset condition changes over time and acts as early-warning intelligence, according to DNV's Gabriel Griffin Booth, Principal Consultant, Energy Systems. This includes leak detection, predictive maintenance, flow adjustment, corrosion monitoring, and third-party impacts.

How does it work?

Data measuring pressure, flow rate, temperature, corrosion levels, vibration, and leaks are gathered from a variety of sources, including IoT sensors (preferably), SCADA, ILI, corrosion/CP surveys, maintenance, and defect reporting – both digitised and undigitised historic and real time data. This all then needs to be standardised for use in what is a layered system, according to Baucom.

Data engineering and standardisation form the system's foundation. Inspection files must be normalised, inconsistent definitions resolved, and records aligned to a consistent spatial reference system.

"This data preparation phase often represents most of the effort in any machine learning or AI initiative, but it is where much of the long-term value is created," Baucom tells *Gas in Transition (GiT).*

Griffin Booth says information is scattered across different datasets and data formats, with different companies having access to part of the picture.

"Often, these records are kept in unstructured formats such as a free text, or other visual outputs from scans, and some may require a specialist skillset to interpret," he says. Greater digitisation and use of IoT sensors should help reduce this burden in future.

On top of that foundation layer, the data feeds into machine learning algorithms that analyse patterns, detect anomalies, and forecast potential future behaviour. These models learn 'normal' patterns of pipeline behaviour from labelled historical data and improve as additional data becomes available, says Baucom – becoming increasingly good at spotting deviations. Specialised models are trained for targeted tasks such as classification, anomaly categorisation, prioritisation, or even imputation of missing attributes.

Griffin Booth says the modeling layer extracts useful information from source data and uses a mix of physics-based network models and ML based predictions for anomaly detection and forecasting. This is then translated into risk scoring per segment and recommended interventions. He says hybrid approaches are best, combining physics-based network models with ML "to improve sensitivity and reduce false alarms compared with either method alone."

Baucom says 'human-in-the-loop' workflows are essential to review results, apply operational context, and make final decisions. "This step ensures safety, regulatory defensibility, and industry acceptance," she says.

Finally, there is an emerging generative AI layer, where large language models allow users to query structured datasets, generate draft summaries, or map regulatory requirements to workflows, Baucom says. "Alignment, structure, and validation are prerequisites."

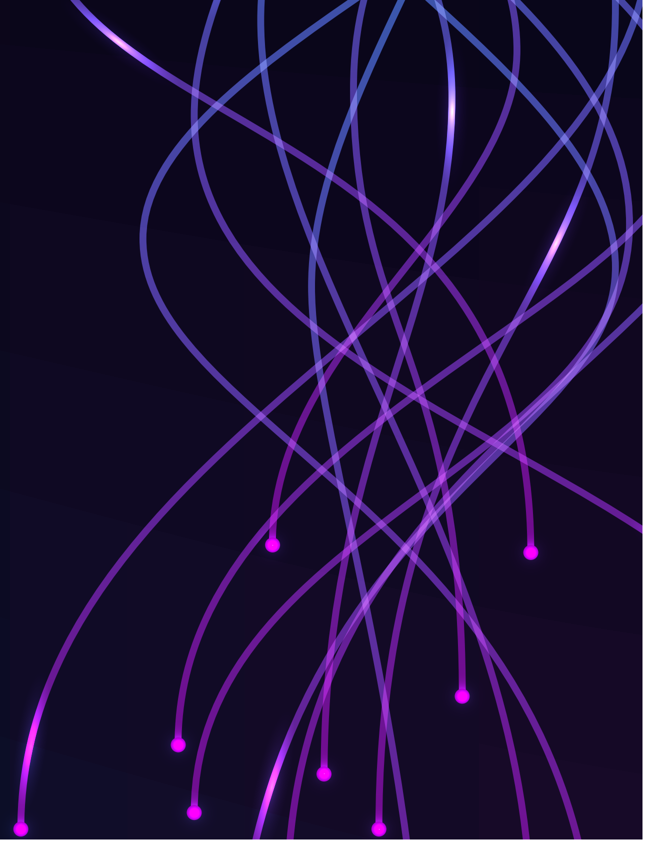
Edge computing

Edge computing avoids transmitting data from remote pipeline locations to centralised servers for processing. Smart devices at pump stations, valves, and compression points can now analyse data in real time without waiting for centralised feedback, which enables faster anomaly detection, operational and emergency responses, as well as reduced bandwidth requirements to the cloud.

Legacy SCADA and DCS systems aren't always "plug-and-play" with AI platforms, says Pipewise. "That's where edge computing and lightweight APIs [Application Programming Interfaces] come in. Modern AI systems can sit on top of your existing data architecture without displacing anything."

The integration of AI and edge computing allows for real-time operational control. Trishita Dhara, Machine Learning Engineer at AI services provider Upper Hand, says that when paired with continuous monitoring systems, smart pipelines can dynamically adjust their own parameters for optimised performance, including changing environmental or →

> "Cybersecurity concerns and safety assurance is required to ensure **the end-to-end pipeline of the AI system is secured."**
>
> GABRIEL GRIFFIN BOOTH, PRINCIPAL CONSULTANT, ENERGY SYSTEMS, DNV



market conditions in real time.

Pipeline integrity improvements

AI models can quickly identify degradation/corrosion trends, maintenance requirements, leakage patterns, and potential third-party interference.

DNV's Griffin Booth says an AI system can assess degradation patterns from historical in-line inspection data alongside real time pressure, temperature, vibration, flow, and other data to help pinpoint when and where corrosion, cracks or pump failure are most likely. Large datasets generated by smart pigging tools, drones and robotic inspections can be analysed using computer vision techniques, automatically classifying corrosion, coating damage, and deformation. The more operational and inspection data available, the better the AI results.

Once analysed, results can be "clustered by severity...maintenance can be shifted to proactive and prioritised tasks, enabling the optimisation of job scheduling and time-to-repair," Griffin Booth says. "By predicting these events before they occur, operators can perform maintenance only when needed, reducing costs and avoiding unplanned outages."

This improves safety, reduces leaks, and optimises inspection and repair spending. An AI system can also consider many more information sources than may be available to an individual or single company, he adds.

In parallel, AI-enabled digital twins (virtual replicas of physical pipelines) integrate real-time IoT data with physics-based models to simulate, analyse and optimise or predict pipeline behaviour. They can also support stress and fatigue analysis, rupture consequence modelling, and optimisation of operating conditions to reduce failure risk.

While traditional systems tend to have fixed thresholds, AI allows for dynamic thresholds based on historical behaviour, seasonal patterns, and equipment performance, according to Pipewise, which further improves leak detection. Pipewise says it is moving towards provision of "self-adaptive leak detection systems that auto-tune sensitivity based on pipeline conditions and seasonal behaviour."

AI models can also reduce the volume of false alarms by filtering out known benign events while prioritising the anomalies that matter, says Pipewise, as well as compensating for low quality data by using known system behaviour, improving overall data integrity.

As capabilities expand, operators should expect fully integrated dashboards combining integrity, operations, maintenance, and optimisation in a unified interface, along with AI co-pilots for control rooms, according to Pipewise.

"Perhaps the most important shift is mindset: from reactive, compliance-driven leak detection to proactive, intelligence-led pipeline management."

Geospatial analytics represent another growing data application. Satellite data analytics can detect geohazards such as landslides, flooding, subsidence, and encroachment along rights of way near pipeline routes to prioritise patrols and inspections, Griffin Booth says.

At a broader strategic level, AI tools can combine this environmental data with technical analysis and economic information to rank pipeline segments by probability and consequence of failure.

Obstacles to AI introduction

The biggest obstacle to AI introduction by far is data quality. Operators must overcome fragmented and inconsistent historical data, which can be challenging to convert into repeatable, automated, and auditable workflows, according to Baucom.

Poor data quality, gaps in data coverage, and the complexity of integrating data from different sources can result in poor performance.

The solution to agree with is to invest in "scheme standardisation, normalisation at ingestion, and robust integration across data sources. Without this foundation, AI will only amplify inconsistencies."

Digital transformation is real, but uneven, says Baucom. Many operators are partially modernised, but the "last mile" – including standardising data definitions across time and vendors, aligning datasets spatially and/or temporally that are in disparate systems, and reducing spreadsheet-driven interpretation – often proves difficult.

"In my experience, the organisations making the most progress aren't buying AI," she says. "They're investing in the foundations that will allow AI: data normalisation, scheme consistency, integration across integrity systems, and governance, so results are reproducible across divisions and years."

Upper Hand's Dhara agrees that operational effectiveness depends heavily on data quality, sensor coverage, and model validation. "False positives, integration challenges with legacy systems, and governance requirements are common obstacles organisations must address before AI can reliably support safety-critical decisions," she says.

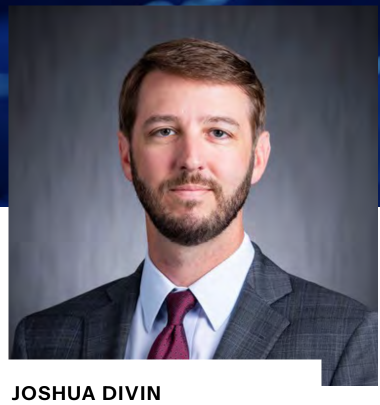
Griffin Booth adds that new analytics also need to ensure cybersecurity resilience. "Cybersecurity concerns and safety assurance is required to ensure the end-to-end pipeline of the AI system is secured with controls evidenced to the appropriate local standards in safety critical environments," he says.

A lack of transparency can also be an obstacle for many engineers, according to Pipewise, so AI systems must offer interpretability, including confidence scores, root cause indicators, and audit trails.

Baucom says transparency is also important to satisfy regulatory requirements: "Integrity decisions must be explainable to regulators. Black-box outputs without traceability will not gain adoption. To achieve this, prioritise explainability, source traceability, and workflow-embedded validation. AI outputs should be transparent, reproducible, and clearly tied back to the underlying data." ●

Embedding data-led decisions and digital twins across the global Gas value chain

Industry is grasping the potential for transformation as trust grows in the models that drive it.



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The global Gas industry is 'leaning in' to the potential of digitalisation within onshore and offshore operations, deploying digital twins to inform and support decision making.

The sheer scale and complexity of next generation energy sector developments requires us to think about design, operations and maintenance in a new way, employing a data-led, digital-first mindset that is also safety-focussed.

Leading LNG majors are advancing this through model-based systems engineering and data-enabled approaches, but the greatest opportunity lies in true life-cycle integration via digital twins across all segments and stakeholders.

How the value chain responds to this transformational challenge will be critical to its ability to manage the projects of the future.

Challenging the installed base

Digitalisation across the global Gas value chain is moving from creating process efficiencies towards digital-first decision-making. The issue the industry faces is that the installed industrial base wasn't designed to be digital-first.

Operators can all recognise the need to move to a data-driven mindset but from a standpoint of operations and maintenance, the industry is working with infrastructure that doesn't reflect data-intensive operations.

Today's practice relies on creating digital models early in the process to inform and drive the design of physical projects. Going forward, developing and integrating digital infrastructure as a critical system, equal in importance to the physical one, will be essential to achieving a successful outcome.

At the design stage, every tag, sensor and system would be specified with a common data model and with digital twin use cases in mind, e.g. process optimisation, integrity, emissions or logistics. There should be a single digital backbone rather than dozens of siloed systems: one trusted source of truth that operations, maintenance, planning and even shipping can all plug into.

The control room would be built for decision support, not just alarm management. Operators would work alongside analytics and AI that can simulate scenarios, propose optimal operating points, and quantify the trade offs between throughput, risk, cost and emissions. Cybersecurity would be treated as a core design constraint, not an afterthought.

Condition-based experience

ABS started its own digital transformation in 2017 – the jump start for us was on work in the maritime sector, where we had traditionally inspected assets against rules and regulations and gone onboard the ships with clipboards and flashlights when an inspection was due.

We had worked for many years providing classification services to the US Navy and in detailed discussions with them, while our process was anchored in rules for safety of operations, we realised it was reactive in nature and could be improved.

Our challenge was to help them better maintain and improve reliability of their assets; to move from a time-based, schedule-driven maintenance model to one based on actual condition supported by data. By focusing on leveraging operational data first, we learned enough from analysis to understand how to approach physical maintenance projects.

We knew what the desired outcomes looked like and by leveraging the available data we could discern trends and create insights into the work needed before we moved to physical inspection.

The proof of the data-first approach can also be seen in the real world. We have subsequently created our own digital twin of a hull form which we fitted with sensors at client request to measure load profiles and other impacts on a vessel in service. When survey time came around, the twin informed surveyors where they should be looking and they found issues exactly where the model predicted they would be.

Development of digital twins

Despite their potential for complexity, digital twins should be seen as one of the tools available for solving problems and creating value. In some cases, a digital twin may not be the right tool to solve a particular problem. To be successful, there needs to be alignment with a use case or intended purpose and a decision on whether a digital twin is the right solution for that use case.

Rather than treat a digital twin like a complete entity, it can be seen as a portfolio of projects to be created in sections.

This is closer to the fail-fast and fail-forward mentality more common in start-ups than in traditional industrial engineering. By applying agile learning and iterative adoption, teams can quickly identify what delivers value for a specific, high-impact →

problem, guided by clear ROI expectations, and scale it effectively. Every successful digital twin starts with data, with cyber security serving as that positive design constraint.

LNG digital twins are already operational. And to move from engineering tool to operational authority, the primary criteria to address are supply of live, reliable data, connecting securely to the control system and gaining operator trust.

Digital projects typically require less capital and carry lower downside risk than large engineering modifications which can be high-risk, slow to deliver and require construction modification, so applying the same hurdle rate as a heavy capex project may undervalue the benefits.

A differentiated hurdle rate, or at least a risk-adjusted evaluation method (low risk, faster, easier to modify), is therefore often more appropriate.

Digital twin initiatives should be judged by whether they increase real plant output and reliability, not by whether they are successful IT projects. When deciding between a digital investment and a physical debottleneck, translate the digital benefit into the same outcomes expected from steel and concrete; focusing on availability, reliability and effective throughput.

We should also consider that Artificial Intelligence will be key to the development of digital twin technology, provided it is founded in managed data. It will evolve as digital twins evolve, whether for process efficiencies, model calibration, or decision support for alerts/recommendations. Large language models could be effective in taking digital twin outputs and quickly contextualising it for users.

Trust and credibility

The credibility of a digital twin is comprised of many factors that extend beyond just the digital twin's fidelity and accuracy: a digital twin that is credible and useful for one use case may not be credible for another.

To make a comparison we can all relate to, today many of us are prepared to get into a driverless cab and have it deliver us to our destination. Five years ago far fewer people would have felt safe enough to do so.

Within the ABS Guidance Notes on Verification and Validation of Models, Simulations and Digital Twins, we identify the need for the digital twin to be trained and operated with trusted data, governed like safety critical systems (verification, validation, and risk assessments) and embedded into operating procedures and culture.

Digital twins that fail do so because they cannot gain authority and do not consistently reflect the live plant. A twin earns operational credibility when the underlying measurements are reliable, time-aligned, and clearly flagged for quality.

For onshore LNG trains for example, it should be possible to allow a digital twin to influence set-points, but only in supervised mode and only after it passes a risk-based acceptance process aligned with solid standards.

In the maritime domain, the trust development process is moving from smart/digital functions to semi-autonomous and ultimately fully autonomous vessel operations. The Autonomous and Smart Function requirements developed by ABS can provide use case-specific functional assessment of these solutions – used in alignment with our Verification and Validation guidance on best practices – as well as consideration of system-of-system elements such as cyber security.

The future

Where does this path lead? Certainly, a digital-first LNG project would design the plant around data flow, not retrofit data onto the plant. A digitally native LNG project developer would start by assuming that high-quality data is as critical as piping, power, or instrument air.

From the outset, instrumentation would be selected to support operational decisions, equipment health, and control stability, not merely minimum compliance. Sensors would be installed with redundancy, clear accuracy expectations, and long-term ownership, positioning the digital infrastructure as a critical contributor to preventative maintenance. Data paths would be resilient, time-synchronized, and easy to audit. There would be no debate later about whether data can be trusted.

The industry has not reached this point because retrofitting foundational data infrastructure into operating LNG facilities is costly, disruptive, and often competes poorly with more visible physical upgrades.

This would collapse the boundaries between engineering, operations and digital. Organisationally these disciplines would not be separate tribes. The people who design the process models would sit close to the people who operate the plant. Operating procedures would explicitly reference live data and model insights, not just static limits. Shift routines would assume that advanced decision support is present and reliable, rather than optional.

A key benefit of building an underlying digital infrastructure is the ability to optimise operational decision-making across what were previously

The energy sector is embracing digitalisation as a means to increase productivity and manage cost performance. There is a consistent pattern that digitalisation initiatives can create sustained economic value, even in asset-intensive industries.

separated silos. Greater transparency means trade-offs such as between engineering and operations, can be more easily seen, rather than being recognised within an individual domain.

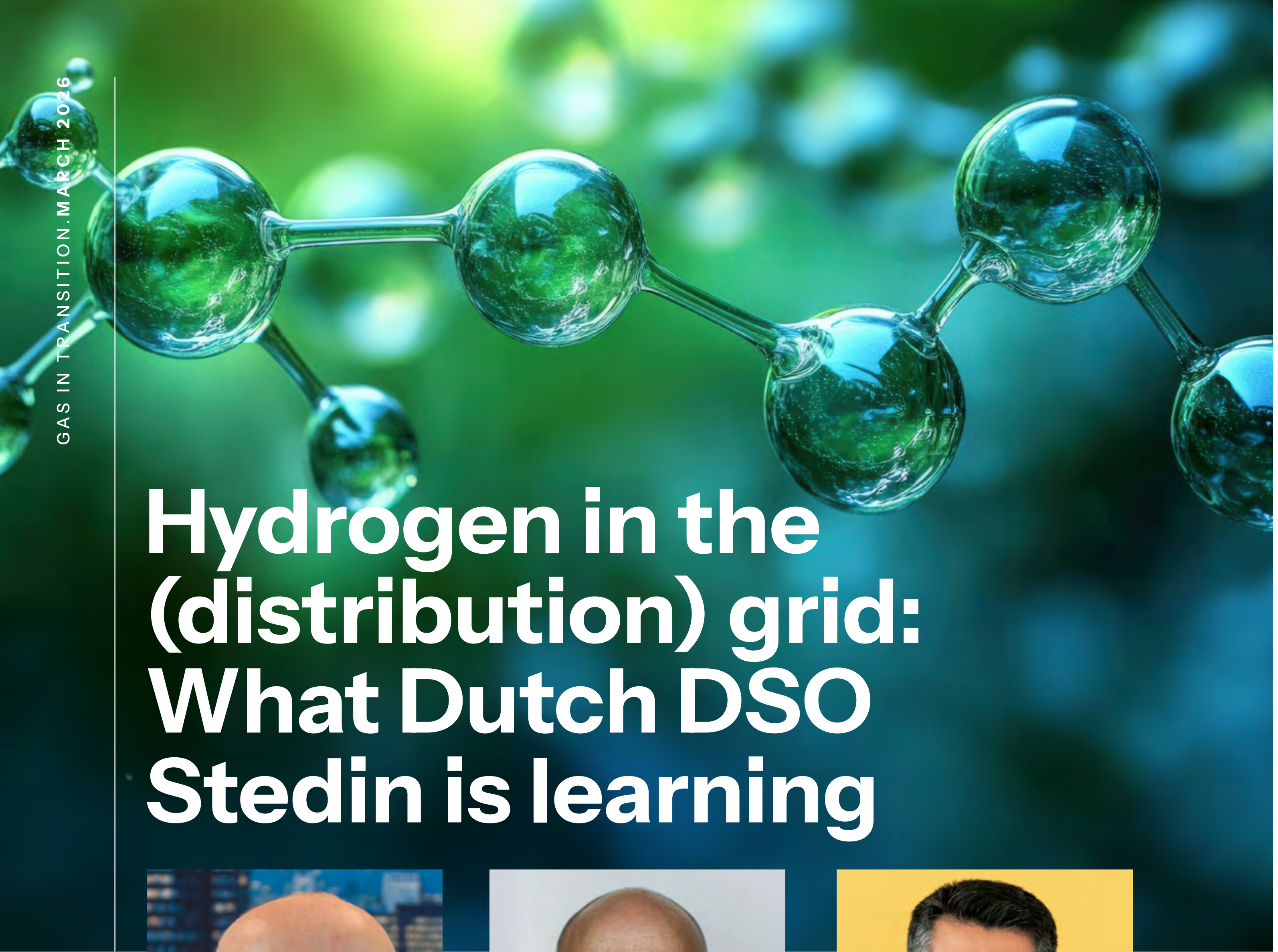
Most LNG value chain organisations have not achieved this because their structures evolved to manage large capital projects. Digital capability arrived later and was often placed in parallel organisations, making ownership and authority unclear.

Going native

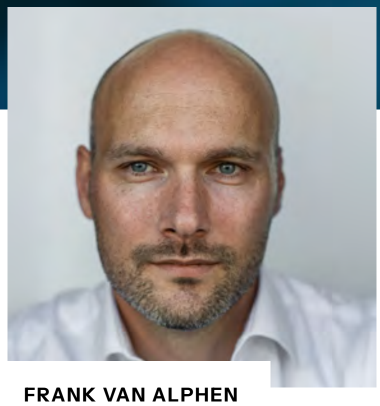
The energy sector is embracing digitalisation as a means to increase productivity and manage cost performance. There is a consistent pattern that digitalisation initiatives can create sustained economic value, even in asset-intensive industries. But perhaps the biggest difference – and barrier to faster adoption – is cultural. A digitally native operator will be data-first model-driven and platform-oriented. They would view authority as something that can be shared between people and systems, as long as it is bounded, observable, and reversible.

Operators would remain firmly in control, but many routine decisions would be supported or steered by systems that earn trust over time through consistent performance. Expertise would be demonstrated not only by individual judgment but by how well teams design, supervise, and improve those systems.

We are not there yet, because trust takes time, evidence and repeated success. LNG operations have been built on individual accountability and caution for good reason. Shifting that mindset toward system supported authority is a gradual process, not a technological leap. ●



Hydrogen in the (distribution) grid: What Dutch DSO Stedin is learning



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A pragmatic Dutch approach

The Netherlands is building a hydrogen economy with clear targets (500 MW electrolysis by 2025; 3 to 4 GW by 2030) and a staged rollout of backbone infrastructure. While Gasunie's Hynetwork aims for first operations in Rotterdam by 2026 and inter-cluster links by 2033, discussions in Netbeheer Nederland, the association of all electricity and natural gas grid operators in the Netherlands, show that full national coverage could extend toward 2040. For DSOs like Stedin, hydrogen in the built environment remains a niche before 2030, but pilots are essential to prepare people, processes, and tools. HyRegions 2 underlines that regional industry will need hydrogen earlier than households, requiring DSOs (distribution system operators), Gasunie (the Dutch gas transmission system operator), and local stakeholders to cooperate on how and where to connect regional demand to the backbone.

What we already did on real streets

Stedin's Rozenburg project (Rotterdam) was the first in the Netherlands to heat existing homes with 100% hydrogen: after verifying a legacy pipeline and installing H_2 boilers, the system supplied part of an apartment complex from locally produced hydrogen (power-to-gas). This gave us practical experience in conversion, operations, and safety management with real tenants.

The second pilot project in Stedin about hydrogen application was in Uithoorn: 14 houses were temporarily switched from natural gas to 100% hydrogen using the existing natural gas infrastructure, which let us execute and check the different activities and present a demonstration on how a series of households and Gas infrastructure in a street can be converted to hydrogen safely and efficiently.

From campus to craft: The Green Village

Together with Alliander and Enexis (two Dutch DSOs), Stedin developed and has been running on hydrogen for more than five years the WaterstofStraat at TU Delft's The Green Village, an open air living lab. The facility lets manufacturers test H_2 appliances and gives DSOs a controlled environment to validate safety measures before entering neighborhoods. These tests confirm what Kiwa research also indicates: existing distribution techniques can be adapted for H_2, but require stricter leak tightness criteria, careful purging (nitrogen), appropriate odorisation, and updated procedures and tools.

Our flagship conversion case: Stad aan 't Haringvliet

On Goeree-Overflakkee island, Stad aan 't Haringvliet is preparing for a village scale conversion under Stedin's lead, with a staged, safe switchover using the existing natural gas distribution network. A joint Stedin–Kiwa study set up the technical concept, timing and safety approach for a conversion of an existing natural gas distribution grid to a hydrogen grid, while local engagement has delivered remarkable resident support. The project will be a real and practical example for the conditions where H_2 in distribution can make sense: no feasible heat network source, local green power production available, and strong community consent, supported by local governmental bodies and national guidance. Recently (December 2025) the Dutch national government granted an additional €6mn (million) for the Stad aan 't Haringvliet project, increasing its feasibility significantly.

Standards, safety and regulation: moving from pilots to policy

Institutionally, the Netherlands has created a Temporary Framework for H_2 pilots enforced by the competition authority (ACM) with safety oversight by SoDM (State Supervision of Mines) enabling pilots in Lochem, Wagenborgen, Stad aan 't Haringvliet and Hoogeveen while broader legislation evolves. On these pilot projects, DSOs of the Netherlands are demonstrating how hydrogen can be safely transported and distributed and delivered to the end users in the different types of houses. These pilots are platforms for DSOs to learn more about possible challenges and prepare their people, processes, and tools for this transition. This progression from theory (future-proof Gas grids) to controlled tests to inhabited pilots sets the Netherlands apart. Where the UK and Germany invested heavily in research, the Netherlands has a more practical approach, and Dutch DSOs are gaining real-world experience with residents.

Strategic perspective for DSOs

Stedin's position has been consistent: until about 2030, hydrogen's primary role is in industry and heavy mobility; in the built environment it is a targeted option for special cases. That is why we test now so that, where justified, we can reuse natural gas assets cost effectively and safely, and be ready when backbone supply reaches our regions. Nationally, hydrogen transmission backbone phasing (2026–2033) and policies confirm that H_2 volumes will scale in five industrial clusters first; in the next step DSOs like Stedin can play an important role to deliver and distribute hydrogen in distribution level to cluster six industries and also play a role in sector coupling and system integration by PtG (power to gas) and GtP (gas to power) plants.

What we still need to solve

- Cost and availability remain decisive. For the built environment, the RVO (the Netherlands Enterprise Agency) view is clear: H_2 heating is technically possible and safe with the right measures (eg, odorisation, excess flow protection), but economical rollout depends on subsidies/regulation.
- In order to make a smooth transition from natural gas to hydrogen possible, Stedin (in close cooperation with several partners) stimulates the development of a multifuel boiler that can switch automatically between natural gas and hydrogen and everything in between. Also the other way around is possible. This way biomethane can be used as a backup when in case of an emergency supply of hydrogen is not possible.
- For safety reasons the Dutch regulator demands →

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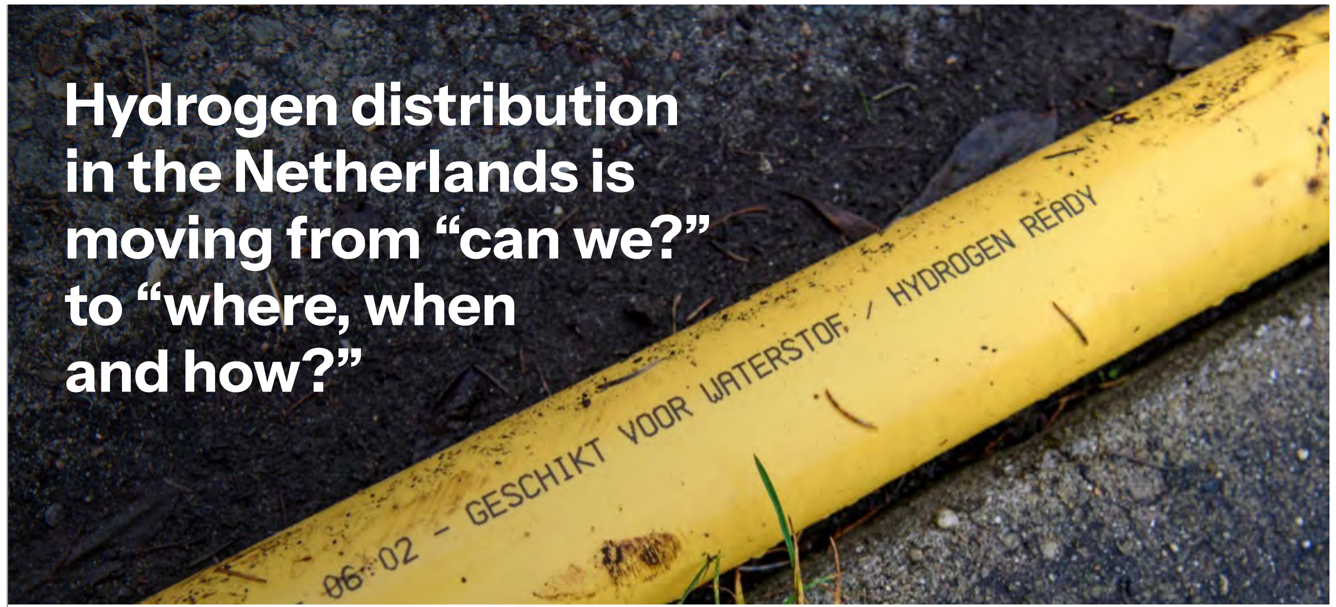

Hydrogen distribution in the Netherlands is moving from "can we?" to "where, when and how?"

hydrogen for households to be odorised. Until now sulphur containing THT has been used. Using THT has many advantages: it works, it is available and its smell is known to many people because it has been in use for many years with natural gas. An important disadvantage is the fact that it contains sulphur which is damaging for low temperature fuel cells. In order not to exclude the application of domestic fuel cells in the future, Stedin (together with partners) does research into new sulphur-free odorants. At the hydrogen test location in Rozenburg another aspect is under investigation: how long does it take for THT on the inside of existing pipelines to reach a concentration level that is acceptable for fuel cells? And what is the effect of the new odorant on desorption of THT in existing pipelines? In the near future these questions will be answered.

Research & Innovation: HyDelta, HyRegions, GroenvermogenNL

In this short article we want to give you a fast review of three main research projects which have some studies about the distribution of hydrogen.

HyDelta

HyDelta is the national research program for hydrogen integration into the Gas grid. It addresses technical, economic, and social barriers to large scale H_2 adoption. Phases 1–3 delivered over 75 reports on topics like leakage detection, material compatibility, odorisation, and safety protocols. HyDelta 4 (2025–2026) focuses on operational planning, emissions monitoring, and asset management for future H_2 networks. All results are open access, making HyDelta a cornerstone for network operators (Gasunie and DSOs) and policymakers.

HyRegions

While HyDelta looks at the "how," HyRegions studies the "where." It maps regional hydrogen demand outside the five big industrial clusters (Cluster 6) and HyRegions 2 explores infrastructure types. It shows that low-pressure networks can be cost-effective for regional industry, mainly due to specific asset choices rather than entire infrastructure. HyRegions calls for early regional cases and a national development plan to align local grids with the national backbone.

GroenvermogenNL

Funded by the National Growth Fund (€838mn), GroenvermogenNL accelerates green hydrogen through R&D, pilots, and human capital programs. It supports electrolysis scaleup (from 5 MW pilots to 100 MW+ chain projects), regional test facilities, and manufacturing of electrolyser components. The program links industry, academia, and DSOs, ensuring that innovation translates into deployable solutions for production, transport, and end use. In the distribution and transmission level, we are now focusing with research bodies on the quality of hydrogen and required sensors for measuring hydrogen quality.

And future?

Hydrogen distribution in the Netherlands is moving from "can we?" to "where, when and how?" The answer is: begin where it adds most value (industrial clusters and suitable towns), build safety and standards through pilots, and synchronise DSO distribution with the national backbone. That is the pathway Stedin is following, practical, staged and focused on societal value. ●

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