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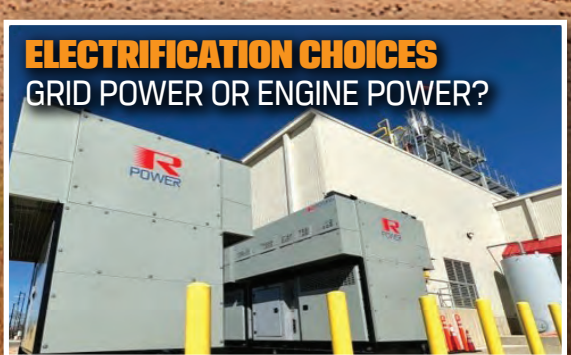

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COMMENT

'Age of Electricity' likely depends on natural gas

The International Energy Agency's (IEA) recent report on global electricity demand calls the next few years the beginning of a new "Age of Electricity." The IEA's experts point to rising global demand for more power, from data centers that underpin AI development to air conditioning for populations who either never could afford it or didn't think they'd need it.

I know there are some in the industry that question the motives of the IEA. That's another discussion. Take what you will from the report, but it's part of the discussion that affects us all.

The report forecasts that the world's electricity consumption will grow close to 4% annually through 2027. Four percent doesn't seem like a crazy-big number, but the report brings some context by noting that would be the equivalent of adding an amount greater than Japan's annual electricity consumption every year between now and 2027. Japan is a country of 125 million.

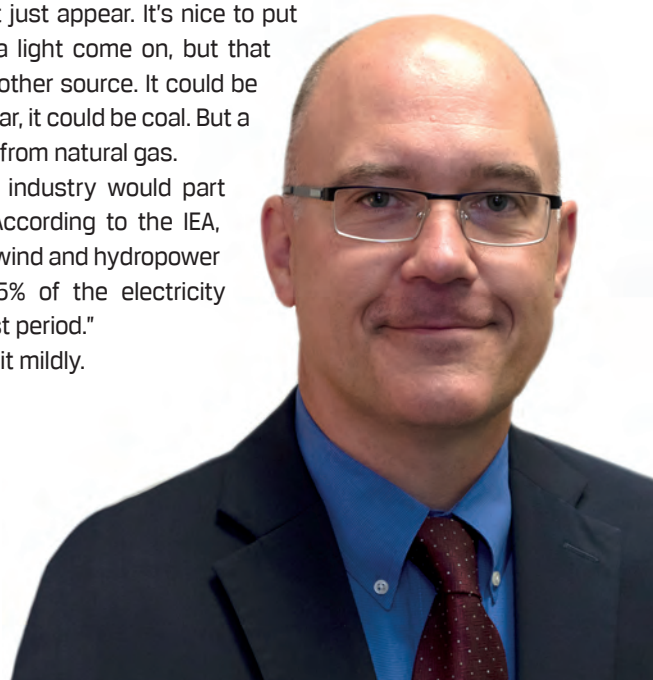
"Most of the additional demand over the next three years will come from emerging and developing economies, which account for 85% of the demand growth," the report states. "The trend is most pronounced in China where electricity demand has been growing faster than the overall economy since 2020."

Notable, too, from the report: Demand for electricity in advanced economies is rising again, bucking a 15-year trend.

Thing is, electricity doesn't just appear. It's nice to put a plug in the wall and have a light come on, but that energy is coming from some other source. It could be nuclear, it could be wind or solar, it could be coal. But a big percentage of it will come from natural gas.

Here's where most in our industry would part ways with the IEA's report. According to the IEA, "Renewables – such as solar, wind and hydropower – are set to meet about 95% of the electricity demand growth in our forecast period."

That seems unlikely, to put it mildly.



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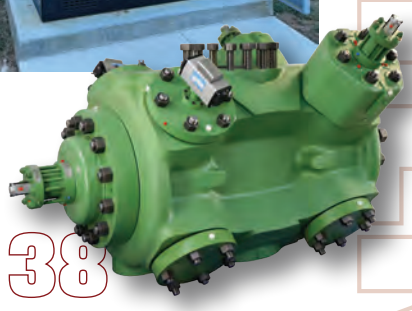
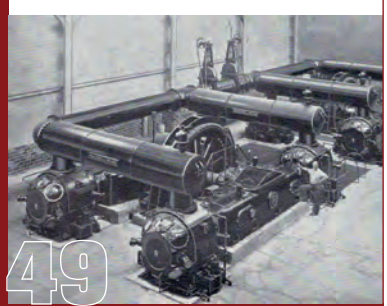
CONTENTS



REGIONAL REPORT

TECHNOLOGY

INDUSTRY



DEPARTMENTS

OUTSIDE

22

North Africa struggles to meet potential.

VOLUME 30 | NUMBER 2

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Baker Hughes picked for LNG terminal

Argent LNG selected Baker Hughes as the liquefaction solution and related services provider for its proposed liquified natural gas (LNG) export facility in Port Fourchon, Louisiana.

Baker Hughes will supply liquefaction solutions, power generation equipment, and gas compression systems for the facility, which is set to deliver approximately 24 million tonnes per annum (MTPA) of LNG. The announcement was made during Baker Hughes' Annual Meeting in Florence.

The project will incorporate Baker Hughes' advanced technologies, including its NMBL modularized LNG solution powered by the LM9000 gas turbine. These modules, pre-fabricated and tested at Baker Hughes' facilities, will help ensure scalable and reliable LNG production to the project and integrate iCenter digital solutions powered by Cordant to maximize availability, reliability, and operational efficiency. Baker Hughes will also provide power generation units driven by LM9000 gas turbines and provide multi-year services to support Argent LNG terminal operations.

By leveraging its extensive knowledge and experience in LNG development, Baker Hughes said it will help optimize project execution, and ensure a streamlined, cost-effective design, allowing Argent LNG to move forward with greater efficiency and financial certainty.

"We chose Baker Hughes because of their proven cutting-edge technology, established LNG market presence, and commitment to innovation — all of which align perfectly with Argent LNG's vision to provide transformative energy solutions," said Jonathan Bass, chairman and CEO of Argent LNG. "This collaboration underscores Argent LNG's commitment to technical

MAN supplying methanation technology

Green hydrogen and e-methane producer Ren-Gas selected MAN Energy Solutions' methanation technology for its Tampere e-methane plant in Finland.

MAN Energy Solutions will deliver 50 MWel methanation reactor for Ren-Gas Tampere e-methane plant. The equipment delivery will consist of catalytic methanation reactor designed and manufactured at MAN Energy Solutions Deggendorf, Germany.

MAN's catalytic methanation technology will be used to convert green hydrogen and captured biogenic CO_2 into renewable e-methane.

MAN Energy Solutions will oversee the design, manufacturing, pre-fabrication, testing, delivery, installation supervision, commissioning, and performance testing of the equipment. This extensive scope guarantees that the project leverages MAN's advanced technology and expertise at every phase, from initial design to final performance validation.

"With (MAN's) methanation technology we are able to reach very good methane production efficiency, and to expand our sector integration opportunities even further," said Mikko Piekkala, Commercial Manager, Ren-Gas.

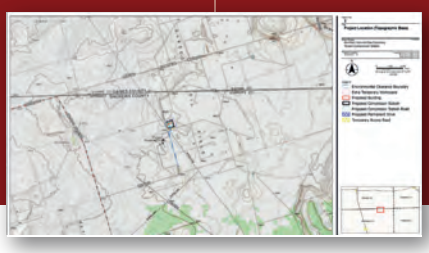
Christian Obermeier, Sales Manager at MAN Energy Solutions Deggendorf, said MAN Energy Solutions is a Power-to-Gas pioneer, commissioning its first methanation reactor in 2013.

"Since then we have collected comprehensive and valuable operational experiences, which will be incorporated into the design of this new reactor making

COMPRESSED NEWS

NORTHERN NATURAL GAS OF NEBRASKA is asking the Federal Energy Regulatory Commission (FERC) for authorization to install and operate a new compressor station consisting of one new 11,152 hp natural gas-fired compressor turbine unit.

The Tarzan Compressor Station Project is located in Andrews County, Texas and will be tied into Northern's existing TXM15501 pipeline. The project will create 87,000 dekatherms per day of incremental firm service, which is fully subscribed. The estimated cost for the project is $36.1 million.



IES HOLDINGS has acquired Arrow Engine Co. from TriMas Corp. for an undisclosed sum.

Arrow, a Tulsa, Oklahoma-based provider of engines, generator sets, compressors, and replacement parts primarily for the natural gas production market, was founded in 1955.

The acquisition includes Arrow's owned manufacturing facility in Tulsa, which consists of 130,000 square feet of manufacturing space. Arrow, with estimated calendar year 2024 revenue of US$20 million, will become part of IES's Infrastructure Solutions segment and continue to operate under the Arrow name.

Arrow's products include single and multi-cylinder engines, replacement parts,

IMAGE: ARGENT LNG

Baker Hughes will provide infrastructure for the Argent LNG's 24 mtpa Louisiana project, seen here in an artist's image. The facility is slated to start construction in 2026.

excellence, cost-effective execution, and energy security, while also strengthening the project's bankability by leveraging Baker Hughes' proven expertise and industry leadership. Today's announcement demonstrates how innovation and collaboration can drive progress in the LNG industry, helping to secure affordable, sustainable energy for global markets."

Phase 1 construction is targeted to begin in 2026, with commercial operations expected by 2030. Phase 2, which aims to expand capacity, is advancing through critical milestones, including resource reporting, securing FERC approvals, formalizing gas supply agreements, and achieving financial close.

Baker Hughes expects orders in relation to this agreement, as the Argent LNG project progresses and reaches Final Investment Decision, further solidifying its key role in Argent LNG's long-term success.

"Today's announcement is a further testament to the technology capabilities that we have built over the past 30-plus years in LNG. This collaboration with Argent LNG underscores our commitment to delivering advanced, best-in-class LNG solutions," said Lorenzo Simonelli, chairman and CEO of Baker Hughes. "As global energy demand continues to grow, we are committed to providing innovative technology solutions to the LNG industry, a key supplier of reliable and affordable energy to many countries around the world."

Argent LNG LLC is a privately held energy company dedicated to developing world-class LNG export solutions to meet the rising global demand for clean, reliable energy. Based in Louisiana, Argent LNG is focused on leveraging cutting-edge technologies and strategic partnerships to deliver cost-effective, sustainable, and efficient energy solutions. The company's proposed export facility at Port Fourchon is designed to strengthen energy security and economic growth while reinforcing the United States' leadership in the global LNG market. **CT2**

it highly efficient and resulting in a high methane quality," Obermeier said. "Our innovative engineering know-how paired with a decade-long experience in methanation makes us unique in the Power-to-Gas field."

Ren-Gas's facility in Tampere is set to produce renewable e-methane for heavy road and maritime transport sectors. The plant will yield approximately 200 GWh of renewable fuel.

The Tampere facility is scheduled for construction in 2025, and commercial operation will start in 2027.

compressors, gas products, chemical pumps and electronics.

GTT, a French developer of containment systems for liquefied natural gas (LNG) carriers and other transport and storage systems, said CEO **Jean-Baptiste Choimet** resigned effective immediately.

The company named Philippe Berterottière, chairman of the Board of Directors, as CEO on an interim basis.

The Board of Directors has decided to initiate a process to select a new CEO.

Energy Transfer, data center firm in natural gas deal

Energy Transfer has entered into a long-term agreement with Denver-based CloudBurst Data Centers to provide natural gas to CloudBurst's flagship AI-focused data center development in Central Texas.

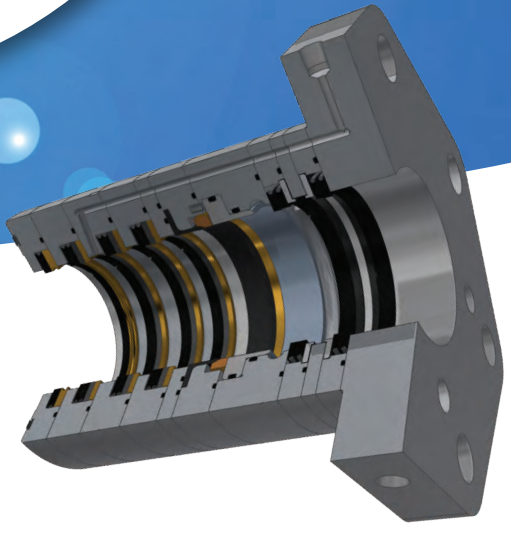
The agreement calls for Energy Transfer's Oasis Pipeline, LP to provide up to 450,000 MMBtu per day of firm natural gas supply to CloudBurst's Next-Gen Data Center campus outside of San Marcos, Texas, subject to CloudBurst reaching a final investment decision (FID) with its customer. The natural gas supply would be sufficient to generate up to approximately 1.2 GW of direct, or "behind-the-meter" electric power for a period of at least 10 years starting with Phase 1 of the data center facilities. CloudBurst expects to reach FID later this year and in such event the facility would be operational in Q3 of 2026.

This represents Energy Transfer's first commercial arrangement to supply natural gas directly to a data center. Energy Transfer said it is uniquely positioned to provide reliable natural gas supply that is crucial to the data center operations under development, many of which are in close proximity to its vast network of more than 105,000 miles of natural gas gathering, and intrastate and interstate transportation pipelines and storage facilities with a combined storage capacity of nearly 236 billion cubic feet. Additionally, Energy Transfer is in discussions with a number of data center developers and expects this to be the first of many agreements to supply, store and transport natural gas to fuel data centers, electric generation facilities and other power demand customers throughout its nation-wide footprint. **CT2**

IMAGE: CLOUDBURST DATA CENTERS

Energy Transfer will supply data center developer CloudBurst Data Centers with natural gas for its data center campus planned for Texas.

NEAR-ZERO EMISSIONS



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EIA raises natural gas price expectations

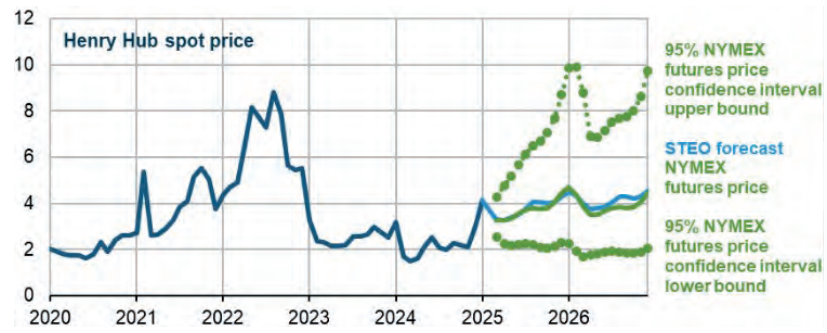
In its February Short-Term Energy Outlook (STEO), the U.S. Energy Information Administration (EIA) updated its forecast for U.S. natural gas prices, reflecting the impact of a cold snap that struck at the end of January. The EIA now expects the average Henry Hub natural gas spot price to rise to nearly $3.80 per million British thermal units (MMBtu) in 2025, an increase of 65 cents from its previous projection in January. This revision follows a spike in prices earlier in January, when the spot price averaged $4.13/MMBtu and reached a high of $9.86/MMBtu on January 17 due to a cold wave and above-average withdrawals from storage.

Looking further ahead, the EIA anticipates natural gas prices will continue to climb, averaging close to $4.20/MMBtu in 2026. Despite this, other energy forecasts in the STEO remain largely unchanged, particularly with regard to the U.S. electricity generation outlook. The EIA projects a 2% increase in electricity generation for 2025 and a 1% increase for 2026, building on a 3% rise in 2024. Growth will be driven by renewable energy sources, particularly solar, which is expected to grow from 5% of the U.S. electricity generation mix in 2024 to 8% by 2026, thanks to a planned 45% increase in solar capacity.

On the other hand, natural gas's share of U.S. electricity generation is expected to decline from 43% in 2024 to 39% by 2026, as rising natural gas prices limit its use in power generation. These shifts reflect the increasing role of renewables in the energy mix, with both solar and wind generation benefiting from planned generator projects.

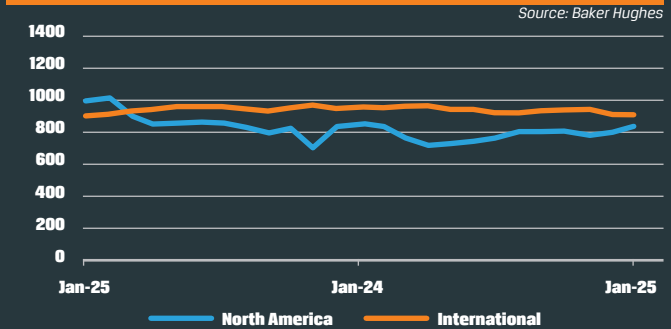
Additionally, the EIA's forecasts are based on macroeconomic assumptions that were finalized prior to the imposition of new tariffs on Canada, Mexico, and China in early February. CT2

HENRY HUB NATURAL GAS PRICE AND NYMEX CONFIDENCE INTERVALS
(Dollars per million British thermal units)

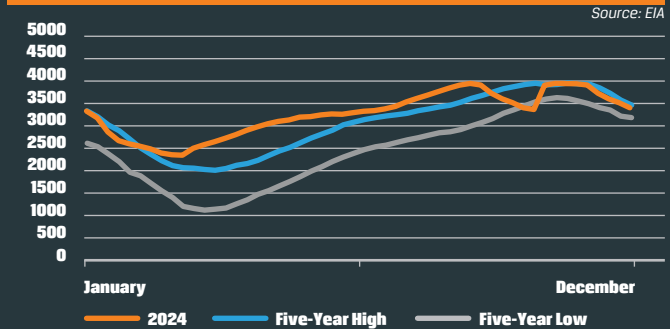


Data source: U.S Energy Information Administration, Short-Term Energy Outlook, February 2025, CME Group, and Refinitiv an LSEG Business
Note: Confidence interval derived from options market information for the five trading days ending February 6, 2025. Intervals not calculated for months with sparse trading in near-the-money options contracts.

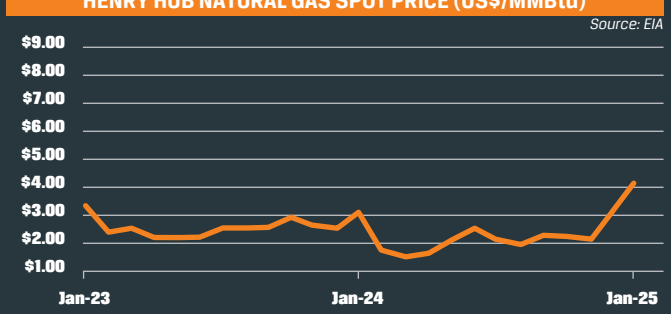
BAKER HUGHES RIG COUNT



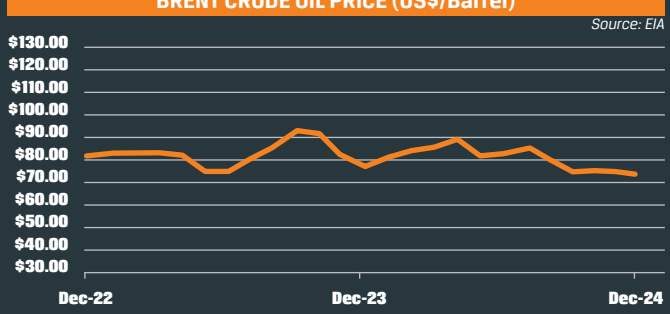
US NATURAL GAS STORAGE (Bcf)



HENRY HUB NATURAL GAS SPOT PRICE (US$/MMBtu)



BRENT CRUDE OIL PRICE (US$/Barrel)



Greenfield gas storage online

Trinity Gas Storage announced the commencement of operations of Texas's first greenfield gas storage facility in more than a decade.

Phase I of the 24 Bcf gas storage facility in East Texas reached operational status 16 months from final investment decision, demonstrating the team's leading development and construction capabilities.

The facility is also one of the first physical assets added to the Texas power grid (ERCOT) that directly addresses the supply and reliability challenges encountered during Winter Storm Uri, the company said.

Positioned strategically in Anderson County to support Texas' growing energy and power demands, particularly related to accelerating AI and data center growth, Trinity is a critical asset to enhancing the state's energy resiliency.

Trinity has already secured contracts with a diverse group of customers, including power generators, producers, utilities, and marketing and trading companies – including those with LNG exposure. Due to growing demand for Trinity's capabilities, the company has already advanced plans to

Trinity Gas Storage announced the commencement of operations of Texas's first greenfield gas storage facility in more than a decade.

RNG project goes online

GreenGasUSA and Pilgrim's Pride announced the commissioning of a renewable natural gas (RNG) project at Pilgrim's poultry processing facility in Sumter, South Carolina.

At the Pilgrim's Sumter processing facility, GreenGas is building upon existing methane capture capabilities and investment to convert biogas from wastewater streams, upgrading the biogas to pipeline quality RNG. The collaboration is expected to reduce greenhouse gas emissions at the Sumter facility while improving wastewater operations, as well as local air and water quality.

GreenGas CEO and Founder Marc Fetten commented, "This project represents another significant win for South Carolina agriculture and industry and our environment. It is a demonstration of industries coming together and leading our collective journey into a lower carbon future while creating economic and environmental benefits for our communities. The renewable energy produced at this project is enough to power almost all the homes of the entire workforce working at the Pilgrim's Sumter plant, and is produced from what, until recently, was simply a waste stream."

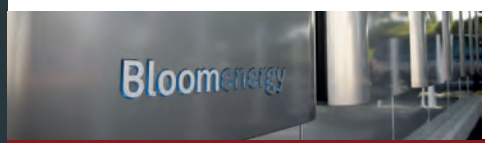
The Sumter RNG project is the first operational site under a strategic partnership between the two companies focused on the adoption of circular economy technologies and repurposing of waste streams into renewable energy.

Bloom Energy, Chart team on carbon capture

Bloom Energy and Chart Industries have joined forces to provide an advanced carbon capture solution that uses natural gas and fuel cells to generate near-zero-carbon, always-on, power.

The companies said the collaboration is set to offer solutions to industries such as data centers and manufacturers looking for low-carbon solutions.

Bloom Energy, known for its fuel cell technology, produces electricity without



Bloom Energy and Chart Industries are teaming up on carbon capture.

COMPRESSED NEWS

Jason Williams has joined **NETZSCH PUMPS USA** as Industrial Regional Sales Manager for the Gulf Coast Region. Based in the Houston office, Williams brings over 20 years of experience in the industrial and oil and gas markets to his new role at Netzsch.

In his position, Williams will lead all sales efforts in the Gulf Coast Region, and his responsibilities will include supporting and developing the Gulf Coast Region Distribution Network and identifying new business opportunities that align with Netzsch's strategic growth objectives.

Williams' extensive background working with distribution channels, OEMs, end users, and EPCs equips him with a comprehensive understanding of the marketplace. This broad vision will be instrumental in driving Netzsch's expansion and market penetration in the region.

Netzsch is the world's largest manufacturer of progressing cavity pumps,

in Texas

expand both capacity and deliverability, with the next phase targeted for completion in the second quarter of 2026.

"The opening of the facility marks a significant achievement for Texas' energy security and electrical reliability," said Trinity CEO Jim Goetz. "The overwhelming support from both our investors and our customers highlights the vital role this facility plays in providing secure and reliable services to Texas' gas market."

The Trinity storage facility will serve as a vital buffer to balance supply and demand for natural gas, ensuring continuous service during times of peak electricity demand. With its central location and robust connections to existing pipeline infrastructure, the facility is well-positioned to enhance reliability across Texas' energy grid. **CT2**

combustion, resulting in a concentrated CO_2 stream with a significantly higher concentration than conventional natural gas-based power generation methods. This creates a more efficient and cost-effective pathway for capturing carbon, the companies said.

Chart Industries, a recognized leader in energy and industrial gas solutions, will leverage its expertise to process the CO_2 captured by Bloom's fuel cells. **CT2**

Cummins, Liberty Energy team on frac platform

IMAGE: CUMMINS

A Cummins HSK78G Gas Generator Series engine. Cummins and Liberty Energy said the industry's first natural gas variable speed, large displacement engine will power Liberty's digiPrime hydraulic fracturing platform.

Cummins and Liberty Energy said they will deploy the industry's first hydraulic fracturing platform to be powered by a natural gas variable speed, large displacement engine.

The Cummins HSK78G natural gas engine will power Liberty's digiPrime hydraulic fracturing platform with deployment coming in the first half of 2025. The companies entered into a strategic partnership in June 2024 to jointly develop the technology for the completions services market.

"The successful development of the variable speed digiPrime pump reflects our continued commitment to innovation in pump technology that advances efficiency goals while reducing emissions," said Ron Gusek, president and named successor to the Chief Executive Officer of Liberty. "A variable speed, direct drive platform enhances our already industry-leading digiFleet offering by combining high fuel efficiency with the ability to manage transient load and precision rate control, unrivaled in the industry."

One of the key benefits of the HSK78G base engine that makes it inherently well suited to the well-servicing industry is its adaptability and flexibility, the companies said. The engine has a high tolerance to fluctuations in the methane content of the fuel and can operate across various gas compositions – offering customers greater flexibility on their fuel source when in the field.

Furthermore, it is designed to be compatible and adapt across multiple well-servicing transmissions. This solution, with its front power take-off, will also provide customers with options to support auxiliary power needs on location when operating below peak load.

The Cummins HSK78G natural gas engine was launched in March 2019 as part of a fixed speed generator set for the power generation market.

Designed to provide reliable power, regardless of the natural gas source or the operating environment, the engine reached new levels of efficiency and improved total cost of operation.

The recent development effort for Liberty's digiPrime platform leverages the already successful HSK78G platform and improves the 78L natural gas spark-ignited engine's response time and load acceptance during operation, the companies said.

rotary lobe pumps, multiple screw pumps, peristaltic pumps, grinders and macerators, metering systems and accessories.

Turbomachinery services company **BLACKSTONE USA** is consolidating its three locations in the Greater Houston area into one state-of-the-art 77,000 sq. ft. facility at 1600 Brittmoore Road in West Houston in the heart of the Energy Corridor.

This facility will be the company's new Technical Center of Excellence for Turbomachinery and will serve as home base for field and corporate, parts distribution center, engineering and technical center and the center for repairs.

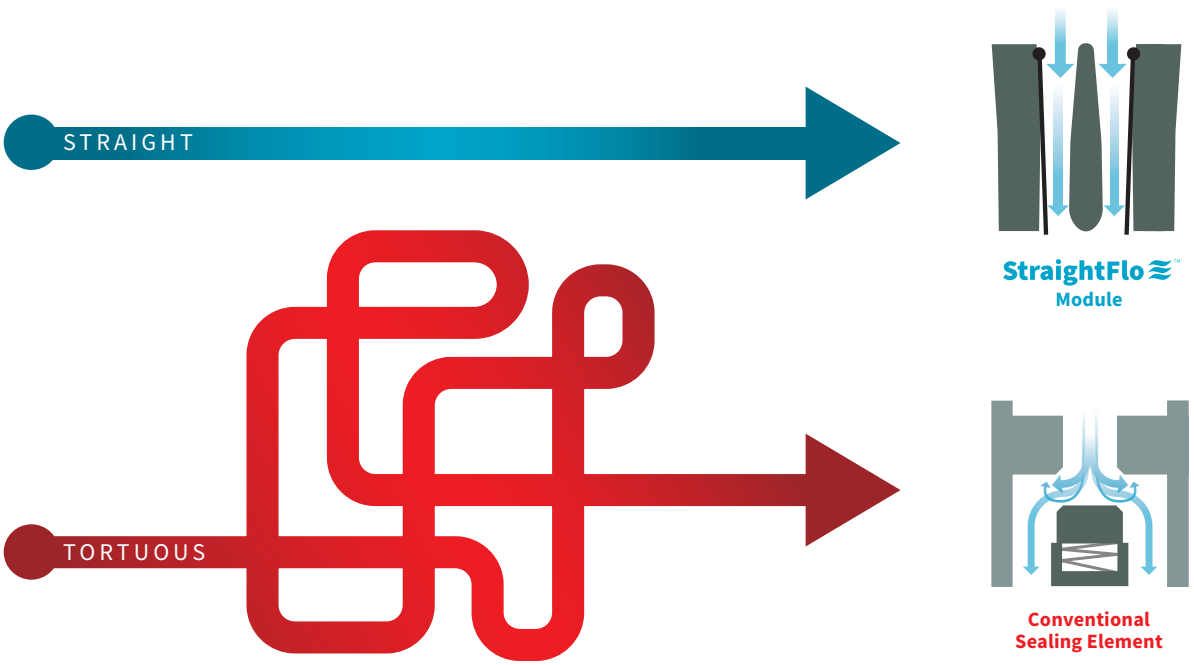
Parts Distribution Center – Streamlined operations for faster delivery and better service.

The company said consolidating operations and expanding repair services under one roof reinforces its commitment to delivering greater efficiency, faster turnaround times, and top-tier turnkey services.

TALOS ENERGY has appointed **Paul Goodfellow** as president, CEO and a member of the company's Board of Directors, effective March 1.

Goodfellow has more than 30 years of domestic and international experience in the oil and natural gas industry. During his tenure at Shell, Goodfellow held various senior executive roles, including leading Shell's global deepwater business.

Straight Vs. Tortuous
Which Uses Less Energy?



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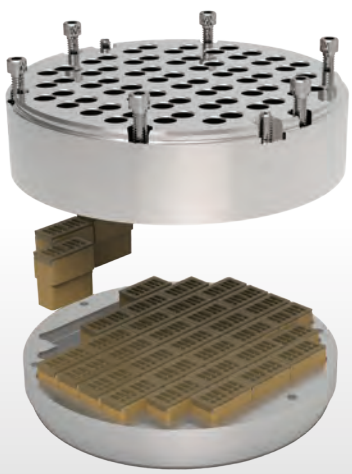

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FERC reinstates certificate for Transco pipeline expansion

Comes after earlier approval thrown out by Court of Appeals. By **Brian Ford**

The Federal Energy Regulatory Commission (FERC) on January 24 unanimously reinstated the certificate for Williams Companies' Transcontinental Gas Pipe Line (Transco) Regional Energy Access (REA) expansion project, which is designed to deliver natural gas to customers in New Jersey, New York, Pennsylvania and Maryland.

FERC's action came after the U.S. Court of Appeals for the District of Columbia Circuit threw out the commission's approval of the project in July last year. The court said FERC should have better assessed the risk of significant greenhouse gas emissions and did not adequately explain why it dismissed studies that said the project was not needed.

Designed to increase natural gas transportation capacity by up to 829,000 dekatherms per day to serve approximately 4.4 million homes annually in the Northeast, the US$950 million project consists of 22 miles of 30-inch diameter lateral pipeline and 14 miles of 42-inch diameter loop pipeline. It includes a new electric motor-driven compressor facility and modifications to five existing compressor facilities.

"The recent bitter cold conditions across the Northeast are an important reminder of the vital role transmission pipelines play in delivering the natural gas necessary to keep millions of Americans warm, safe and secure," said Alan Armstrong, president and chief executive officer of Williams. This winter, natural gas volumes on the Transco pipeline system surged due to frigid temperatures, Williams said, leading the system to reach an all-time peak day on January 23, with a total volume of 19.17 billion cubic feet per day.

The American Gas Association said the expansion project, which is currently transporting natural gas, had been at risk of being taken out of service on January 28 without FERC's reinstatement.

FERC originally granted the certificate order for the project in January 2023. But in July 2024, the Court of Appeals remanded and vacated the certificate, saying the certificate order violated the U.S. Natural Gas Act and the National Environmental Policy Act. Despite the court's action, Williams' Transco was allowed to continue operating the project.

Studies called into question

At the time of the court's action, the expansion project was already partially in service, and began full operation on August 1, 2024.

In vacating FERC's certificate, the Court of Appeals said the commission had "arbitrarily discredited" two studies that showed existing natural gas capacity in New Jersey would be enough to meet demand after 2030. One study said demand could be met with existing gas supply over the coming years by contracts for off-system peaking resources. According to the court, FERC "stopped short of making or supporting any prediction that off-peaking supplies are in fact likely to become scarcer in the future or suffer new uncertainty or increased variability. It gestured at 'the potential for extreme weather events' as jeopardizing New Jersey LCDs' (local distribution companies) access to off-system supply sources," but "failed to clarify why the current supply of off-system peaking sources is insufficient to meet the potential demand created by extreme weather events and to provide a basis for its claim that the potential for extreme weather creates uncertainty in the availability of these resources to New Jersey LDCs."

In reinstating the project certificate, FERC said the study that was cited by the court "significantly understated the need for additional pipeline capacity," particularly during times of heightened demand. FERC said the study "ignored the fact that if the downstream firm capacity customers exercise their rights to the capacity, then New Jersey LDCs will not be able to rely on it." In short, that study "ignored demand from other customers, including electric generators and industrials."

The appeals court also maintained that FERC failed to properly balance the benefits of the pipeline project against the harm caused by greenhouse gas emissions, and instead "seemingly swept the issue under the rug."

FERC said it "continued to find that Transco has taken sufficient steps to minimize adverse impacts on landowners and surrounding communities, and that the benefits of the project in improving reliability and diversifying supply outweigh potential adverse effects." **CT2**

THE AUTHOR

BRIAN FORD is editor in chief for Industrial Info Resources, which provides up-to-date project information on a wide range of industries across the globe. He has worked as a reporter and editor for newspapers and other publications since 1979.

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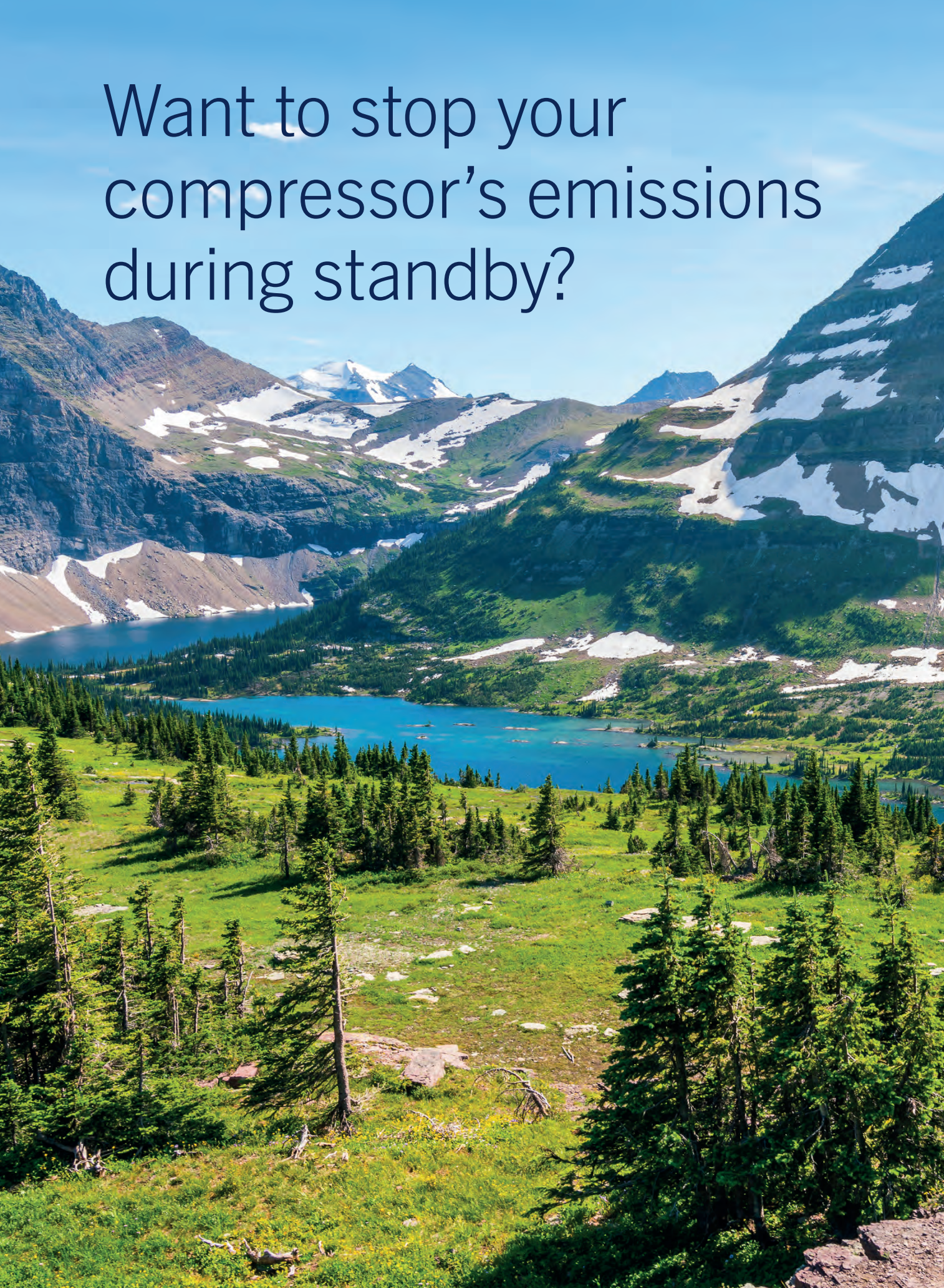

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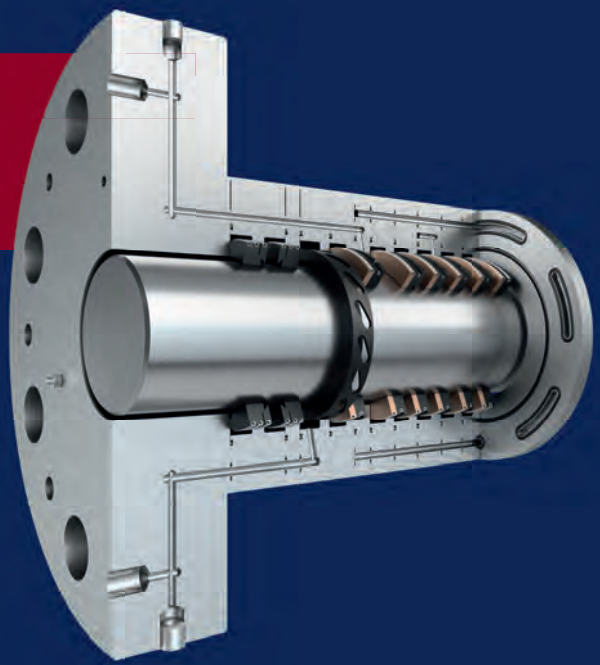

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Shale play-by-play

James Willis highlights the latest news from the major North American shale plays

BAKKEN/WILLISTON

Kinder Morgan buys Outrigger Energy II

Kinder Morgan said its subsidiary, Hiland Partners Holdings will buy North Dakota natural gas gathering and processing system from Outrigger Energy II for $640 million. The acquisition includes a 270 MMcf/d processing facility and a 104-mile, large-diameter, high-pressure rich gas gathering header pipeline with 350 MMcf/d of capacity connecting supplies from the Williston Basin area to other markets. Long-term contracts with commitments from major customers in the basin back the gathering and processing system.

Open season for natgas pipeline to serve the Bakken

Intensity Infrastructure Partners LLC launched an open season to determine whether there is support for constructing the Intensity Pipeline. The proposed 136-mile, 42-inch-diameter natural gas transmission pipeline, with a capacity of approximately 1.5 Bcf/d, would originate in the Bakken-producing region in western North Dakota and terminate in southern McLean County, North Dakota. The open season was scheduled to end on March 7, 2025.

Pearl invests in Eagle Mountain II

Eagle Mountain Energy Partners II (EMEP II) announced an undisclosed money commitment from investment firm Pearl Energy Investments. This commitment enables EMEP II to pursue U.S. onshore acquisition and development opportunities, primarily focusing on the Williston Basin. EMEP II's predecessor, EMEP I, successfully monetized its Williston Basin assets in 2024, also in partnership with Pearl.

EAGLE FORD (Austin Chalk, Tuscaloosa Marine Shale)

Plains All American buys Ironwood

Plains All American Pipeline signed an agreement to acquire Ironwood Midstream Energy, which owns an Eagle Ford Basin gathering system, from EnCap Flatrock Midstream for approximately $475 million. Ironwood's assets include 400 miles of crude oil and natural gas pipeline serving ≈245,000 dedicated acres. System throughput is ≈400,000 bpd of crude oil and ≈410 MMcf/d of natural gas. The transaction is expected to close in the first quarter of 2025 following satisfaction of customary closing conditions.

MARCELLUS/UTICA

MVP flows full capacity for first time

On June 14, 2024, the 303-mile Mountain Valley Pipeline (MVP) that runs from Wetzel County, WV, to Pittsylvania County, VA, announced the pipeline had, after a decade of planning and building and legal delays, finally begun to flow Marcellus/Utica molecules. The effect was profound and immediate, raising prices for M-U gas at the source and lowering the price at the destination. However, in the first month the pipeline was online, it flowed only about half its rated 2 Bcf/d capacity. Since then, other pipelines connecting to and taking gas from MVP have come online, gradually boosting flows. It was not until January of this year that MVP flowed a full 2 Bcf/d (technically 1.96 Bcf/d) of M-U gas for the first time.

New project to flow M-U gas to D.C.

Eastern Gas Transmission and Storage, a subsidiary of Berkshire Hathaway Energy, filed a new project with FERC to expand three compressor stations in Centre, Clinton, and Franklin counties in Pennsylvania and

PERMIAN (Delaware, Midland)

Diversified to acquire Maverick

Diversified Energy signed a deal to acquire and merge with Maverick Natural Resources, a portfolio company of EIG, for $1.28 billion. The multi-basin deal gives Diversified an entry into the Permian Basin with Maverick's assets in multiple operating zones in the northern Delaware Basin, Northwest Shelf, and Central Basin Platform. The combined company will have an enterprise value of approximately $3.8 billion and operate across five distinct operating regions. Diversified, with over 60,000 mostly conventional gas and oil wells, currently produces ≈850 MMcfe/d. Maverick currently produces ≈350 MMcfe/d from roughly 8,000 wells.

Gulf Coast Express construction

Kinder Morgan, Inc. reports preliminary construction is underway on the fully contracted Gulf Coast Express Pipeline LLC (GCX) expansion project. The $455 million project will increase natural gas deliveries from the Permian Basin to South Texas markets by 570 MMcf/d. It is expected to be in service in mid-2026. KMI operates the pipeline, which it jointly owns with an affiliate of ArcLight Capital Partners.

Evangeline Pass nears completion

Construction continues on the second phase of the $672 million Evangeline Pass project, which is expected to be in service on July 1, 2025. The two-phase project involves modifications and enhancements to portions of the Tennessee Gas Pipeline and Southern Natural Gas systems in Mississippi and Louisiana, which will deliver 2 Bcf/d of natural gas to Venture Global's Plaquemines LNG export facility.

MIDCONTINENT (Anadarko/ SCOOP/STACK)

NGP looks to sell Camino

Reuters reported anonymous sources claim private equity firm NGP Energy Capital Management is exploring a $2 billion sale of natural gas producer Camino Natural Resources. Camino is one of the largest remaining private producers in Oklahoma's Anadarko Basin, owning roughly 135,000 net acres. NGP is rumored to be working with RBC Capital Markets on an auction of the assets.

one compressor station in Loudoun County, Virginia, to flow Marcellus molecules to the Washington, D.C. area. Called the Capital Area Project, the upgrades will allow an extra 67,500 Dth/d of Marcellus molecules to flow from the Transco-Leidy Station in northeastern PA to the Loudoun Station in northern Virginia. Washington Gas Light Company, a regulated natural gas utility serving 1.1 million customers in metropolitan Washington, is contracted to purchase all of the gas.

TETCO wants to swap gas for electric

Texas Eastern Transmission Pipeline Company (TETCO) filed a FERC request to revise plans for the pipeline's Entriken Compressor Station in Todd Township, Huntingdon County,

HAYNESVILLE

Kinder Morgan FID for Mississippi Crossing

Kinder Morgan's Tennessee Gas Pipeline subsidiary announced a final investment decision to build the Mississippi Crossing Project (MSX Project) after securing long-term, binding transportation agreements for all of the capacity. The $1.6 billion project involves the construction of nearly 206 miles of 42-inch and 36-inch pipeline and two new compressor stations aimed at flowing 2.1 Bcf/d of natural gas. The project will originate near Greenville, Mississippi, and conclude near Butler, Alabama, with connections to provide supply access sourced from multiple supply basins.

Pennsylvania. Several years ago, TETCO filed to build the Appalachia to Market II Project (A2MII) and the Entriken HP Replacement Project. Both projects work together to flow 55,000 Dth/d of natural gas from the Marcellus/Utica in southwest Pennsylvania to existing local distribution companies in New Jersey. The original plan was to replace an existing gas-fired turbine at Entriken with a new electric motor-driven compressor unit. The electric compressor requires running an 8-mile high-voltage transmission line to the station. The electric utility can't get the proper permits in time, and residents oppose having a high-voltage line running through their backyards. Given that the project will be completed long before the electric line installation, TETCO is asking FERC for permission to swap out the planned electric compressor unit with a gas-fired turbine.

ROCKIES (Powder River Basin, Denver-Julesburg Basin, Niobrara)

TXO drilling in the Mancos

TXO Partners announced its technical team has identified an "extraordinary play" within TXO's operated production base. The Mancos Shale is part of the San Juan Basin in the Southwestern U.S. The Mancos is an upcoming natural gas field where TXO holds a 58,500 contiguous-acre position held by production. TXO estimates its acreage in the Mancos holds nearly 3 Tcfe of natural gas potential. It represents as much as five times TXO's current total reserve base on an oil equivalent basis. The company has identified a 3,520-acre block as Phase I with plans to drill 8-12 15,000-ft wells.

Tiburon plans to start Utica drilling in 2Q

Tiburon Oil & Gas Partners, LLC, was formed last fall to target the Ohio Utica Shale. Four former executives from Carrizo Oil & Gas, Inc., founded the company, which Post Oak Energy Capital backs. In a recent interview with Oil & Gas Investor, Scott Hudson, President and CEO of Tiburon, said the company plans to drill its first Utica wells and connect them to production in the second quarter of this year.

Gulfport well explodes in Guernsey County

An explosion and fire at a Gulfport Energy well pad in Guernsey County, Ohio, in early January, resulted in a half-mile evacuation around the site. A local fire official reported no extensive damage or injuries. According to a statement issued by Gulfport, a storage tank located at the pad was ignited. The fire burned itself out around noon the next day. In addition to Gulfport Energy, the Ohio Department of Natural Resources is investigating the cause of the explosion. CT2

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Euro gas report

Anna Kachkova provides information on the latest gas compression news from Europe

EUROPE

Imports of Russian gas to Europe via TurkStream pipeline hit record

Imports of Russian natural gas to Europe via the TurkStream pipeline hit a record high in January, various media sources have reported. Data from the European Network of Transmission System Operators for Gas (ENTSOG) showed that Russian gas supplies entering Europe via TurkStream in January were up 26.7% year on year. Calculations by Reuters found that this equated to 1.8 Bcf/d (5.06×10^7 m^3/d) of gas.

This comes after Ukraine

declined to renew a gas transit agreement with Russia, ending the transit of Russian gas through its territory at the start of this year. The move by Ukraine resulted in some pushback, with Hungary and Slovakia seeking to have supply via Ukraine restarted and Hungary threatening to veto the latest extension of European Union sanctions against Russia unless the bloc helped to restart flows. Nonetheless, EU sanctions on Russia were renewed in late January and for now, TurkStream remains the only pipeline carrying Russian gas to Europe, via Turkey.

Record high shipments through TurkStream last month came despite Moscow claiming in mid-January that it had downed Ukrainian drones that had tried to attack a compressor station in the Krasnodar region, on the Russian portion of the pipeline.

BOSNIA AND HERZEGOVINA

Bosnia, Herzegovina eye Southern Interconnection

Bosnia and Herzegovina (BiH) has taken a step towards building the proposed Southern Interconnection natural gas pipeline after over 15 years of political gridlock over the project. In mid-January, the House of Peoples, the upper house of BiH's Parliament, adopted legislation that clears the way for construction of the pipeline.

The 217-mile pipeline would have a capacity of 53 Bcf/y (1.5×109 m^3/y) and would pass through Croatia, Montenegro, BiH and Albania. The BiH section of the pipeline would run from Posušje through Mostar to Novi Travnik. Construction of the project is expected to take around 10 years.

If the pipeline is built, it will become

THE AUTHOR

ANNA KACHKOVA is an independent oil and gas writer based in Edinburgh, Scotland. She has over 13 years' experience of covering the energy industry, including five years in Houston, Texas, as NewsBase's North America editor. Her email address is: aikachkova@gmail.com

EUROPE

Cross-border hydrogen infrastructure projects granted EU funding

The European Commission announced in late January that it was awarding a total of EUR1.25bn ($1.31bn) in grants that are being allocated to 41 cross-border energy infrastructure projects. The grants are being allocated from the Connecting Europe Facility (CEF) under the Trans-European Networks for Energy (TEN-E) policy framework to schemes that obtained Project of Common Interest (PCI) and Project of Mutual Interest (PMI) status in 2024.

Among the projects selected to receive grants were the Nordic Baltic Hydrogen Corridor (NBHC) in Northern Europe and the H2med project, an initiative to connect the hydrogen networks of the Iberian Peninsula to Northwest Europe.

The NBHC project is set to receive a EUR6.8mn ($7.1mn) grant to support its feasibility study phase. The corridor is being jointly developed by six European transmission system operators (TSOs) – Finland's Gasgrid vetyverkot, Estonia's Elering, Latvia's Conexus Baltic Grid, Lithuania's Amber Grid, Poland's Gaz-System and Germany's Ontras. The project is

DENMARK

Further setbacks for Tyra II during ramp-up

The TotalEnergies-led Tyra II redevelopment project offshore Denmark has run into further delays while in the process of ramping up to full production.

BlueNord, one of the partners in the Danish Underground Consortium (DUC), which operates Tyra II, published a series of updates in January and February. In mid-January, BlueNord said TotalEnergies was carrying out work to replace a seal on a gas compressor and that Tyra II was therefore not running at full technical capacity. In subsequent updates, BlueNord said that adverse weather conditions and "minor" operational challenges had resulted in the date the project was expected to reach plateau production being pushed back, first to late January, and then to February.

This comes after the DUC ran into unexpected issues with two transformers delivering power to gas compressors at the Tyra facility upon starting production in early 2024. Full technical capacity was achieved at the project in November, but the issues now cited by BlueNord had prevented Tyra II from reaching full production as of early February.

The Tyra II redevelopment offshore Denmark has run into further delays.

the first interconnector between BiH and Croatia. It is expected to help BiH diversify its sources of supply by giving it access to gas being imported to Croatia in the form of LNG, as well as to gas arriving from the Caspian region via pipeline.

The pipeline was initially estimated to cost $108mn, which was due to be funded by the European Bank for Reconstruction and Development (EBRD). However, more recent projections have put the project's cost at over $216mn.

Delays to the project since it was first proposed in 2009 have been attributed to extreme partisan gridlock along ethnic lines in BiH's Parliament – a situation that has persisted since the Bosnian war ended in 1995, with frequent disagreements between nationalist parties representing the country's Bosniak, Croat and Serb communities. In particular, Bosnian Croat parties had repeatedly blocked the project's parliamentary adoption, calling for it to be overseen by a new company managed by ethnic Croats and headquartered in Mostar instead of state-owned, Sarajevo-based BH-Gas.

BULGARIA

Azerbaijan reports doubling of gas supplies to Bulgaria in 2024

Azerbaijan doubled the amount of natural gas it has supplied to Bulgaria to 70.6 Bcf (2 × 109m^3) in 2024, according to Azerbaijani Ambassador to Bulgaria Huseyn Huseynov. During an interview on Bulgarian television in late January, Huseynov said this meant Azerbaijan was now meeting a large portion of Bulgaria's gas demand.

This comes as part of a broader ramp-up in gas supply from Azerbaijan to Europe. The Southern Gas Corridor (SGC) had originally been designed to ship 353 Bcf/y (1 × 10^{10} m^3/y) of gas to Europe, but volumes reached 459 Bcf/y (1.3 × 10^{10} m^3/y) by the end of 2024 as Europe increasingly pivoted away from Russian gas and sought alternative sources of supply. CT2

designed to integrate renewable hydrogen across the six participating countries by linking production centers in the Nordic and Baltic regions with demand hubs.

The CEF grant is expected to help the project developers execute feasibility phase studies across the participating countries. The studies will focus on aspects of the project including pipeline routing, compressor station planning, financial and economic analysis, environmental and safety permitting issues and investigations on an implementation timeline. They are expected to run until the end of 2026.

Meanwhile, the H2med consortium has been awarded grants worth a combined EUR35.6mn ($37.4mn) for project studies. Of this, EUR28.3mn ($29.8mn) will go towards the Barcelona-Marseille (BarMar) section of the project, and EUR7.2mn ($7.6mn) will go to the Portugal–Spain interconnection, known as CelZa. These grants will allow the BarMar consortium to partially finance engineering studies, including marine and environmental reconnaissance campaigns, and for CelZa, they will be used to execute the basic and detailed engineering phases for a planned pipeline and compressor station. The funds will also be used to support work required for environmental assessments and permitting.

North Africa struggles to meet export potential

Domestic challenges, international market dynamics are just two things holding North Africa back from its full natural gas potential. By **Anna Kachkova**

North Africa is a long-standing, major producer of natural gas, with Algeria and Egypt playing particularly significant roles. The region's role as an exporter of gas has been in the spotlight in recent years as a result of the war in Ukraine, with Europe pivoting away from imports of Russian pipeline gas and seeking alternative supplies. However, a combination of domestic challenges within North African countries and international market dynamics is holding these countries back from reaching their full production and export potential.

North African countries' reserves are considerable. According to the Gas Exporting Countries Forum (GECF), Algeria had an estimated 159 Tcf (4.504 × 1012 m^3) of proven natural gas reserves in 2023. Egypt's proven gas reserves for that year were estimated at 63 Tcf (1.784 × 1012 m^3).

However, growing domestic gas demand, as well as production challenges, has increasingly constrained North Africa's export ability. According to a January 2025 report from the UK-based Oxford Institute for Energy Studies (OIES), North Africa's gas exports fell by almost 30% between 2021 and 2024, with the largest drop seen in Egypt.

Efforts are underway to address this. Both Algeria and Egypt are holding new oil and gas bidding rounds, and Libya – where the political situation remains highly volatile – is planning to do the same. The region's producer countries hope to attract new investment from international oil companies (IOCs) to help boost output. However, even if they succeed, it will take time for investment to translate into new production.

Regional trends

GECF data show that Algeria's marketed gas production in 2023 amounted to 3.7 Tcf (1.055 × 1011 m^3), while its gas consumption rose to 1.9 Tcf (5.29 × 1010 m^3). Algeria exported 1.2 Tcf (3.45 × 1010 m^3) of gas via pipeline and 628 Bcf (1.78 × 1010 m^3) in the form of LNG that year.

"Currently, Algeria is one of the main suppliers of natural gas to Europe," a GlobalData Middle East and Africa upstream analyst, Rami Khrais, told **COMPRESSOR**Tech^2. "In 2024, Algeria was the second-largest pipeline gas supplier to Europe, after Norway. Algeria exports gas to Europe through two pipelines: TransMed and Medgaz, with Spain and Italy being the largest consumers of Algerian gas on the continent. Algeria also exports LNG to Europe and other countries, primarily Turkey. Algeria provided around 15% of Europe's gas needs last year."

Khrais added that Algeria was now the only country in North Africa exporting gas to Europe, following the decline in production in Egypt and Libya.

Egypt's marketed gas production totalled 2.1 Tcf (5.93 × 1010 m^3) in 2023, while its domestic demand reached 2.2 Tcf (6.19 × 1010 m^3) that year, according to GECF data. In 2024, Egypt lost its status as a net gas exporter and turned to LNG imports in order to cover the shortfall between domestic output and growing demand.

One of the major challenges for Egypt is the depletion of the giant Eni-operated Zohr field. The field, which had previously accounted for around 40% of Egypt's gas output, has underperformed expectations, seeing production decline more rapidly than anticipated.

"This decline has forced Egypt to halt LNG exports from the Idku and Damietta plants and secure contracts to import LNG cargoes through a floating terminal," said Khrais. "As a result, it is unlikely that Egypt will be a gas-exporting country in the foreseeable future."

This trend is playing out across the broader region.

"That's the story with much of North Africa – the growth of domestic demand," Rapidan Energy's director of global gas, Alex Munton, told **COMPRESSOR**Tech^2. He sees a similar scenario playing out in Algeria, with "no real supply growth" while domestic demand gradually increases.

Missing out

These dynamics are hampering North Africa's ability to meet rising demand from Europe for non-Russian sources of gas.

"Rising domestic consumption and a lack of investment represent the primary obstacles preventing Algeria and other North African countries from increasing energy

supplies to Europe or even maintaining current levels," said Khrais. He added that Algeria's gas production was expected to decline gradually over the coming years, "unless the country decides to improve its investment environment to attract more major players to its upstream sector."

However, Khrais sees the latest developments as having the potential to spur development of new production in North Africa.

"The suspension of Russian gas supplies to Europe via Ukraine at the start of this year might increase the strategic importance of Algerian pipeline gas and LNG," he said. "This could encourage Western companies, particularly in countries like Italy and Spain, to deepen their co-operation with Algeria's state-owned energy company, Sonatrach, to develop additional gas projects."

Crystol Energy's CEO, Carole Nakhle, also pointed to the importance of new upstream investment in order to help North Africa meet its production and export potential.

"Domestic reforms are essential as well as increasing investment in upstream to support production and discoveries," Nakhle told **COMPRESSOR**Tech². "To increase production, and subsequently exports (assuming local demand doesn't rise faster), the region needs more investment in upstream activities – in aging assets by increasing recovery (we are seeing greater emphasis on recovery across the industry) as well as investment in new discoveries."

Positive signs

There are hopes that new investment could indeed be forthcoming, given the licensing rounds underway in North Africa and the interest being shown in the region by IOCs. Positive results from exploration encourage other upstream players to move in. However, the pace and relative unpredictability of exploration – not just in North Africa but globally – are cause for caution.

"There's been some recent positive exploration news on the upstream but moving from discovery to production takes a while, and it remains to be seen just how significant some of the recent discovery announcements actually are," said Munton.

In the meantime, like Nakhle, he also pointed to moves to increase recovery from producing assets. One such project saw Baker Hughes announce in May 2024 that it had been awarded a contract by Sonatrach to provide compression trains to help boost output from Algeria's Hassi R' Mel gas field.

"In Algeria, there is going to be a market for equipment," Munton said. "It's a market that will require increasing levels of investment in equipment, particularly compression, to get as much out of these aging natural gas fields as possible, Hassi R' Mel being the giant field producing for decades and absolutely vital to Algeria's gas sector."

Khrais also cited efforts to increase production from Hassi R' Mel as being worth watching to assess the attractiveness of Algeria's investment environment.

"Algeria's expansion projects in the Hassi R'Mel field should be closely monitored, along with its efforts to develop unconventional gas reserves in the Ahnet and Berkine basins," Khrais said.

On top of this, the new Algerian licensing round will be closely watched, especially as it is the first bid round to be held in Algeria in over 10 years. It comes as various IOCs are eyeing the country's upstream sector, having stayed away in recent years owing to a combination of factors including security concerns – notably in the wake of the terrorist attack on the In Amenas gas plant in 2013 – complex bureaucracy and an unfavorable investment environment.

"Algeria has been not closed off, but it has been a very restrictive environment post the In Amenas terrorist incident," said

A general view of Tiguentourine Gas Plant In Amenas, 1600 km (994 miles) southeast of Algiers. IMAGE: REUTERS

Munton. He added that Algeria and IOCs would need to consider how best to re-engage in order to address the challenges that have deterred these companies in the past.

There is already evidence that re-engagement is happening. Aside from the bid round, Algeria has also been engaged in bilateral talks with various IOCs that have resulted in memoranda of understanding (MoUs) being signed, aimed at advancing new exploration and development opportunities. Most recently, Algeria's National Development Hydrocarbon Agency (ALNAFT) signed a deal with Chevron for offshore co-operation in January. This follows a number of preliminary agreements signed with other IOCs including ExxonMobil over the past couple of years.

"I think it's very notable that these announcements have been made in the first place, particularly given the geopolitical context, with Algeria's stance, being a very independent voice on geopolitical issues and certainly unaligned with the US and the West," said Munton. IOCs can contribute their expertise in maximizing production from mature areas and can offer skills, technologies and capabilities that Algeria would benefit from, he continued, but added that the political context remains "very challenging" for these companies.

"I think we have to be quite cautious in terms of how quickly we think there's going to be a return of significant activity by the Western majors and US majors in particular," Munton said. "It'll take time, but potentially it could make a difference – we're just not talking anytime soon."

Midstream challenge

While there is some progress in the upstream sector both in Algeria and more broadly across North Africa, this may not translate to new midstream infrastructure. Prospects look poor for major planned cross-border pipelines, such as the proposed 4,128-km (2,565-mile) Trans-Saharan Gas Pipeline.

That pipeline was first proposed in 2009, as a route for shipping Nigerian gas to Algeria via Niger. But while the three countries signed new agreements to advance the project in February 2025, there is considerable skepticism over whether the pipeline will ever be built.

"The Trans-Saharan pipeline project has remained on the table for nearly 20 years, but it has not moved in any direction," said Khrais. "Declining gas production in Nigeria, security issues such as gas theft and terrorist activities, along with the long distance the pipeline would need to cross through the desert, make it an unfeasible project."

On top of this, there are questions over whether a new pipeline would even be needed.

"There is already an existing pipeline network between Algeria and Europe consisting of three lines: TransMed, Medgaz and GME," said Khrais. "While the GME pipeline was shut down in 2021 due to the diplomatic spat between Algeria and Morocco, the other two pipelines are not operating at full capacity. This means that there is already significant spare capacity in the network to transport more gas. In other words, the bottleneck lies in the volume of gas available for export, both in North Africa and Nigeria, not in the infrastructure needed to transport it."

Nakhle, meanwhile, noted that while a cross-border pipeline could make sense to the countries and companies involved, geopolitical realities and growing competition from both LNG and other sources of gas posed a challenge.

Competition

Indeed, growing competition from other suppliers is one of two major factors that Nakhle sees as holding back North Africa's gas export potential, alongside growth in domestic gas demand within inefficient local markets. Competition from other suppliers is intensifying in Europe, with leading LNG exporters the US and Qatar seeking to send more volumes to the continent in recent years. On top of this, there is also growing competition from renewables.

"Remember: one of the main 'weaknesses' of natural gas is that it has a substitute in each of its applications," said Nakhle.

This was echoed by Munton, who pointed to Europe increasingly turning to LNG for replacing lost volumes of Russian gas in the short term, and to other sources of energy including renewables in the longer term.

"The longer that Europe is in this crisis mode and facing very, very high natural gas prices, the more pressure there is politically to transition away from gas, to look for alternatives and to increase investment in renewables," said Munton. "Of course, there have been lots of challenges with the expansion of renewables, but gas demand has dropped considerably in Europe over the last few years."

Short-term advantage

In the short term, this can put North African gas at an advantage.

"For the industry North Africa is, in some ways, a logical and attractive place to consider increasing activity because of its proximity," said Munton. "Europe needs the gas. North Africa is a proven gas province," he added. "I think in the short term North Africa is still a vital piece of the supply picture."

A GlobalData senior upstream analyst, Paul Hasselbrinck, is relatively optimistic over North Africa having a supply role to play beyond the short term too.

"Having effectively phased out Russian piped gas and considering the slower development of alternatives to gas in renewable hydrogen and energy storage systems, Europe's energy transition finds itself at a crossroads in looking for a

A view of a gas plant seen from the desert road of Suez outside Cairo, Egypt. IMAGE: REUTERS

secure supply of energy for the continent," Hasselbrinck told **COMPRESSOR**Tech^2. "This will likely mean a sustained gas demand in the medium-term future, underscoring Algeria's continued importance as a supplier."

Hasselbrinck also pointed to the risk profile of competing sources of supply.

"Current turmoil with Trump's trade war and position on the Russia-Ukraine war damages the risk profile of a significant portion of current LNG supply to Europe from the US, opening up an opportunity for North African suppliers," he said. He added, though, that North African exporters would still have to compete with suppliers from elsewhere in the world.

"The uncertainty over North Africa's advantage as a supplier holds back significant investments that are needed to fulfil this EU-North Africa energy partnership," Hasselbrinck said.

On top of addressing its domestic challenges, North Africa will also have to increasingly consider the emissions profile of its gas production, according to Nakhle.

"The business-as-usual model is not sufficient anymore in a world that is more climate conscious," Nakhle said of efforts to ramp up gas production. "North Africa is not globally competitive when it comes to carbon intensity. This is something that the industry and governments in the region should equally focus on."

Bearing these challenges and uncertainties in mind, Munton sees demand-side management as a useful tool for North Africa's gas producers as they consider how best to proceed.

"From a government standpoint, I think there really needs to be a look at renewables – particularly solar – and where that can help to reduce domestic natural gas demand," Munton said. "The upstream is going to do what it's been doing for some time, but on the demand side, I think that's where there are more avenues by which the region could maybe look to make a difference." **CT2**

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Choosing

Bridging power needs depends on multiple factors. By **Jack Burke**

As the demand for power continues to rise, the need for reliable power sources, especially in remote or infrastructure-limited regions, becomes increasingly critical. The midstream energy sector is often faced with gaps in power availability due to long lead times associated with utility connections. As noted by Ryan Rudnitzki, Senior Vice President of Sales at RPower, the options for bridging these gaps in power needs depend heavily on the specifics of the situation.

Although Rudnitzki's employer, Texas-based RPower, offers a suite of services including design, construction, ownership, operation and maintenance of power generation systems, he said each application is different.

"There is no one-size-fits-all solution. The best option for meeting your power needs really depends on the individual circumstances," Rudnitzki said during a presentation at the Gas Machinery Conference (GMC) 2024 in Houston. Rudnitzki's presentation, "Waiting on Wires—How the electrification of our industry is affecting projects and what options exist to meet desired demands," looked at options and challenges of electrifying operations in the natural gas industry.

Options for remote or infrastructure-limited regions.

Current power generation trends

Rudnitzki emphasized that the current power landscape has seen demand growth stagnate over the past couple of decades, driven in part by efficiencies in power usage, despite increasing electronic and digital consumption. However, new factors, including the electrification of industries and the rise of data centers, are pushing demand higher. "With the electrify everything movement , and data centers growing, demand is expected to rise significantly," he said.

One of the major contributors to this demand increase is the rapid growth of artificial intelligence (AI) and cloud computing, which heavily rely on data centers. According to Rudnitzki, more extreme forecasts suggest that power demand could theoretically double over the next five years, although challenges including grid capacity constraints and efficiency gains will likely prevent such a rapid increase.

Simultaneously, the power mix is shifting. "In the first half of the year, 70% of new power generation came from wind and solar," he pointed out, alongside growth in battery storage. Despite this, the intermittency of renewable power sources and the need for dispatchable power have highlighted the continued importance of natural gas. Rudnitzki noted that natural gas remains a crucial part of the energy mix, particularly in Texas, where significant incentives are pushing for more natural gas generation to firm up the grid.

Challenges in power supply: A Texas case study

A significant challenge in power availability is the mismatch between demand and the pace at which utilities can provide new connections. Rudnitzki presented a hypothetical scenario in which a midstream company needs power for a new processing plant but is faced with a multi-year wait for utility connections.

As Rudnitzki said, "A midstream company might

a power source

request power from the utility, but the utility could be unable to provide it until 2030, resulting in a delay of several years before the plant can be operational." This gap, which initially might cause an additional 18-month delay to an expected 18-month project schedule, is often extending far longer due to systemic issues and increased power demand, particularly in areas like Texas.

In these cases, midstream companies must consider alternative power solutions, as traditional utilities cannot meet the timeframes required. Rudnitzki's experience with these companies highlights the growing concern: "It's not just about needing power—it's also about avoiding sending your producer a higher monthly power bill compared to your competitor," he said.

Power options for bridging the gap

To meet power demands in the face of delays, midstream companies have several options, which Rudnitzki categorized into three basic approaches:

1. **Engine driven equipment:** Using natural gas engine-driven compression equipment is a common solution when companies face limited or delayed access to electricity. This approach is particularly appealing when natural gas is readily available onsite. Rudnitzki said that, "If you already have to put power into the facility, it's sometimes more cost-effective to fully electrify the facility, consuming 30 MW instead of just 15 MW. However, if the local substation can only support 15MW of power, you may opt for engine driven compressors to avoid needing additional on-site power generation"
2. **Rental power generation equipment:** Rental power is an effective solution for bridging the power gap for shorter periods. Rudnitzki described this as an option suitable for temporary power needs: "Rental power equipment is ideal when you need a quick solution for the short term."
3. **Microgrids:** As the duration of the power gap extends, microgrids become a more economically viable solution. "The economics of microgrids make more sense when you're looking at bridging power gaps of three, four, or more years," Rudnitzki noted. Microgrids are typically a longer-term turnkey installation, integrating power generation assets, switchgear and (if necessary) transformers.

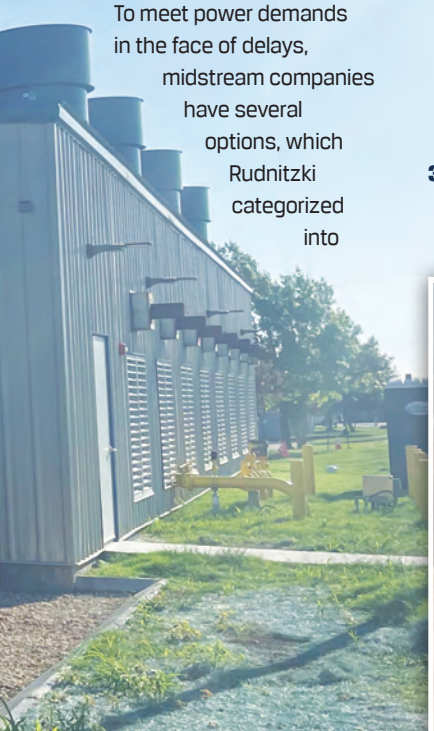
Microgrids: A longer-term solution

Microgrids are increasingly being considered as a robust solution to power gaps in energy-intensive industries, especially those requiring consistent, reliable power. While the initial cost of building a microgrid may seem high compared to renting or using engine-driven equipment, the long-term benefits can outweigh these costs in situations where bridging a power gap could take years.

"The economics of microgrids start to make more sense when you're looking at three to five years of temporary power needs," Rudnitzki said. He highlighted that the integration of renewable energy sources, battery storage, and local power generation provides an added layer of security, reducing the dependency on traditional utilities and mitigating risks associated with power volatility.

Challenges in power availability and scheduling

A key issue that companies face is the inability to access power on time, often due to long wait times for utilities to review and approve power requests. As Rudnitzki put it, "It's not so much that there's not necessarily power there; certainly there are often power shortages. But what also can happen is that there's such a long line for these utility companies to even review the request, you might wait a year before anything gets looked at from the time that you submit, so even if there is power available, you're



ABOUT RPOWER

Founded in 2021, RPOWER is a power generation company focused on prime and backup power generation solutions. RPower specializes in providing power generation to companies with mission critical loads; with a focus on serving energy intensive business including the Data Center and Oil & Gas segments. The RPower team of analysts and engineers has a proven track record in the electric power industry serving large industrial customers and utilities with power generation project development, asset operations, asset optimization, project financing, and retail energy.

A standby genset installed at Kristen Distribution in Byron, Texas.

waiting a while for an answer."

Once an interconnection request is reviewed, utilities often find that they need to install specific equipment to ensure the safe and stable distribution of power. This equipment may include transformers, switches, reclosers, and breakers, each of which can face significant lead times due to supply chain issues, with some utilities struggling to install everything on time due to workforce limitations.

In the face of such delays, companies often need to reconsider their expectations. "People expected certain interconnect lead times based on past experience, and they're learning that they can't just plug the cord in the wall and expect there to be power," Rudnitzki said. As a result, businesses must explore alternative power solutions to bridge gaps until their grid connection is finalized.

Engine-driven compression to reduce electricity demand

One potential solution for companies in need of immediate power is the use of engine-driven compressors. Rudnitzki highlighted the role of engine-drives for inlet and/or residue compression needs could reduce customer demand for grid-based power. This approach could be particularly beneficial in regions where grid infrastructure is not reliable.

An additional benefit of engine-driven solutions, particularly for gas companies, is that they are often fully hedged. As Rudnitzki points out, "The gas used to power the compression equipment just gets passed back to the producer. And if the producer is paying a lot for gas consumption in your facility, they're also getting a lot of money for their gas in the market, so they don't care as much."

However, despite its effectiveness, the gas-powered approach comes with trade-offs. While gas engines can be efficient, they often have higher emissions compared to electric alternatives. This is especially important in the context of emissions reductions and sustainability goals. "Gas engines are clean, but the grid, especially in Texas, is cleaner from a carbon dioxide equivalent (CO_2e) perspective," Rudnitzki said. Companies that are focused on reducing emissions may find themselves at odds with their goals if they rely too heavily on gas engines.

Moreover, gas engines come with higher maintenance requirements and lower availability if not properly maintained. "Engines have a lot going on, and there's more moving parts than with an electric motor, so it takes more effort to maintain availability," Rudnitzki said.

Rental generation: A short-term power solution

Another viable option for securing power is rental generation, which is typically used for short-term needs. Rudnitzki describes one solution as "slick" that comes in the form of trailers containing turbines. For smaller footprints, such as those in the Marcellus Shale region, rental turbine-based generators can be a highly effective option. "This is a really good solution," he states, "if you're talking about customers, say, in the Marcellus, where they don't have a lot of space period, much less for onsite generation."

However, rental turbines have some drawbacks. These units are subject to performance degradation at higher altitudes and/or extreme temperatures. Rudnitzki cites a 25% loss in available power when turbines are deployed at higher altitudes and higher temperatures. An additional consideration with turbines is that "the bigger you get into turbines, the better your efficiency typically is," but if you lose a unit for whatever reason, you lose a lot of capacity all at once. Also, if your site load fluctuates, there may be times where your turbine isn't loaded close to its design conditions, which can impact service intervals and fuel consumption.

An alternative to turbines is reciprocating engine-based generators, which can help with the aforementioned concerns, depending on their design. However, rental rates for engines tend to be higher, they come with more intensive operational and maintenance (O&M) requirements, and often require more space for a given power need.

Microgrid solutions: A sustainable, long-term approach

The concept of microgrids presents an innovative solution to power challenges, offering a more permanent, sustainable power infrastructure. Microgrids can be designed to provide backup power not only to the customer but also to the larger grid in many cases. Rudnitzki said, "The idea is basically, you give us gas and we give you power at whatever voltage you want it at. We draw a line around our little plot of land, and gas

comes in, power goes out."

Microgrids are particularly advantageous in deregulated markets such as ERCOT, where companies can hedge their power prices and avoid the risk of high price spikes, once the grid interconnect arrives. By monitoring real-time pricing, companies can activate their microgrid when power market prices are high, thus controlling overall power costs and mitigating exposure to market volatility.

However, the implementation of a microgrid is not without challenges. It requires significant upfront capital investment – typically ranging from $1,000 to $2,000 per kilowatt for installation – often making it a less attractive option for short-term needs. Additionally, the operation and maintenance of microgrids require specialized knowledge, which may not be readily available within companies focused on their core operations.

These issues can be addressed partnering with a company that will build and lease a turnkey plant that is owned, operated, maintained by a 3rd party (like RPower). In the RPower use case, the environmental permit belongs to the owner of the microgrid, which often avoids aggregation with the permit owned by the customer consuming the power.

Another key benefit of a microgrid is the opportunity to generate revenue through economic dispatch and emergency response services (ERS). For instance, when power prices spike, companies can generate power on-site and sell it back to the grid. Similarly, in markets like ERCOT, participation in programs like the Four Coincident Peak (4CP) program enables companies to offset demand charges by reducing consumption during peak demand periods. As RPower is a Retail Electric Provider and Level 4 Qualified Scheduling Entity in ERCOT, with decades of experience in energy management and power generation equipment, the company is well-positioned to optimize the value and availability of generation assets, Rudnitski said.

Conclusion

As energy demands continue to rise and grid infrastructure struggles to keep pace, oil & gas companies are seeking alternative power solutions. While engine-driven compressors and rental generation units provide short-term fixes, microgrids can offer a sustainable, long-term solution to power reliability and cost management. Despite the challenges associated with upfront costs, operation, and maintenance, microgrids present opportunities for companies to not only secure reliable power but also generate revenue and reduce exposure to market price volatility.

As Rudnitzki puts it, "You're not just throwing your money away in your rentals because you're making money in the process." The evolution of power generation solutions – whether through gas engines, turbines, or microgrids – represents a significant shift toward more decentralized, flexible, and financially viable power infrastructures for industries grappling with the demands of the modern energy landscape. **CT2**

AMB controller upgrade optimizes turboexpander performance in NGL recovery

Bearing health is key for turboexpanders.

By **Nikolaj Malnac**

Turboexpanders are the beating heart of midstream natural gas liquid (NGL) operations. As a radial in-flow turbine through which high-pressure gas is driven to power a compressor or generator, turboexpanders help enable fast and efficient liquid recovery.

Bearings are a crucial component of a turboexpander, supporting the weight of the turboexpander's rotor and helping the machine maintain correct relative positioning. Active magnetic bearings (AMBs) are an oil-free bearing system that uses electromagnetic forces to maintain the relative position of a rotating assembly (rotor) to a stationary component (stator). An advanced electronic control system adjusts these electromagnetic forces in response to forces generated from machine operation, and any issue that compromises the operation of an AMB controller can bring NGL processing to a halt.

So, when an NGL processing company approached Troy O'Steen looking for the best way to upgrade an outdated analog AMB controller, he understood the importance of finding a reliable and expedient solution.

As Sales Director at Valencia, CA-based L.A. Turbine (LAT), a Chart Industries company, O'Steen was accustomed to working with all brands of turboexpanders and supporting equipment. In addition to designing and building its own turboexpanders, the company specializes in aftermarket service and repair for turboexpanders from any OEM. However, the analog controller was outdated and repair wasn't feasible.

LAT had a history of successful collaboration with Waukesha Magnetic Bearings of Worthing, United Kingdom, a subsidiary of Waukesha Bearings, Waukesha, WI, that has been providing complete solutions for AMBs and magnetic bearing controllers in a variety of specialized applications for nearly 40 years. Waukesha Magnetic Bearings has designed magnetic bearing controllers to be compatible with a wide range of AMB sizes, sensor technologies and operational environments. This versatility and experience enable the company to design controllers that are effectively brand-agnostic, making them the perfect partner to help LAT promptly deliver a cost-effective application-specific solution.

Outdated analog AMB controller stalls NGL processing

The troublesome analog AMB controller, and the cabinet in which it was housed, were due for an update. Over several months, the company tried to troubleshoot its shortcomings, but the original manufacturer considered the controller obsolete. That meant the OEM would no longer provide support. Instead, the OEM pushed its customers to upgrade to new AMBs with a more advanced controller.

The concern was that installing new bearings would require significant investment, a capital commitment that was beyond the company's allocated budget for the project. Plus, they would have to wait for an opening in the previous supplier's schedule to get the engineering support required for the AMB controller's installation, which meant extended turboexpander downtime. By extension, NGL processing would be stalled during the upgrade, and it was uncertain when a regular NGL processing schedule could resume.

The company sought an alternative that didn't involve the considerable expense and lengthy downtime of upgrading to entirely new AMBs and controllers. Unfortunately, the quotes they received weren't any more appealing. Most companies proposed the same solution: replace the entire AMB system, including the controller, for easy compatibility.

It seemed like there was no choice but to purchase the expensive replacement AMB

THE AUTHOR

NIKOLAJ MALNAC has more than 20 years of commercial experience in various industries. Malnac has been with Waukesha Bearings for more than 12 years. He has served as the director of Magnetic Bearings for the last three years.
He can be reached at nmalnac@doverprecision.com.

system until a service call with LAT yielded a different and more satisfying solution.

Controller retrofit beats costly replacement

Rather than replacing the entire system, LAT proposed working with Waukesha Magnetic Bearings to retrofit a new, more modern and feature-rich controller for the existing AMBs and turboexpander. Pairing a new controller with an existing AMB is not typical because most companies require using the same manufacturer for both pieces of equipment. However, LAT and Waukesha Magnetic Bearings already had collaborated on similar projects in the past with great success.

In fact, the two companies had a history of ambitious collaborations. When LAT set out to design the industry's first and only skid-mounted turboexpander cabinet for hazardous-area applications, they reached out to Waukesha Magnetic Bearings to be a design partner. Together, the companies built the ARES AMB Turboexpander, featuring a skid-mounted Zephyr controller.

The Zephyr controller also proved to be an ideal solution for retrofitting the midstream energy customer's obsolete analog controller. The Zephyr controller is highly configurable, making it "bearing-agnostic," or able to integrate with many different sensors and magnets.

Beyond technical compatibility, Zephyr controllers are simple to operate, which was a key requirement for LAT's customer. After relying on the outdated analog controller for so long, they were also seeking a more robust solution with modern features such as remote monitoring and adjustment capabilities.

All in all, Zephyr fit the bill.

A dedicated service team makes installation seamless

While it was clear the new controller and cabinet would be an enormous upgrade, the engineers at LAT and Waukesha Magnetic Bearings most impressed the customer with their responsiveness and customer service.

Because the LAT and Waukesha Magnetic Bearings teams understood the impact downtime has on NGL-processing companies, they worked tirelessly to install the upgraded equipment as quickly as possible.

"This type of integration isn't simple," Carlos Pi, Key Account Manager at Waukesha Magnetic Bearings, explained. "But we do everything in our power to make it easy." In this case, that meant constant communication – plus sharing lessons learned from previous retrofitting projects.

Years of experience taught the team to spend plenty of time collecting relevant details and preparing thoroughly before the shutdown for installation. They meticulously familiarized themselves with the OEM's programmable logic controller (PLC) to make integration seamless.

An onsite commissioning engineer also proved critical for smooth installation, providing detailed information about the site and assembling the controller according to design specs.

As a result, the LAT and Waukesha Magnetic Bearings teams were able to install the controller and make it operational quickly. "We make every effort to make this plug-and-play. We don't just drop it off; we'll help you troubleshoot until it's done," said Pi.

Advanced new controller exceeds expectations

The new controller has proven to be an optimal solution. Now, LAT's customer can keep an eye on the AMB remotely and make adjustments if needed. Zephyr's remote monitoring and adjustment functionality includes multi-coordinate control, runout compensation, an automatic balancing algorithm and an advanced amplifier algorithm for software flux feedback.

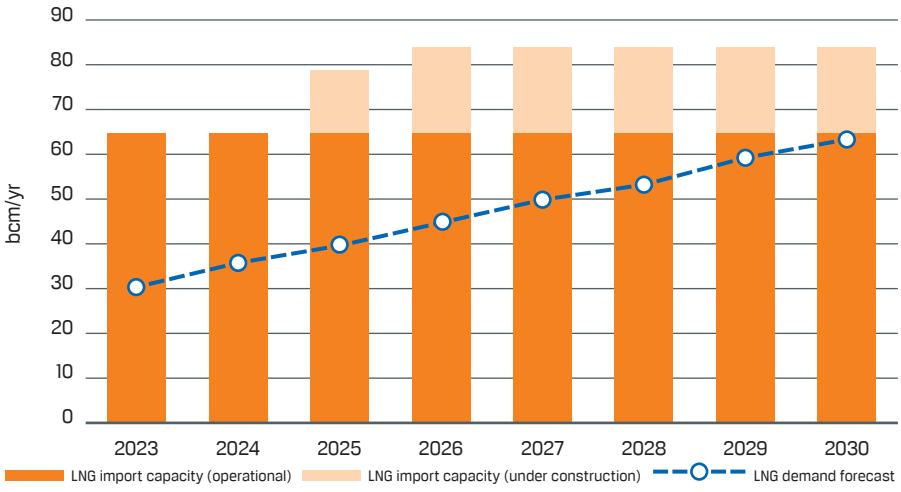
With inductive sensor support, Zephyr also boasts simple troubleshooting features – a stark contrast to the old analog controller. Its diagnostic capabilities include a web-server interface, event logging, automatic clearance check, and built-in tools that show compliance with ISO sensitivity performance criteria. It offered everything the customer wanted, and then some.

Backed by the LAT team's exceptional customer service and field support, the upgraded controller gave the customer renewed peace of mind about the AMB's long-term performance. In fact, Waukesha Magnetic Bearings' devices are known to stay operational for decades, and Zephyr controllers have the same reputation for long-term reliability. With no moving parts, predictive maintenance and an extended warranty option, the AMB controller is expected to perform reliably in the field for many years to come. CT2

India's gas market poised for major expansion: A new era of growth by 2030

India's natural gas market is at a critical inflection point, with consumption set to surge by nearly 60% between 2023 and 2030, according to the International Energy Agency's (IEA) India Gas Market Report. This monumental growth is powered by key drivers, including the rapid expansion of gas infrastructure, a resurgence in domestic production, and a favorable global gas market outlook. With the Indian government actively supporting natural gas consumption through policy reforms, India is set to become a dominant player in the global energy landscape by the end of the decade.

LNG DEMAND FORECAST AND IMPORT CAPACITY IN INDIA, 2023-2030



SOURCE: IEA analysis based on data from **ICIS LNG Edge**

Driving forces behind growth

The report highlights three primary forces behind India's forecasted gas boom: the expansion of gas infrastructure, a revival of domestic production, and easing global gas market conditions. These trends are projected to position India as a top consumer of natural gas, with consumption set to reach 103 billion cubic meters (bcm) by 2030 – putting it on par with Saudi Arabia's current gas usage.

City gas distribution (CGD) is the driving force behind this growth. The widespread adoption of compressed natural gas (CNG) for both residential and small industrial users will push gas consumption in urban areas to new heights. In addition, the manufacturing sector – particularly industries like steel production – will account for a significant share of this demand, adding around 15 bcm per year by 2030. India's power sector is also set to see a dramatic increase in natural gas use, with demand for gas-fired power generation forecasted to nearly double, reaching 15 bcm per year.

While growth in the petrochemical and fertilizer sectors will be slower, the potential for natural gas to transform India's industrial landscape remains immense. Furthermore, targeted policy strategies could accelerate gas uptake beyond projections, potentially reaching 120 bcm per year by 2030 – nearly matching the current total gas consumption of South America.

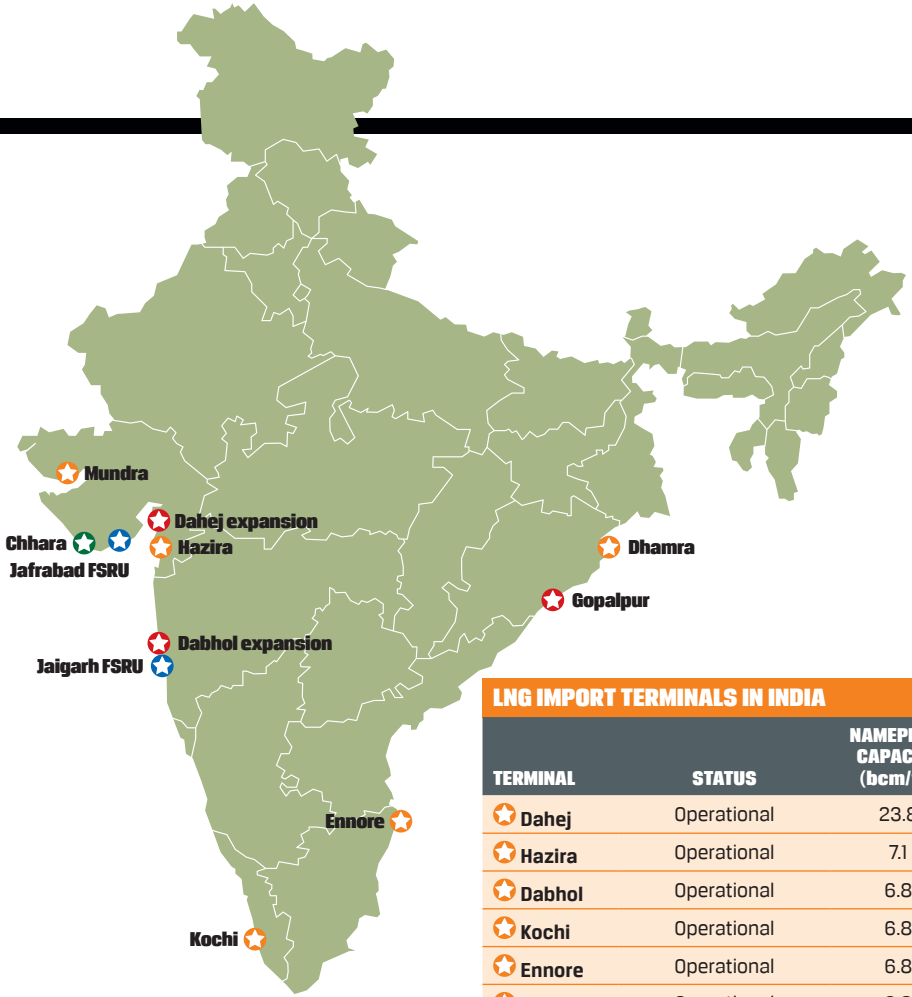
A resurgence in domestic production

India's domestic gas production is on the rise after nearly a decade of stagnation. In 2023, India's natural gas production reached 35 bcm, meeting 50% of its total demand. The resurgence is largely driven by new output from deepwater fields in the Krishna-Godavari basin, which now account for 25% of the country's production. However, production growth is expected to moderate moving forward, with total output projected to only reach 38 bcm by 2030.

While India's reserves of compressed biogas (CBG) are largely untapped, the government has introduced policies to bolster CBG production. With an estimated potential of 87 bcm per year, CBG could play a crucial role in India's energy transition. Yet, logistical challenges and underdeveloped infrastructure hinder the growth of this sector. By 2030, CBG output could reach 0.8 bcm per year, but much work remains to build a robust CBG ecosystem.

LNG imports set to surge

India's LNG market has seen impressive growth in recent years, with imports reaching a record 36 bcm in 2024, maintaining its position as the fourth-largest LNG importer globally, behind China, Japan, and Korea. Since 2013, India's LNG



Operational
Commissioning in progress
Under construction
Planned

imports have doubled, with an average annual growth rate of nearly 8%. However, this growth has been characterized by significant fluctuations, with the highest annual growth rate of 28% observed in 2016, driven by low spot LNG prices and government subsidies for natural gas-fired power plants.

In 2024, LNG imports grew by nearly 20% year-on-year, marking the second-highest growth rate of the past decade. By contrast, 2022 saw an unprecedented 17% decline due to the global energy crisis and high energy prices.

Looking ahead, India's LNG demand is projected to grow steadily, reaching 64 bcm per year by 2030. This represents an annual growth rate of approximately 11% from 2023 to 2030 – double the average rate observed in the previous decade. As domestic natural gas production is projected to see only modest growth, LNG imports will be crucial to meet the country's future gas demand.

India's LNG requirements will be supported by a combination of long-term contracts and increased spot market purchases. Balancing contracted LNG supply with the need for spot market flexibility will be essential to ensure supply security and cost-effectiveness. To accommodate the rapid rise in LNG imports, India will need to expand its LNG import capacity, particularly in the latter half of the decade. The gap between contracted LNG supply and projected demand could widen significantly after 2028, leaving India more vulnerable to fluctuations in the spot market unless new long-term contracts are secured in the coming years. CT2

> "India's LNG demand is projected to grow steadily, reaching 64 bcm per year by 2030 . . . an annual growth rate of approximately 11% from 2023 to 2030."

LNG IMPORT TERMINALS IN INDIA

TERMINAL	STATUS	NAMEPLATE CAPACITY (bcm/yr)	STORAGE CAPACITY (m^3/LNG)	START-UP YEAR	STATE
Dahej	Operational	23.8	1,104,000	2004	Gujarat
Hazira	Operational	7.1	320,000	2005	Gujarat
Dabhol	Operational	6.8	480,000	2013	Maharashtra
Kochi	Operational	6.8	310,000	2013	Kerala
Ennore	Operational	6.8	360,000	2019	Tamil Nadu
Mundra	Operational	6.8	320,000	2020	Gujarat
Dhamra	Operational	6.8	360,000	2023	Odisha
Total operational		***65***	***3,254,000***		
Chhara	Commissioning in progress	6.8	200,000	Expected in 2025	Gujarat
Jafrabad FSRU	Under construction	6.8		Expected in 2025	Gujurat
Jaigarh FSRU	Under construction	5.4		Expected in 2026	Maharashtra
Total under construction		***19***	***525,000***		
Gopalpur	Planned	5.4			Odisha
Dahej expansion	Planned	6.8			Gujarat
Dabhol expansion	Planned	6.8			Maharashtra
Total planned		***19***			

NOTE: The effective capacity of the Dabhol terminal is limited to 4 bcm/yr due to the absence of breakwater facilities, which makes the terminal inoperable during the monsoon season. The Kochi terminal has been operating significantly below its nameplate capacity due to insufficient end-use demand linked to the facility.
SOURCE: IEA analysis based on data from **ICIS LNG Edge**, **IGU**, **GIIGNL** and **PNGRB**

Speaker, new date for LNG webinar

Sanjeev Daruka, Head of Global LNG at Siemens Energy, will present during free online event

Sanjeev Daruka, Head of Global LNG, Siemens Energy

COMPRESSORTech^2 is proud to announce that Sanjeev Daruka, Head of Global LNG, Siemens Energy, will be presenting during our free webinar on liquefied natural gas (LNG) at 9 a.m. CST April 29.

The event, originally scheduled for May 27, will cover key aspects of the LNG value chain. Audience members will be able to ask questions of the presenters during the hour-long event.

Daruka will highlight the tremendous opportunities to improve LNG process design and gas turbine-driven refrigeration compression trains that can support today's dynamic energy transition with an equal emphasis on profitability and local job creation.

Daruka has more than 30 years of experience associated with rotating equipment for the oil and gas and power generation industries.

His expertise includes sales strategy development, contract negotiations and complex problem solving and he is well-versed with the technical aspects of gas turbines and centrifugal compressors.

At least one more speaker will present during the event. The magazine expects to announce that person soon. **CT2**

To register for the event, click here: https://us06web.zoom.us/webinar/register/WN_DpTkv3Z_Qk67j0GP3RizkQ

2025

MARCH

Spring Gas Conference
March 2-5
Charlotte, NC
Southerngas.org

GPA EXPO & CONFERENCE
March 23-26
Galveston, Texas
www.gascompressor.org

APRIL

2025 GPA Midstream Technical Conference
April 7-10
Plano, Texas

GPSA Engineering Data Book Training
April 14-18
Englewood, Colo.

MAY

Offshore Technology Conference
May 5-8
Houston, Texas
2025.otcnet.org

EASTERN GAS COMPRESSION ROUNDTABLE
May 6-8
Pittsburgh, Pa.
Egrc.org

SENSOR+TEST
May 6-8
Nuremburg, Germany
Sensor-test.de

World Gas Conference
May 18-23
Beijing, China
wgc2025.com

JUNE

ASME TURBO EXPO
June 16-20
Memphis, Tenn.
Events.asme.org

Hydrogen Technology Expo N. America
June 25-26
Houston, TX
Hydrogen-expo.com

SEPTEMBER

Gastech Expo
Sept. 9-12
Milan, Italy
www.gastechevent.com

Turbomachinery & Pump Symposia
Sept. 16-18
Houston, Tx.
Tps.tamu.edu

GPA Midstream
Sept. 21-24
San Antonio, Tx.
www.gpamidstream.org

GMC
Sept. 28-Oct.1
Louisville, KY
WWW.gmrc.org

OCTOBER

EFRC Conference
Oct. 14-16
Hamburg, Germany
www.recip.org

NOVEMBER

ADIPEC
Nov. 3-6
Abu Dhabi
Adipec.com

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For a complete listing of upcoming events, please visit our website: www.compressortech2.com/events

Solidifying the leadership spot

Chad Brahler on ACI Services' acquisition by Cooper Machinery Services. By **Jack Burke**

The acquisition of ACI Services, a leading provider of engineered solutions for reciprocating compressors, by Cooper Machinery Services further solidified Cooper's position as the leader in the compression and engine systems market, according to Chad Brahler, vice president for Operations with ACI Services, which is now a division of Cooper Machinery.

Founded in 1960, ACI's offerings include engineering services, hardware products, and tailored solutions. **COMPRESSOR**Tech² reached out to Cooper about the acquisition and received these responses from Brahler on behalf of the company.

WHAT MOTIVATED COOPER MACHINERY SERVICES TO ACQUIRE ACI SERVICES AND HOW DOES THIS ACQUISITION FIT INTO THEIR LONG-TERM GROWTH STRATEGY?

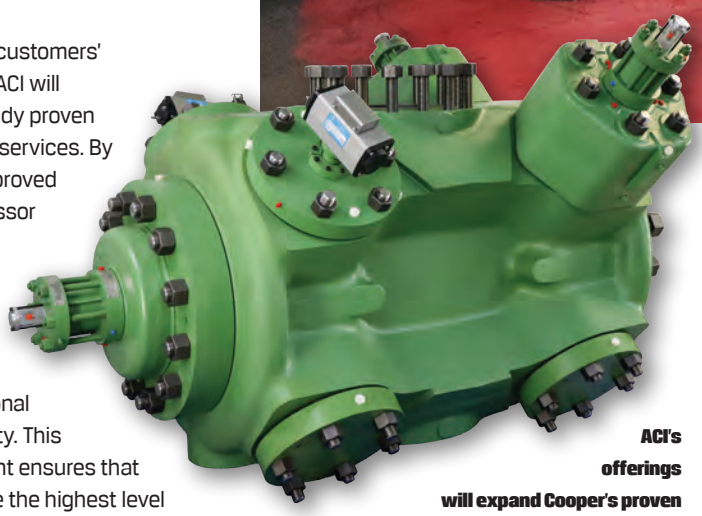
The acquisition of ACI ensures customers benefit from enhanced engineering expertise, expanded technological capabilities, and a stronger portfolio of compression solutions. ACI's industry leadership and specialized manufacturing knowledge will drive innovation, delivering more advanced, reliable, and efficient products. This integration also means improved support, deeper technical expertise, and a continued commitment to keeping customer operations running smoothly and efficiently.

HOW WILL THE ACQUISITION OF ACI ENHANCE COOPER'S POSITION AS A LEADER IN THE COMPRESSION AND ENGINE SYSTEMS MARKET?

The acquisition of ACI brings expanded capabilities, greater innovation, and enhanced support directly to our customers. Rather than simply integrating into an existing structure, this move creates new opportunities for advanced solutions, improved service, and cutting-edge technology. Customers will benefit from a stronger, more comprehensive platform designed to meet their evolving needs with greater efficiency and expertise.

WHAT SPECIFIC BENEFITS DO COOPER AND ACI'S CUSTOMERS STAND TO GAIN FROM THIS ACQUISITION?

To better support our customers' infrastructure needs, ACI will expand Cooper's already proven suite of products and services. By aligning our much-improved reciprocating compressor offerings with our customer specific requirements, we can provide tailored solutions that enhance operational efficiency and reliability. This strategic enhancement ensures that our customers receive the highest level of support, enabling them to achieve their goals with confidence.



ACI's offerings will expand Cooper's proven suite of products and services.

CAN YOU ELABORATE ON HOW ACI'S EXPERTISE IN RECIPROCATING COMPRESSORS AND ENGINEERING SOLUTIONS COMPLEMENTS COOPER'S EXISTING SERVICE OFFERINGS?

With our combined experience and extensive portfolio of products and resources from ACI and Cooper, we are perfectly positioned to offer complete turnkey solutions for all compression equipment needs. ACI brings proven engineering solutions for reciprocating compressors. Its customer-centric portfolio of solutions is built upon advanced modeling abilities, detailed manufacturing of innovative hardware products, and effective customer service. The ability to offer solutions when others cannot will ensure the customer has a partner that is positioned to align resources to keep

Cooper's integration of ACI is expected to enhance operational efficiencies and improve production processes for both companies.

their equipment operational both today and in the long term as their compression requirements change.

WHAT ARE SOME KEY INNOVATIONS OR TECHNOLOGIES THAT ACI HAS DEVELOPED IN THE RECIPROCATING COMPRESSOR SPACE, AND HOW DO THEY ALIGN WITH COOPER'S GOALS?

ACI's focus on reciprocating compressor optimization and efficient operation directly aligns with our customer goals of reducing fugitive emissions and ensuring the safe, reliable operation of their compression equipment.

HOW WILL THE INTEGRATION OF ACI IMPACT COOPER'S GLOBAL MANUFACTURING AND SERVICE OPERATIONS, PARTICULARLY AT THE HOUSTON, SALINA, AND MCPHERSON FACILITIES?

ACI will continue to operate within their existing facilities. However, the overall integration of ACI is expected to enhance operational efficiency by combining the strengths and expertise of both companies. This will result in improved production processes through the sharing of ideas and best practices implemented at our facilities, fostering a culture of continuous improvement. Our primary objective is to align our resources with customer requirements, ensuring we meet customer objectives for product solutions within a competitive timeframe.

WHAT ROLE WILL ACI'S ENGINEERING EXCELLENCE AND CUSTOMER-CENTRIC APPROACH PLAY IN ENHANCING COOPER'S CURRENT SERVICE OFFERINGS?

ACI's engineering excellence and customer-centric approach perfectly align with our core values of accountability, customer focus, teamwork, and excellence. This alignment will make the integration seamless. The ACI Team will enhance our ability to provide the customer with innovative solutions, ensuring the delivery of safe and reliable energy.

WHAT CAN WE EXPECT NEXT FROM COOPER AND ACI IN TERMS OF PRODUCT DEVELOPMENT, INNOVATION, OR CUSTOMER SERVICE INITIATIVES POST-ACQUISITION?

As our customers' goals and objectives evolve, they can rely on Cooper and ACI to align our resources to meet their requirements. Our extensive experience and expertise enable us to develop solutions that build on existing capabilities and address emerging needs. For instance, we efficiently utilize engine and compressor analytics, along with hardware solutions, to maintain optimal compressor load, ensuring emissions are minimized while meeting operational demands. **CT2**

Ahead of time

Shaping the future of compression

Setting concrete goals is the first step for any business looking to optimize its operations. The next step? Thinking ahead by partnering with you to leverage technologies and drive impactful solutions. That's why Siemens Energy has an extensive portfolio of compression solutions and services that are designed to power your success today and tomorrow.

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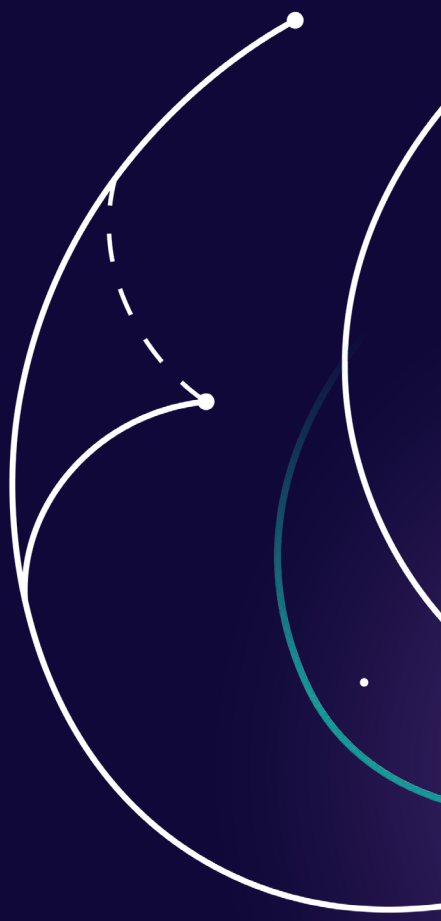

SIEMENS energy

A few highlights from the rescheduled event.

By **Jack Burke**

GMRC

Tech updates abound at rescheduled GMC

The Gas Machinery Research Council's recent Gas Machinery Conference offered attendees three days of in-depth content and a chance to network with others from the industry. The event was originally scheduled for October in Tampa, Florida, but Hurricane Milton forced organizers to reschedule the event and move it to Houston.

A session on tech updates was one highlight of the event. Here's a brief overview of some of the presentations:

Recent innovations from Windrock include:

- **Platinum 2:** An update to their online protection system, enhancing cybersecurity and improving the user interface to make it more intuitive based on customer feedback.
- **Spotlight with Luxard:** Spotlight, launched in 2016, is a cloud-based online monitoring system for compressors and engines that offers detailed, real-time data on pressure, vibration, and temperature. With the addition of Luxard, it now includes valve cap monitoring, eliminating the need for labor-intensive field diagnostics.
- **On-Premise Solution:** In response to customer concerns about cloud-based systems, Windrock now offers an on-premise solution for large suppliers, ensuring enhanced control over data while maintaining robust system monitoring.
- **Portable Analyzer Upgrades:** Windrock's portable analyzer now features *Speed Sync*, which automates and simplifies data file transfers, providing easier cloud access and allowing for real-time collaboration with field experts.
- **Winrock Optimum:** An updated software platform for Windrock's 6400 analyzer, providing improved functionality and stability, ensuring users get the most accurate and actionable insights from their data.

Data Acquisition

Monico's MCore SDR system offers a suite of powerful tools designed for condition-based maintenance and data acquisition for a range of industrial applications, including compressors and engines. At the heart of Monico's offering is Compressor Watch, a condition-based maintenance platform that utilizes existing sensors and data without requiring additional hardware. This solution is aimed at improving the overall reliability of compressors and engines by providing automated, actionable insights into performance and maintenance needs.

One of the key differentiators of Compressor Watch is its automation—users receive specific, actionable recommendations for maintenance, reducing the need for constant monitoring. The system identifies potential issues across various components, including emissions, knock sensors, and engine parts, and offers engineers and mechanics an intuitive dashboard to monitor, analyze, and generate custom displays.

Monico's system is built on a data historian, which not only tracks historical data but also stores and backs up valuable performance data, helping teams to optimize maintenance schedules and enhance operational reliability. In a study conducted with 20 compressors over a 16-month period, Compressor Watch demonstrated a 1.7% improvement in overall reliability, leading to nearly 3,000 additional hours of runtime and the potential for an additional 3.7 BCF in production.

Carbon control

Elliott Group, Ebara Corp. discussed its CO_2 compression and pumping system designed to address the growing need for efficient CO_2 management, including capture, transportation, and sequestration. Their solution combines both a centrifugal compressor and a pump into a single system to handle CO_2 in both its gaseous and dense phases.

The CO_2 compression system consists of a three-section centrifugal compressor, which gradually increases the pressure of the CO_2 from atmospheric levels to up to 3000 psi. The process involves compressing the gas multiple times, cooling it between stages, and reaching the dense phase or supercritical pressure—where the CO_2 becomes significantly denser. Following compression, the gas is then pumped to the required final pressure, typically ranging from 1400 psi to 2100 psi for pipeline transport.

Portable power

Solar Turbines has developed a versatile Mobile Turbine Machinery (MTM) product line, aimed at providing efficient, portable power generation solutions for various industries. Initially launched in 2019 with the SMT60, the product was designed specifically for oil field production, enabling the use of flared gas to generate electricity, thus eliminating the need for costly diesel fuel. The SMT 60 is a plug-and-play solution that can be quickly set up and operational within hours, making it an ideal choice for

Solar Turbines gave an update on its SMT130 mobile power solution.

remote sites and fracking operations.

Following the success of the SMT60, Solar Turbines introduced the SMT130—a larger, more powerful mobile power solution. The SMT 130 is based on the Titan 130 turbine and features a two-unit design that provides up to 16 megawatts of power. It is adaptable for various environments, capable of operating in extreme cold weather (down to -40°C) and high ambient temperatures (up to 55°C or 131°F), making it suitable for use in regions like Canada, the Middle East, and North Africa. The SMT 130 also offers dual-fuel capability and is available in 50 Hz configurations for international markets, including Europe and Asia.

Telematics

EMIT Technologies' latest advancements in telematics, sensor technology, and monitoring solutions offer enhanced flexibility, ease of use, and data transparency for compressor and engine systems.

1. **Telematics Integration and Configuration Auditing:** EMIT has expanded its telematics services, which have been integrated directly into compressor panels for years. The panels are highly configurable, allowing for quick changes in the field. New features include automated configuration reports that notify a designated distribution list whenever a configuration is altered. These reports allow users to monitor changes and ensure they align with operational standards. Additionally, users can download configuration data from multiple panels and review settings quickly, providing an extra layer of review without sacrificing flexibility.
2. **Wireless Nodes for Remote Monitoring:** EMIT is introducing wireless nodes that gather sensor data from around a site—beyond the compressor itself—and transmit it to the cloud via a base station. These low-power wireless sensors can cover long distances and are equipped with solar panels for sustained power. This system allows for monitoring across large areas while reducing the need for extensive wiring.
3. **Non-contact IR Temperature Sensor:** The new IR temperature sensor is a low-resolution infrared camera that enables non-contact temperature measurement. This sensor is useful for monitoring hard-to-reach areas where wiring would impractical. The sensor integrates with the EMIT panel's screen, allowing users to track multiple points and set alarms based on temperature variations. **CT2**

Executive summary
In the natural gas Industry, centrifugal compressors equipped with oil seal technology are generally acknowledged as the leading source of methane emissions offshore and a significant source in onshore operations.

This emission source represents a significant economic opportunity for operators. It is also an area of focus both for regulation and voluntary programs such as the Global Methane Initiative, US Natural Gas Star and the United Nations Environment Program's Oil and Gas Methane Partnership 2.0 — the only comprehensive, measurement-based international methane reporting framework for the oil and gas sector. There are numerous technologies available to reduce methane emissions from centrifugal compressors equipped with oil seals. Gas seal technology is market-ready, proven and proposed as the best available technology for reducing methane emissions from centrifugal compressors equipped with wet seals. Over the last 25 years, numerous operators have successfully reduced methane emissions by upgrading from wet seal technology to gas seal technology. John Crane's wet-to-dry gas seal retrofits have helped customers reduce approximately

Sealing solutions

The economic benefits of retrofitting wet seal-equipped centrifugal compressors with gas seal technology.

Background

Globally, the economic, environmental and energy security impacts of methane emissions from the natural gas industry continue to garner attention.

From an economic perspective, the amount of methane lost in fossil fuel operations in 2023 was 170 billion cubic meters — more than Qatar's natural gas production. Methane emissions from oil and gas operations cost $10 billion annually in the U.S. alone. According to Environmental Defense Fund estimates, the nation's operators wasted $500 million worth of gas in 2019, the latest year for which there is data.

From an environmental standpoint, methane — the principal constituent of natural gas — is a potent greenhouse gas (GHG) with a significantly higher climate-forcing impact than CO_2. From an energy security perspective, methane emissions have the potential to hamper the role of natural gas as a clean bridge fuel between the heavy fossil fuels of the past and low-carbon energy sources of the future.

Although some progress has been made over the last decade through several industry and geopolitical mechanisms, methane's combination of economic, environmental and energy security impact makes it a mission-critical issue in the new energy era. As a result, governments, NGOs and the private sector are all seeking proven technologies that deliver economic and environmental benefits across the natural gas value chain.

EDITOR'S NOTE: The following white paper from John Crane was originally presented to the United Nations Economic Commission for Europe in March 2017. It has been updated slightly to reflect the latest developments in both sealing technologies and the energy transition.

The relevance of this emissions source

Region- and industry-specific studies can be extrapolated to provide insight into methane emissions for the natural gas industry. These studies have guided stakeholders to shape voluntary and involuntary activities over the past two decades. Centrifugal compressors with oil — or "wet" — seal technology have consistently appeared among the top contributors to total methane emissions.

The specific impact varies upon numerous factors. These include the profile of natural gas operations in a given region — gas production, processing, transmission and/or storage — as well as the balance of onshore and offshore operation, the technology available at the time the equipment was commissioned and operating practices. However, the ever-present relevance of this emission source is evidenced by:

1. The analysis of key independent studies, including those from ICF and the Environmental Defense Fund
2. The consistent visibility of mitigation efforts in established NGO forums including GMI and Natural Gas Star
3. Its focus within industry coalitions; one of nine sources addressed in OGMP
4. Its inclusion in regulations from the US Environmental Protection Agency's New Source Performance Standards and Environment and Climate Change Canada

It is unlikely that these authoritative sources are all incorrect regarding the relevance of this emission source.

Where are centrifugal compressors applied?

Centrifugal compressors are an integral part of the natural gas value chain from extraction to the city gate. This equipment is most intuitively understood as providing the motive force behind the intercontinental transmission of natural gas. Beyond transmission, centrifugal compressors are

278,000 tonnes of CO_2 equivalent emissions per year over the last decade.

In addition to discussing the methane mitigation benefits of gas seal technologies, this paper presents a decision-support tool that evaluates three available technology options from an economic perspective and takes the understanding beyond previous case studies.

also deployed in a wide range of upstream and midstream natural gas applications, including both onshore and offshore, gas processing and storage.

Shaft sealing technology is an integral subsystem of centrifugal compressors. Before the mid-1980s, a variety of oil seal designs were incorporated into centrifugal compressor designs. Although these technologies were regarded as "state of the art" for many decades, low emissions levels were in most cases not a design objective. In many cases, normal operational wear and tear only further exacerbates these emission levels.

Since John Crane introduced gas seal technology in the mid-1980s, the oil and gas industry has progressively adopted it as the preferred design standard for new equipment. In doing so, they have realized numerous economic and environmental benefits.

In some cases, stakeholders operate an existing fleet of equipment that contains a mix of compressors. This ratio is closely tied to the age of the equipment. Many legacy oil seal-equipped compressors have been upgraded to gas seal technology, with economic and environmental factors representing key motivators. However, the remaining legacy equipment requires urgent attention.

What is gas seal technology?

It is beyond the scope of this discussion to provide a comprehensive technical review of gas seal technology. The fundamental difference in design is in sealing medium. The result is a favorable step change in operating costs, reliability, emission levels and the overall operational carbon footprint, with additional important benefits relating to safety.

Since their introduction more than 40 years ago, gas sealing technologies have increasingly become the "de facto" shaft seal standard in centrifugal compressors throughout the oil and gas industry — including in upstream, midstream and downstream operations, and markets such as extraction, production, reinjection, LNG refrigeration and refining. This technology has been adopted by both major centrifugal compressor manufacturers and the oil and gas majors operating the equipment. This technology is globally available, globally supported and globally proven.

Technologies to reduce methane emissions from centrifugal compressors equipped with wet seals

There are numerous core technologies available today that can mitigate uncontrolled methane emissions from existing centrifugal compressors equipped with wet seals. Three of these technologies include:

1. Capturing the uncontrolled methane emission and routing it to a flare device
2. Capturing the uncontrolled methane emission and routing it to be used for some other productive purpose, as seen in Seal Gas Recovery (SGR) systems
3. Upgrading the oil seal solution to a gas seal solution

Over the years, the methane emissions reduction community has documented examples of all three technologies being deployed to reduce methane emissions in the natural gas industry. While each approach delivers comparable methane emission abatement, numerous factors must be considered when adopting a given technology.

Capture and flare

The use of a flare solution is universally applicable. However, it transforms the methane emission into a CO_2 emission with no opportunity for economic payback. This strategy is in direct opposition to the oil and gas industry's parallel efforts to reduce flaring.

Capture and reuse

The capture and use of emissions for other productive purposes usually takes one of three forms:

1. Reinjection back into the compressor or process
2. Use as a supplementary fuel source for the gas turbine powering, or driving, the compressor
3. Use as a supplementary fuel source for other equipment in the vicinity of the compressor, such as a boiler

In contrast to flaring, these approaches share a key advantage: the methane emission is no longer "wasted" and an economic payback can be achieved. The opportunity to deploy a given solution is situation-dependent.

Wet-to-dry gas seal upgrade

In contrast to these two approaches, the implementation of gas seal technology — and the resulting transition from contacting to non-contacting seal technology — eliminates methane emissions at the source. As discussed earlier, the implementation of non-contacting technology also delivers substantial operational cost benefits over and above the economic value of methane

	CAPTURE AND FLARE SOLUTION	CAPTURE AND REUSE SOLUTION	WET-TO-DRY GAS SEAL UPGRADE
Upfront Investment	Low	Low	High
Methane Savings	No	Yes	Yes
Operational Savings	No	No	Yes

emissions reduction. With this strategy, emissions levels are reduced to near zero. The opportunity to deploy this solution is situation-dependent.

The selection process for mitigation approaches

The selection of an appropriate mitigation approach is situation-specific, stemming from an evaluation of environmental, technical and economic considerations. This discussion focuses on the economics of the decision, as this is often the most complex to evaluate.

Assuming a base case of uncontrolled methane emissions from a centrifugal compressor equipped with oil seals, it is relatively straightforward to prepare a qualitative assessment of the economics for implementing the three solution families.

All three solutions deliver a comparable reduction in methane emissions. While this analysis is not particularly complex, it is insightful. A fundamental understanding of these basic principles allows all stakeholders — including policymakers, operators and NGOs — to make a much more informed assessment of the economics behind these solutions. This understanding takes us well beyond the simple measure of abatement cost. It is clear that in the long term, gas seal technology represents the lowest-cost solution.

As the discussion moves from qualitative to quantitative, simple generalities are no longer sufficient. Globally, the wide range of centrifugal compressor applications results in a wide range of operating characteristics and resulting economics for each mitigation option.

Examples include:

- Whether or not the compressor operator owns the natural gas being compressed and lost to emissions
- Whether the compressor is operated in isolation or as part of an installation of multiple compressors
- Whether the installation is onshore or offshore
- The percentage of time in operation versus standby
- The applicability of a carbon tax or credits
- The unit value of the gas being emitted
- The remaining useful life of the compressor in question
- Numerous other factors that influence the economic value of one solution over another

Historically, interested parties have created case studies and guidance based on specific use cases. However, these examples relate to typical scenarios and are not easily adaptable to specific circumstances. Simply put, there is no substitute for expertise — and advanced economic tools that leverage it.

The lifecycle cost calculator

Recognizing the opportunity to improve collective understanding in this critical area, John Crane has leveraged its legacy of technology leadership and innovative solutions to develop a quantitative Lifecycle Cost Calculator. This tool provides data-driven decision support for all relevant stakeholders.

The Lifecycle Cost Calculator guides the stakeholder to input the baseline costs of methane emissions and annual operating costs relating to an oil seal-equipped centrifugal compressor with uncontrolled emissions. From there, the user is prompted to input one-time upgrade costs, the cost of resulting methane emissions and annual operating costs associated with each potential mitigation strategy. The output is a thorough comparison of the total lifecycle cost associated with the baseline sealing solution for each of the three strategies — capture and flare, capture and reuse, and wet-to-dry gas seal upgrade. The tool provides insights on:

- Reducing total cost of ownership
- Managing environmental responsibility by reducing methane emissions
- Achieving regulation compliance

Of interest to those with a technical background, the tool accommodates such factors as offshore and onshore installations, multiple driver types, standby versus operating hours, static and dynamic leakages, seal reliability data, pipeline efficiency factors, parasitic losses and various upgrade costs.

To address common concerns for policymakers, the tool calculates abatement costs and CO_2 equivalent emission levels and accommodates various assumptions such as wholesale natural gas prices, carbon tax or other incentives, and whether the compressor operator owns the natural gas.

Explore the Lifecycle Cost Calculator at https://www.johncrane.com/en/lifecycle-cost-calculator

Case studies

The replacement of oil seal solutions with gas seal technology in centrifugal compressors is a well-understood methane mitigation strategy in the oil and gas, petrochemical and natural gas industries. Industry stakeholders have presented numerous case studies in methane emission forums over the years, including installations in the Americas, Europe and Asia. Among John Crane customers, these wet-to-dry gas seal retrofits have reduced approximately 278,000 tonnes of CO_2 equivalent emissions per year over the last decade.

Conclusion

Addressing existing oil seal-equipped centrifugal compressors is mission-critical to accelerating global methane emissions reduction efforts in the natural gas industry. Gas seal technology is market-ready, proven, widely available and supported on a global basis. When compared with "capture and flare" and "capture and reuse" strategies over the long term, gas seal technology provides the most favorable environmental, safety, reliability and lifecycle cost benefits.

The application of this technology to existing equipment has been well-documented over the years. John Crane has taken this understanding further with the introduction of its Lifecycle Cost Calculator — an essential tool for operators and policymakers seeking a robust, accurate and customizable evaluation of existing methane mitigation strategies. CT2

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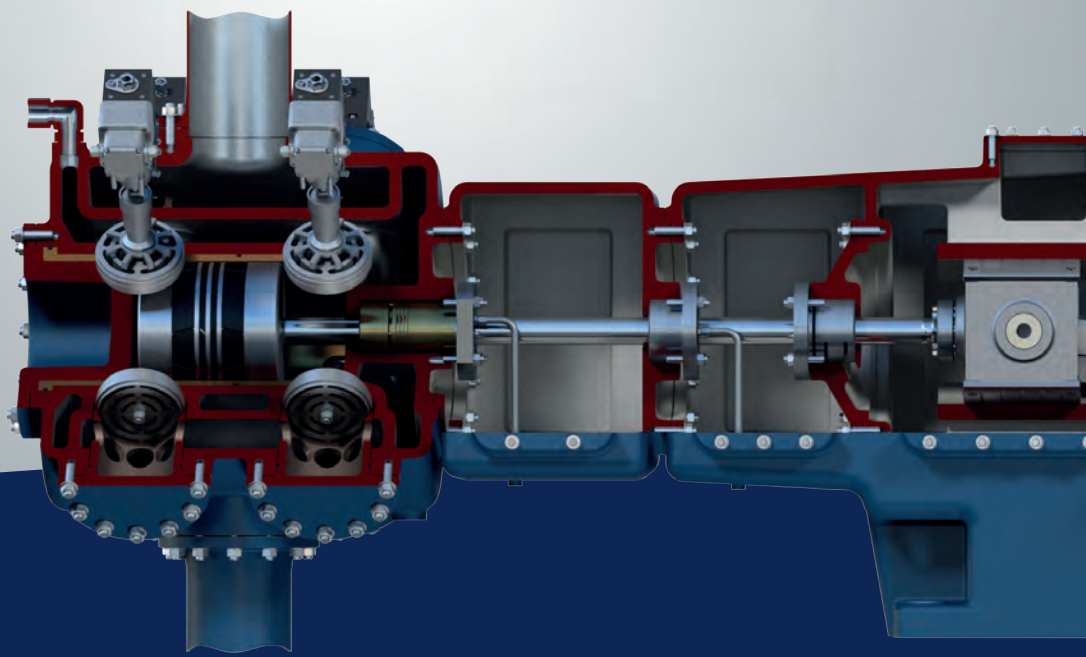

HCO

Compressor Overhaul

The lifespan of equipment in the oil and gas industry is measured in decades. This makes it all the more important to carefully maintain and service long-running compressors. This applies to the entire compressor, and goes far beyond just replacing worn-out components. Our Packing Case Repair (HPR), as part of our Compressor Overhaul (HCO) service, can significantly increase your compressor's lifespan. When replacing internal parts, closer inspection of packing cases and piston rods can result in longer overall runtime. This also saves energy, lowers costs and minimizes fugitive emissions, leading to more sustainable and cost-effective production. Our service team offers the unique expertise to make sure your compressors run better and longer. Contact us to learn more!

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CORNERSTONES COROLLARY: INDUSTRY EVOLUTION

This continues a series of Cornerstones of Compression articles that provide an historical look at the industries that drove the invention and technological evolution of compressors and supported the growth and development of the industries that depended on them. This issue concludes a review of the evolution of industrial air compressors.

The evolution of air compressors for mining, construction and manufacturing part 5.

Air compressor applications

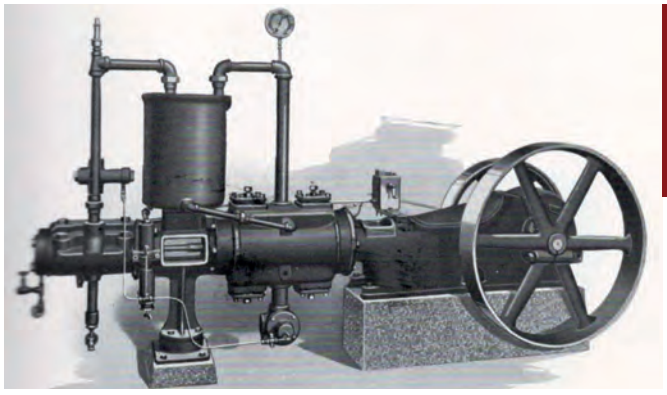
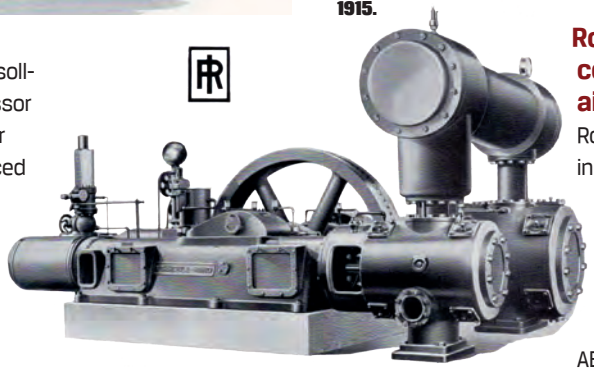


FIGURE 1
Ingersoll-Rand Class ER-2 belt-driven air compressor, 1915.

FIGURE 2
Ingersoll-Rand Type XPV steam-driven duplex compressor, 1915.



Despite many competitors, Ingersoll-Rand led the way in air compressor development and production for many decades. Ingersoll-Rand introduced a popular Class E small straight-line reciprocating compressor in 1905. The Class ER, Fig. 1, which followed by 1915, was the first compressor to use Rogler valves and force-feed cylinder lubrication, a big improvement over sight-feed lubrication which required constant operator attention.

The Ingersoll-Rand Type XPV, Fig. 2, also introduced in 1915, set an industry standard for steam-driven duplex compressors for air as well as gas and ammonia services. By 1927, an aggregate of nearly one million hp (745,712 kW) of steam- and motor-driven XPVs had been shipped, in sizes ranging from 50 to 1500 hp (kW). The Class PRE was introduced in 1914, also featuring the Rogler valve. It used two ER-type frames with a direct-connected synchronous motor mounted directly on the compressor crankshaft. The largest PRE version had two opposing throws on either side of a central flywheel as shown in the two 2500 hp (1864 kW) compressors in Fig. 3. This compressor series was the unquestioned leader of heavy-duty electric-driven air compressors for many decades.

No period in human history saw as much technological development as the 20th century. During the first half of that century alone, people witnessed the introduction of automobiles, aircraft and countless products sold in stores that hailed from factory assembly lines. The production for all of these things was largely driven by compressed air, which made it possible for workers at factories to assemble heavy, intricate items at speeds that were impossible in the previous century.

Smaller, higher speed reciprocating air compressors were developed by numerous companies, including Ingersoll-Rand, Gardner-Denver, Joy and others, and these were used in countless stationary and portable applications. Reciprocating compressors would continue to dominate air compressor production for many decades, but just as turbocompressors eventually took over blast furnace applications, other technologies would eventually replace most of the reciprocating air compressors.

Rotary screw and centrifugal compressors dominate industrial air compression applications

Rotary screw compressors were developed in the 1930s and 1940s by AB Ljungströms Ångturbine of Stockholm, Sweden for compressing combustion air in jet engines. Fig. 4 shows the unique arrangement of the spiral lobed rotors. Later becoming Svenska Rotor Maskiner AB, the company developed standard screw air compressor designs that were licensed to multiple companies beginning in the early 1950s. By the 1970s, screw compressors

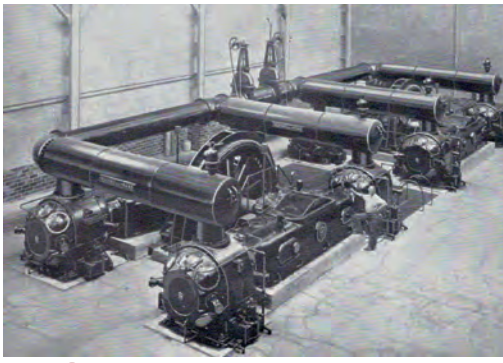


FIGURE 3
Ingersoll-Rand Class PRE compressor, c.1928.

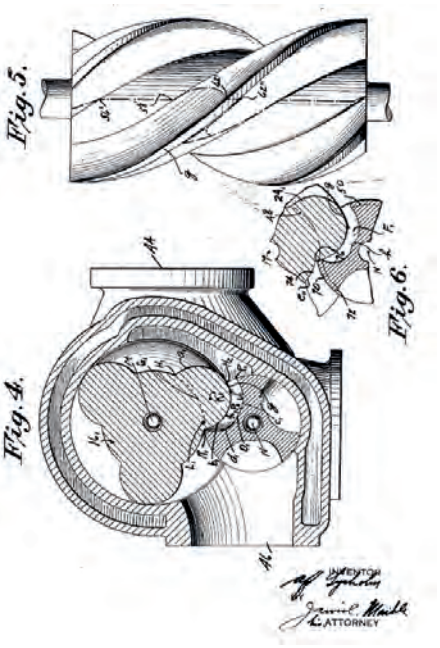


FIGURE 4 AB Ljungströms Ångturbine patent drawing showing the unique arrangement of the spiral lobed screw compressor rotors, 1939.

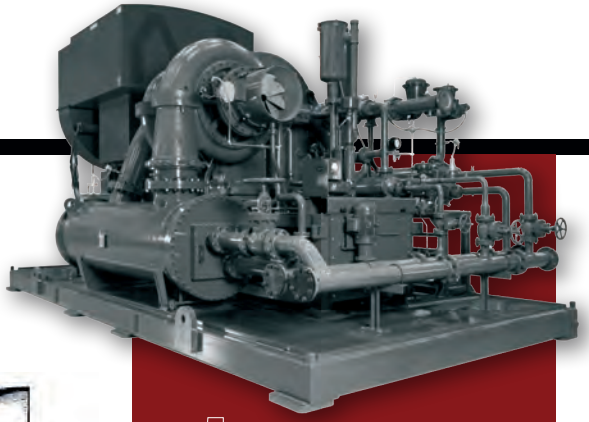


FIGURE 5 Elliott plant air package (PAP), c.1953.

were dominating portable construction and most small and medium sized plant air compression applications.

Another breakthrough occurred in 1962, when the Elliott Company of Jeanette, Pennsylvania extended their experience with turbocharger compressors to the development of plant air compressors. Elliott's plant air package (PAP), Fig. 5, was a compact centrifugal air compressor that deployed multiple pinion-driven single-stage centrifugal compressor impellers around a central electric motor-driven bull gear. Joy Manufacturing Company of Buffalo, New York introduced this type of machine at about the same time. Ingersoll-Rand and several other companies also soon developed compressors of this type. Together with rotary screw compressors, centrifugal compressors and some axial compressors essentially displaced large and medium sized reciprocating compressors in most of the industrial and process air compression markets. Reciprocating compressors retained significant shares in specialized high-pressure applications and remain common for small home and service shop air applications.

Satisfying the demand for higher-pressure combustion air

Another significant requirement for compressed air resulted from the advancement of internal combustion engines. The idea of using a compressor driven by exhaust gases to force air into an engine to increase power output came in 1905 from Alfred Büchi, a Swiss engineer at the Gebruder Sulzer engine company. During World War I Renault and General Electric had some success fitting turbochargers to engines powering various fighter aircraft, demonstrating that they could eliminate the power loss usually experienced at high altitude. General Electric called the system "turbosupercharging", which later became just "turbocharging".

Ships and locomotives equipped with turbocharged diesel engines began appearing in the 1920s. In 1940, the Elliott Company of Jeanette, Pennsylvania obtained the first U.S. license to manufacture Büchi turbochargers, which used a single centrifugal compressor stage as shown in Fig. 6.

Turbocharging grew during World War II for aircraft, vehicles, ships and locomotives. Elliott became a major supplier of turbochargers to U.S. manufacturers of large reciprocating engines for decades. Large engine manufacturers, e.g. Cooper-Bessemer and Clark, developed their own turbochargers in the 1950s, and other companies developed mass-produced turbochargers for smaller engines used in various industrial applications.

Axial compressors take flight

The development of combustion gas turbines was dependent on efficient methods of compressing large volumes of atmospheric air. The need grew with the development of compact and powerful gas turbines, aka jet engines, for aircraft. Centrifugal and axial compressors soon filled the need.

Charles A. Parsons originated the idea of an axial compressor, supplying the first commercial unit in 1901 for use in a lead smelter. These machines, driven by steam turbines, found other industrial uses such as supplying air to blast furnaces. Parsons' compressors had poor efficiency, but this changed in the late 1920s and early 1930s after it was discovered that the use of flat blades caused stall. The use of curved airfoils increased the efficiency to the point where an axial compressor became practical for a turbine engine. During World War II, German engineers were the first to successfully apply axial compressors routinely in aircraft jet engines, followed closely by similar developments by several U.S. companies. By the 1950s almost every major jet engine was developed with an axial compressor. The axial had a smaller frontal size than a centrifugal, resulting in less drag on the aircraft. Additionally the axial flow design could improve its compression ratio simply by adding additional stages and making the engine slightly longer.

In the 1950s, industrial gas turbines with axial compressors were successfully developed by General Electric, Westinghouse, Solar Turbines and others. They are currently the dominant prime mover for pipeline compressors and gas-fired electric power generation. **CT2**

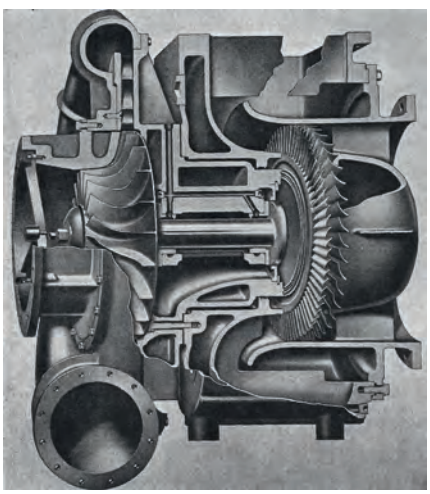


FIGURE 6 Elliott turbocharger based on Büchi license, c.1955.

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