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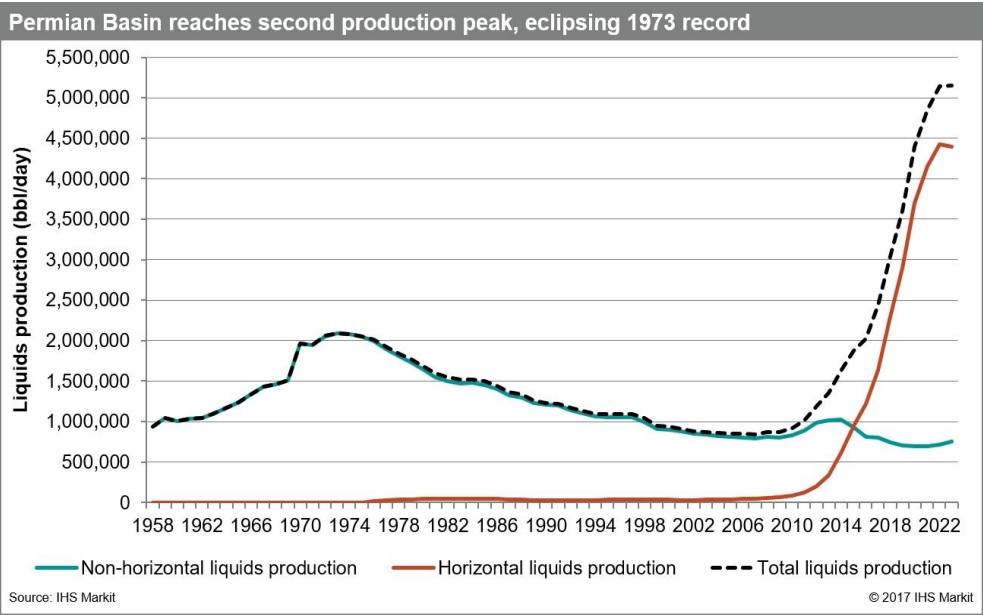
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Prolific Permian Basin Reaches Second Production Peak in 2017, Eclipsing 1973 Levels by More Than 25 Million Barrels, IHS Markit



The prolific Permian Basin, a mature hydrocarbon “super basin” located in west Texas and southeastern New Mexico, reached a new oil-production record of 815 million barrels or more in 2017-far exceeding its previous peak of 790 million barrels set in 1973, according to new analysis from IHS Markit, a world leader in critical information.

The 2017 production milestone does not just crawl past the previous 1973 peak, but eclipses the 44-year-old previous production record by more than 25 million barrels, IHS Markit said.

“The magnitude of the rebound in Permian Basin liquids production is unprecedented,” said Reed Olmstead, director, energy research and analysis, IHS Markit. “Not so long ago, many in the industry were saying the Permian was dead, but the Phoenix has again risen from the ashes and is soaring to new heights. The Permian Basin is on track to add more than two million barrels per day in new production since 2007, and after the final-year production count is in for 2017, we will see the previous all-time liquids-production peak of 2.16 million barrels per day during 1973 surpassed by a significant margin, with total Permian volumes at roughly 2.75 million barrels per day. In turn, this surge in Permian production is projected to push total U.S. liquids production to a new all-time high by the end of 2018. We see U.S. production exceeding 10.5 million barrels per day by the end of 2018.

According to the IHS Markit U.S. Energy Well and Production database, peak annual liquids production

for the Permian Basin during 1973 was nearly 790 million, an average of nearly 66 million barrels of oil per month. Peak-month liquids production in the Permian during 1973 occurred in September, with slightly more than 68 million barrels produced.

By mid-year 2017, average monthly production already exceeded the best month of Permian production during the former peak year of 1973. For 2017 year-to-date through July, Permian liquids production exceeded 484 million barrels, or an average of slightly more than 69 million barrels per month.

Aside from the overall E&P activity and related investment that is significant to the region, the state, and operators in the basin, “the implications for U.S. energy security are significant-since we have become, in a relatively short period of time, more self-sufficient in terms of energy supply and are less reliant on imports,” Olmstead said.

Longer-term implications for Permian Basin oil supplies are evolving, and the future looks promising, according to IHS Markit energy researchers, who have completed the first, three-year phase of a massive Permian Basin research project entitled: The Permian Basin Interpreted in 3D: The IHS Markit Permian Basin Unconventionals Kingdom Geology Project. It models and interprets the giant basin’s key geologic characteristics to better estimate its remaining hydrocarbon potential, and initial results indicate the giant basin still holds an

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2018 Summer Outlook for Natural Gas

The Natural Gas Supply Association’s (NGSA) 2018 Summer Outlook for Natural gas summarizes the association’s view of this summer’s natural gas market conditions and fundamentals. The analysis covers the key points that can affect supply and demand dynamics, which ultimately impact all consumers of natural gas.

NGSA forecasts whether natural gas prices will be subject to upward, downward or level pressure to the upcoming summer compared to the summer of 2017, but the association does not forecast actual prices.

Based on an analysis of the weather, economy, consumer demand, production and storage, NGSA expects neutral (flat) price pressure on the natural gas market in summer 2018 compared to last summer.

Our expectation for flat price pressure is based on a forecast for tremendous growth in demand that is matched by even more impressive growth in production.

A glance at the natural gas market’s major pressure points for summer 2018 reveals:

- ◆ **Weather:** The National Oceanic and Atmospheric Administration (NOAA) predicts that the continental United States will on average experience a summer that will be 5 percent cooler than last summer, but 2 percent warmer than the 30-year average. Compared summer-over-summer, the total number of cooling degree days (CDDs) is less than in summer 2017, leading to a projection that weather will place **downward pressure** on demand and prices.
 - ◆ **Economy:** Public data anticipates the economy will show positive growth in GDP and a significant improvement in manufacturing, however the growth is similar enough to summer 2017 that it translates to **neutral pressure** on natural gas prices compared to last summer.
 - ◆ **Demand:** NGSA expects record demand in summer 2018, fueled by record growth in electric sector demand for natural gas due to massive natural gas-fired generation additions since last summer, along with temporary coal-to-gas switching that together are forecasted to spark a summer-over-summer 10 percent increase in
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Prolific Permian Basin Reaches Second Production Peak in 2017,
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estimated 60 billion to 70 billion barrels of technically recoverable resources-about twice as much as the cumulative oil production to date.

Since it first began producing in the 1920s from the famed Santa Rita #1 well, the legendary Permian Basin has produced more than 39 billion barrels (cumulative) of oil reaching peak volumes in 1973. As conventional oil production in the play declined steadily during the following three decades, many in the industry thought the Permian’s best days were behind it, but unconventional drilling and completion technology changed the game in the 2000s. This advance made possible the extraction of unconventional shale resources that were previously uneconomic to produce, and changed the view of geologists, who, for decades, had bypassed the less desirable targets in favor of conventional reservoirs.

“The Permian is one of the most prolific basins in the history of oil production, with the onset of horizontal drilling and new completion technology during the past decade, the production decline in the Permian has been reversed and the basin has eclipsed its previous peak,” said Pete stark, Ph D, executive director, upstream research at IHS Markit. “The significance of this second production peak cannot be overstated, since it truly revived a basin, and in many ways, the U.S. E&P industry. When we consider the impact on the world’s crude markets, the Permian has to be considered a global disrupter.”

IHS Markit says the Permian Basin is of such significance to the global

oil and gas industry that the basin is the model IHS Markit uses as the benchmark for its ongoing research study on super basins, entitled Super Basins: The Basins that Keep on Giving Analysis. The IHS Markit researchers identified more than 25 onshore “super basins” that have multiple reservoirs and source rocks, diverse play types across numerous geologic horizons, infrastructure with access to markets, and established service sector and supply chains.

To earn “super-basin” status, the IHS Markit analysis said, basins must have achieved greater than 5 billion barrels of cumulative production and have an estimated remaining production potential that is greater than 5 billion barrels.

IHS Markit estimates the potential upside recoverable oil from 25 global super basins to be approximately 840 billion barrels. This is far larger than the resources required to generate the 40 million barrels per day of new oil supplies that may be required to meet estimated 2040 global oil demand, IHS Markit said.

“The key question for truly optimizing the potential of these super basins is whether the global petroleum industry had the wherewithal to successfully implement the Permian Basin model in mostly onshore, international super basin,” said Jerry Kepes, executive director, plays and basins at IHS Markit. “Established, mature super basins offer many potential advantages including lower subsurface risks, established infrastructure, existing supply chains and service sectors, as well as access to markets, but above-ground challenges pose substantial hurdles.”

2018 Summer Outlook for Natural Gas
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- ◆ demand for natural gas from the power sector. An increased volume of LNG exports further contributes to this summer’s demand growth, with a forecasted summer-over-summer increase of 1.6 Bcf/day-about a 76 percent increase for this young, but fast-growing market. Demand from the residential and commercial sectors is forecasted to grow by 7 percent, primarily attributable to a cold April that prolonged the use of space heating. The industrial sector is projected to experience slight growth of 0.5 Bcf/day in gas demand compared to last summer, with most growth attributed to new construction and capacity expansions. Mexican exports are also projected to grow by 0.5 Bcf/day. When all sectors are combined, overall demand is projected to be more than 6 Bcf/day (9 percent) greater than the summer of 2017 and thus to place **upward pressure** on natural gas prices compared to last summer.
- ◆ **Storage:** The natural gas industry entered the summer cooling season with storage inventories that were below the five-year average and below last summer. Filling storage to adequate levels will require weekly injections of 70 Bcf-about 23 percent larger than last summer’s weekly injections. Storage is forecasted to place additional **upward pressure** on prices.
- ◆ **Production:** Production is projected to smash through previous robust levels, due to increased production of both dry gas and “wet” gas often associated with oil and valuable natural gas liquids (NGLs) production. The increased production also reflects continued advances in drilling efficiency and a number of wells coming online. Dramatic

- ◆ increases in summer-over-summer levels of production are likely to result in **downward pressure** on natural gas prices.
- All of these projected pressure points are interrelated and a deviation in one affects the other assumptions in this equation. Increased demand from the power sector, for LNG exports and to build storage inventories all together place upward pressure on prices that is counterbalanced by tremendous growth in production-ultimately resulting in a forecast for neutral pressure on prices compared to the summer of 2017.

- Natural Gas Outlook: Summer of Flexibility**
- ◆ **Unparalleled production growth:** Associated gas significant contributor due to value of oil, NGLs Efficiencies in drilling and production make wells more productive at lower cost
Pipeline infrastructure expansions provide greater deliverability
 - ◆ **Summer (April-October) demand growth:** Driven by new gas generation, exports and unseasonably cool spring
 - ◆ **Exports provide growth, stability to market:** Welcome outlet for strong production
 - ◆ **Overall, stable natural gas outlook for consumers and a diverse market for producers**

- Overview: Record Production Enables Industry to Easily Match Record Demand**
- ◆ Strong Production supporting remarkable electric growth and growth in U.S. LNG exports
 - ◆ Electric demand growth fueled by numerous new gas-fired power units coming into services and temporary fuel switching.
 - ◆ Growing LNG exports along with pipeline exports to Mexico.
 - ◆ Industrial demand spurred mainly by new builds and expansions in petrochemical, fertilizer and steel.

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Gas Industry Partners GTI Celebrates 75 Years
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- Today, plastic pipe is the material of choice for natural gas distribution systems.
4. GTI helped pioneer development and market adoption of trenchless technologies and keyhole excavations solutions-which help reduce annual North American utility excavation and restoration expenses (which are on the order of \$3 billion annually).
 5. A key breakthrough in understanding and mitigation, GTI was influential in shining the light of science on the role of Microbial Induced Corrosion (MICV) in pipelines. GTI was the first one to use quantitative Polymerase Chain Reaction (qPCR) techniques, and today is one of only a few laboratories in the world that offers accredited DNA testing.

Gas Industry Partners GTI Celebrates 75 Years
Continued from page 4.

came from Europe and the OTD members said it was something that was of interest to them, so first we brought it over for evaluation to see if it met their needs and challenges.”

OTD stands for Operations Technology Development and is a consortium of 24 gas utilities representing more than 45 million North American natural gas customers. The consortium manages about \$10 million annually on research. Since its formation in 2003, much of the research has been through GTI.

“After the OTD members decided, based on what GTI found, that the technology meets their needs and challenges, there were updates that needed to be made to better fit our gas industry in North America,” Jarnecke continues. “We then worked with that manufacturer to make the improvements, and beyond that we helped with the implementation.”

Industry Interactions

Hosting its own conferences, like the annual Shale Exchange and CH4 Connections Methane Emissions conferences, plus regular attendance at American Gas Association (AGA) events, PHMSA Office of Pipeline Safety public forums on R&D and NASTT’ No-Dig Show, are among the industry outreach efforts that GTI is often involved with.

The involvement is not limited to North America, but includes the international natural gas industry as well. Miller notes that David Carroll, GTI president and CEO, is serving as the president of the International Gas Union (IGU) for the U.S. team through June 2018, when the triennial World Gas Conference will be held in Washington, D.C., in conjunction with AGA’s 100th anniversary.

“Being around 75 years in the oil and gas industry, we are linked with a lot of customers at many levels, and many of the operators, so we make it our business to know what their needs are,” Ersoy says. “We proactively meet with our customer, the pipeline and local distribution companies, on a regular basis.”

In addition to physical equipment, GTI has made a name for itself in natural gas system modeling as well. Typically, the modeling comes as a reaction to new code requirements. A federal or state regulator will tell the industry, “Now you have to do this.”

For instance, Ersoy notes, there is “grandfathered” pipe out there without verified maximum allowable operation pressure (MAOP) records or material strength or grade.



Ultra-Trac MJI (metallic joint locator), Ultra-Trac APL (acoustic-based pipe locator) -shown here –handheld Sensit PMD (portable methane detector) are key locator and methane detector technologies developed by GTI with OTD funding and brought to market by SENSIT Technologies.

“These projects get quite technical, and we may conduct finite element analysis, fracture mechanics, we may do probabilistic modeling or advance statistical techniques and regression analysis to develop casual and correlated models,” he says. “These deliverables are not a physical technology, but they are equally important, and we do that in different areas of the industry.”

No matter if the research comes from GTI seeing a need, or is identified by OTD or other companies involved in the gas industry, or if new training is born from research work or an evolution of a program that traces its roots to the 1950’s, GTI’s mission and core will always be the same.

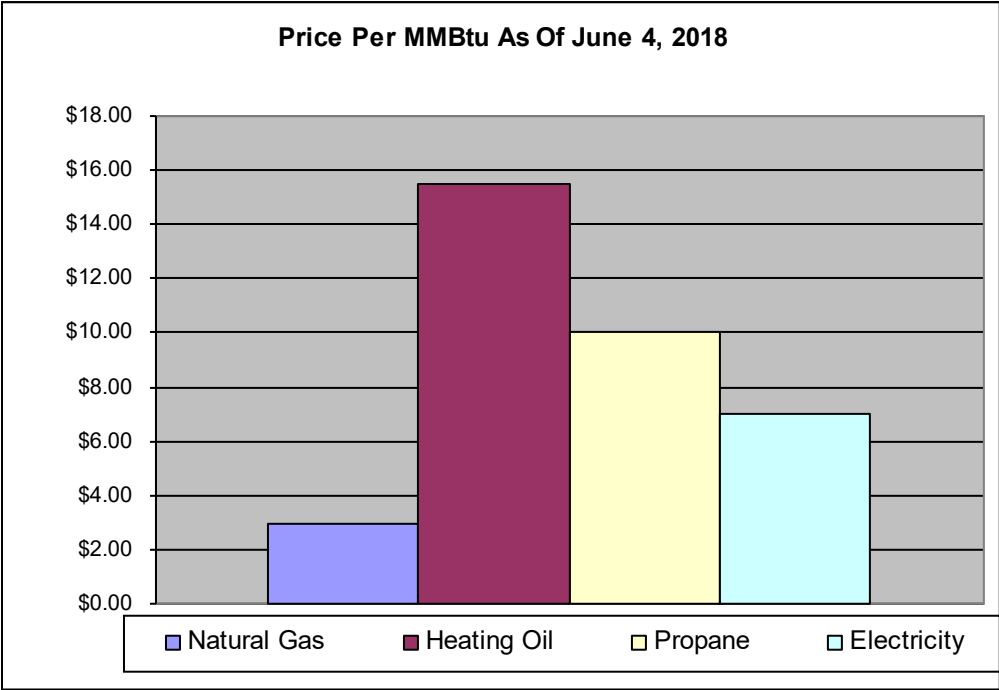
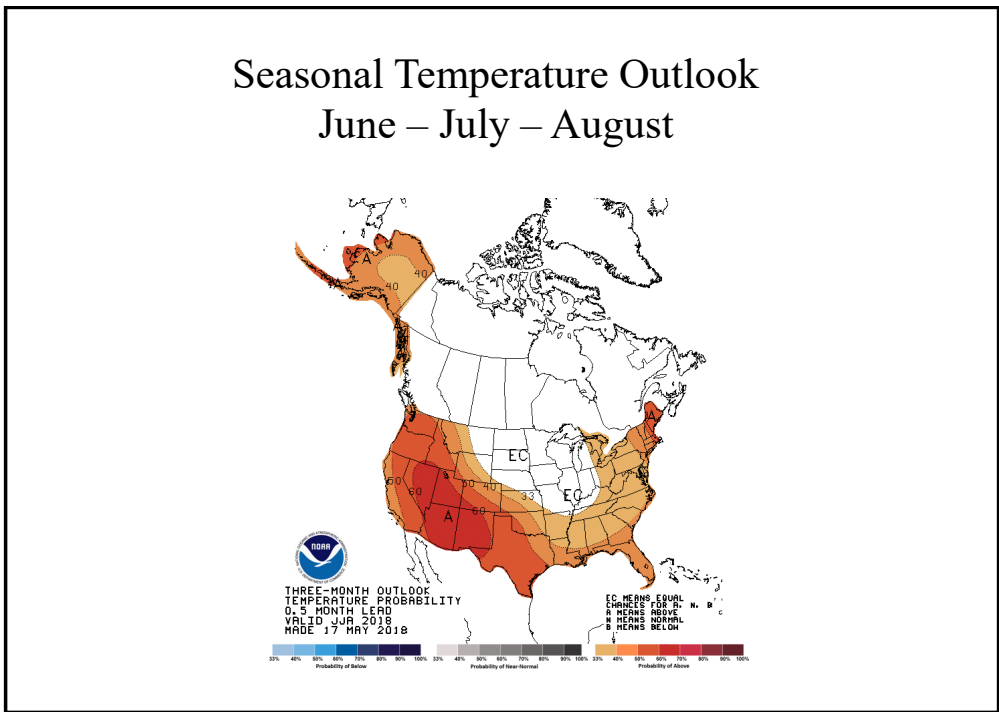
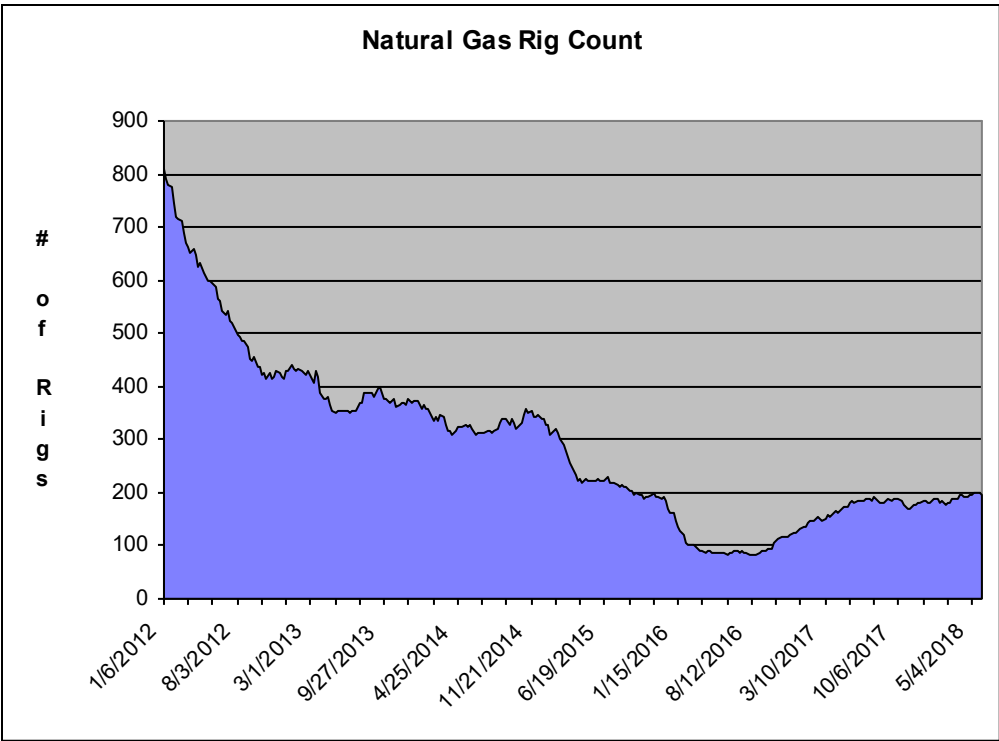
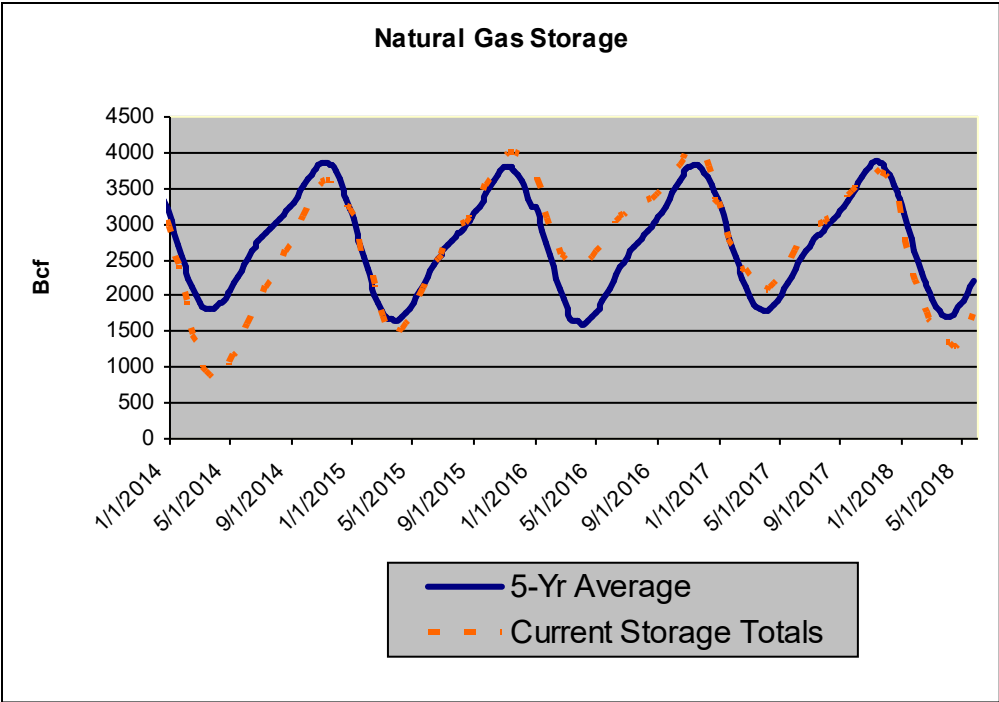
“Everything GTI does in gas operations revolves around safety, integrity, efficiency, and the environment. These are always the key focuses of the industry,” Ersoy says. “With aging infrastructure and an underground crowded with multiple utility infrastructures, all of the technologies that come to bear on safety and integrity have always been at our core. From better locates of plastic pipe underground to right-of-way incursion to third-party damage prevention to improved materials that are tougher, stronger, and more corrosion resistant. We focus on those things that are the standard concerns of the industry that never go away. Other things may come and go but those are the core areas.”

GTI Top Products/Processes on the Market

1. Sustained 25-year, more than \$600 million R&D program related to shale gas, including advances in hydraulic fracturing, horizontal drilling and advanced 3D imaging. Shale gas is now saving U.S. consumers more than \$75 billion annually.
2. Advances during the 1980s-1990s that enabled large-scale coalbed methane production to become a proven new natural gas resource.
3. With work from the 1980s on, GTI confirmed the suitability of polyethylene (PE) plastic pipe for gas distribution systems. New equipment, tools, instruments, techniques and guidelines for safe and efficient installation and

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Snapshots



**.Gas Industry Partners
GTI Celebrates 75 Years**



Chances are good that if you’ve worked on a natural gas pipeline project, upgraded a local distribution system or even fired your Viking range at home, the Gas Research Institute (GTI) or its predecessor organizations were in some way related to the process.

Though GTI-as it is known today-came into being just 17 years ago, the not-for-profit research organization traces its roots to the 1940s and the formation of the Institute of Gas Technology (IGT) and later the creation of the Gas Research Institute (GRI) in 1976. It was the combination of these highly recognized industry organizations that GTI was born.

IGT, founded in 1941, had a mission to specialize in research and education pertaining to the production, distribution and use of natural gas and its byproducts. The organization supported the gas industry’s need to train graduate engineers, IGT was affiliated with the Illinois Institute of Technology (IIT) as a degree-granting institution from 1941 to 1994, when IGT moved off IIT’s campus to larger facilities in Des Plaines, Illinois.

As the gas industry evolved, IGT also evolved in parallel, focused on a world-renowned research program with support from many industry sources, including GRI. GRI was founded in 1976 in response to the Federal Energy Regulatory Commission (FERC) encouraging increased gas research and development. GRI administered research funding provided by a surcharge on shipments of natural gas sold by the interstate pipelines.

As a result of the phasing out of GRI’s funding mechanism, the gas industry encouraged GRI and IGT to combine activities. In 2000, the GRI/IGT combination became official.

GTI has 360 employees, the bulk of whom are headquartered in Des Plaines, with additional locations across the country.

“We cross the entire value chain from E&P through gas operations all the way to end use-whether it be residential/commercial water heating or space conditioning, energy efficiency of buildings, commercial food service, power generation or alternative transportation fuels-we run the whole gamut,” says Diane Miller, GTI senior marketing communications manager.

Miller adds that GTI played a role over the past 75 years in shaping the natural gas industry as it is known today through the development and deployment of new technologies including, plastic piping innovations, horizontal directional drilling (HDD) and other trenchless technologies, hydraulic fracturing and more. On the gas operations side, GTI works tirelessly to reduce risk, improve safety and increase efficiency through the development of technology and knowledge.

Developing Technologies

“GTI has spent the last seven decades developing high-impact technologies and providing technical insight to unlock the potential of natural gas and other energy resources making them economically and environmentally sustainable while reducing energy costs for consumers,” says Bill Liss, GTI managing director of Delivery & Utilization. With the creation of GTI in 2000, Liss notes that the organization sharpened its focus and became much more aligned with its customers’ needs.

“The company evaluated its program portfolio and reduced emphasis and redeployed assets from underperforming area that lacked scale and provided limited competitive advantage,” Liss says. “GTI strengthened its capabilities and corporate focus in areas that align with gas industry and customer needs and interest.”

One of those areas that always has and always will align with the industry is training. It is no wonder because training is a cornerstone of GTI, tracing its roots to IGT and its mission to train graduate engineers for the gas industry. As the industry

developed, the training shifted to encompass all aspects of the industry. GTI’s certification programs let those taking the courses customize their training to best suit their industry-related needs. Two of the more popular certification courses are the Register Gas Distribution Professional (RGDP) and the Certified Gas Transmission Professional (CGTP) courses.

To date, GTI boasts training more than 70,000 gas professionals both in the classroom, customized onsite, online or via webinars. In 2013, GTI developed it’s Natural Gas Field Skills Training program, series of 77 training modules aimed squarely at field workers in the natural gas operations and maintenance sector. According to Miller, utilities often used the modules to train both contractors on the fundamental processes or work with GTI to tailor the training to meet the utility’s specific requirements.

Important Research

Sometimes, the training offered dovetails nicely with the research end of the organization. Case in point is GTI’s onsite, field-applied pipeline coatings workshop, which was born after nearly a decades-long study.



Sections of pipe are removed at GTI’s field-applied pipeline coatings testing site.

“The largest threat to steel transmission pipelines is corrosion. Third-party damage usually trumps for the smaller distribution pipelines, but if you go into the PHMSA database and look at all the incidents on transmission pipe, external corrosion is usually one of the to three every year, and because of that, it is always at the forefront,” says Daniel Ersoy, GTI R&D executive director, Energy Delivery & Utilization.

Ersoy was instrumental in the \$4 million program that tested 684 coated joints from five different coating classes, using 75 coating systems from 18 different manufacturers. The tests were conducted at an outdoor facility adjacent to the Des Plaines headquarters. Partners on the project included BP, Chevron-Texaco, multiple local distribution companies, GRI before it sunsetted and several OEMs.

The field site measured approximately three football fields, and the soil conditions mimicked a variety of different types to make this a truly real-world study. It included proper drainage, cathodic protection, in some instances heat to imitate outlet at compressor stations, and a variety of sizes including 24-and 8-inch pipes to demonstrate transmission and distribution, as well as transmission laterals and tie-ins.

“It was a watershed program that tested upward of over 90 percent of all available field-applied coatings,” says Ersoy. “These are coatings that system owners or contractors have to apply in the field, and it is a difficult task to perform properly with a variety of materials and choices.”

The end result is an unbiased, real-world, product-specific way for owners and contractors to select coatings that are appropriate to their requirements. Ersoy points to the fact that there will always be a baseline need for this training as people cycle through the industry. “About 90 percent of the coatings tested are still on the market,” Ersoy notes. “So, the results are still applicable and the training is fundamental corrosion coating training, which never changes.”

Both training and research opportunities are based on GTI’s strong ties to the industry. In some instances, the industry comes to GTI. At other times, GTI bids on the research proposal, and other times GTI begins the process on its own. The research yields a number of products or processes used in the market today.

“The OTD member utilities really drive a lot of the efforts that we are doing,” says Dennis Jarnecke, GTI R&D director, Energy Delivery & Utilization. “Technologies such as the alternative flow stopping system

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