



**GAS POWER PLANT
EXHIBITION & CONFERENCE**
20-21 JUNE, DAVID L. LAWRENCE CONVENTION CENTER, PITTSBURGH, PA

**CLICK
HERE**



2019 US Gas Power Plants Engineering & Construction Trends and Outlook



Featuring Insight from:

- › **Timothy Wroe**
GE Power
US/CAN Project Portfolio Manager
- › **Jeffrey Peet**
Duke Energy
Lead Project Engineer
Citrus County Combined Cycle Plant
Project Management & Construction
- › **Daniel Groves**
CEO Construction Industry Institute
Construction Users Roundtable
- › Construction Industry Resources
- › U.S. Energy Information Administration
- › Invenergy
- › Entergy
- › Minnesota Power
- › BAE Systems



TABLE OF CONTENTS

Natural Gas Power Generation U.S. Market Overview

- A. Power Projects Outlook
- B. Factors Driving Gas Power Investment
- C. Fuel Supply and Outlook

2. Project Updates

- A. Major project updates
- B. Gas Powered Electric Generator Projects

3. Case Studies

- A. Invenenergy's Lackawanna
- B. Duke Energy's Citrus Combined Cycle Station

4 Construction Market Trends and Issues

- A. Power block increases-EIA analysis
- B. Workforce solutions

5. Conclusion & Forward-Looking Assessment



Introduction

Cheap and abundant natural gas, reduced production costs, and improved technology continue to give natural gas-fired power plants and renewable energy resources a competitive advantage over traditional coal and nuclear generation.

As nuclear-fired plants retire and coal fired units are shuttered, gas and renewables are making up an increasingly larger piece of the pie.

The U.S. Energy Information Administration (EIA) expects the share of U.S. total utility-scale electricity generation from natural gas-fired power plants to rise from 35% in 2018 to 36% in 2019 and to 37% in 2020. Meanwhile, the EIA forecasts that the electricity generation share from coal will average 26% in 2019 and 24% in 2020, down from 28% in 2018. The nuclear share of generation was 19% in 2018 and EIA forecasts that it will stay near that level in 2019 and in 2020.

The generation share of hydropower is forecast to average slightly less than 7% of total generation in 2019 and 2020, like last year. Wind, solar, and other non-hydropower renewables together provided about 10% of electricity generation in 2018. The EIA expects them to provide 11% in 2019 and 13% in 2019.

Gas and renewables comprise most incremental new capacity in the U.S. and North America. The EIA projects that by 2025 natural gas will comprise about 25% of the power sector, and by 2050, 39%.

The discovery of shale gas and fracking has altered the previous \$8-12/MMBtu price of long-term natural gas fuel supply contracts on the U.S. down to the \$3-4/MMBtu range making the fuel a cost-effective resource for power. Natural gas is becoming a prime fuel choice for new power generation and now ahead of coal for the highest percentage of U.S. capacity.

With U.S. capex and maintenance investment in the billions, schedules spanning years and an ever-changing supply/demand outlook, owners and contractors must be prepared for the enormous challenges that come with project management of building and managing gas powered electricity generators.

Read on to discover key trends shaping the industry, an update on projects and investment, and gain insight from engineering and construction leaders who have recently completed mega projects.

US Market Overview

The greatest opportunities for natural gas power development in the U.S. are in the Mid-Atlantic region, where owners can take advantage of inexpensive and abundant Marcellus shale gas, as well as in the Texas and Louisiana Gulf Coast regions.

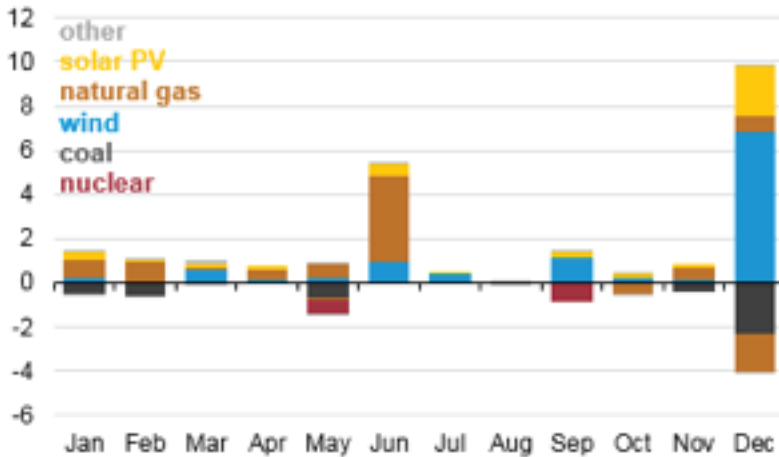
New 2019 electric generating capacity to come from renewables and natural gas

According to the U.S. Energy Information Administration's (EIA) January 2019 inventory of electric generators, 23.7 gigawatts (GW) of new capacity additions and 8.3 GW of capacity retirements are expected for the U.S. electric power sector in 2019.

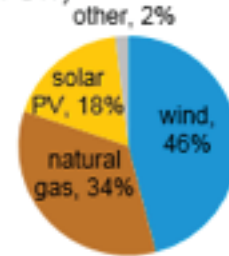


The utility-scale capacity additions consist primarily of wind (46%), natural gas (34%), and solar photovoltaics (18%), with the remaining 2% consisting primarily of other renewables and battery storage capacity.

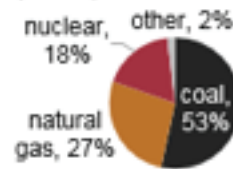
U.S. electric capacity additions and retirements, 2019
gigawatts (GW)



planned additions
(24 GW)



planned retirements
(8 GW)



Wind

A total of 10.9 GW of wind capacity is currently scheduled to come online in 2019. Most of the capacity will not come online until the end of the year, which is typical for renewable capacity.

Three states—Texas, Iowa, and Illinois—will be home to more than half of the 2019 planned wind capacity additions.

Natural Gas

Planned natural gas capacity additions are primarily in the form of combined-cycle plants (6.1 GW) and combustion-turbine plants (1.4 GW). Most of the natural gas capacity is scheduled to be online by June 2019 in preparation for high summer demand.

Of the planned natural gas capacity additions, 60% will occur in Pennsylvania, Florida, and Louisiana.

Solar photovoltaics

Nearly half of the 4.3 GW of utility-scale electric power sector solar photovoltaic (PV) capacity additions are in three states: Texas, California, and North Carolina.

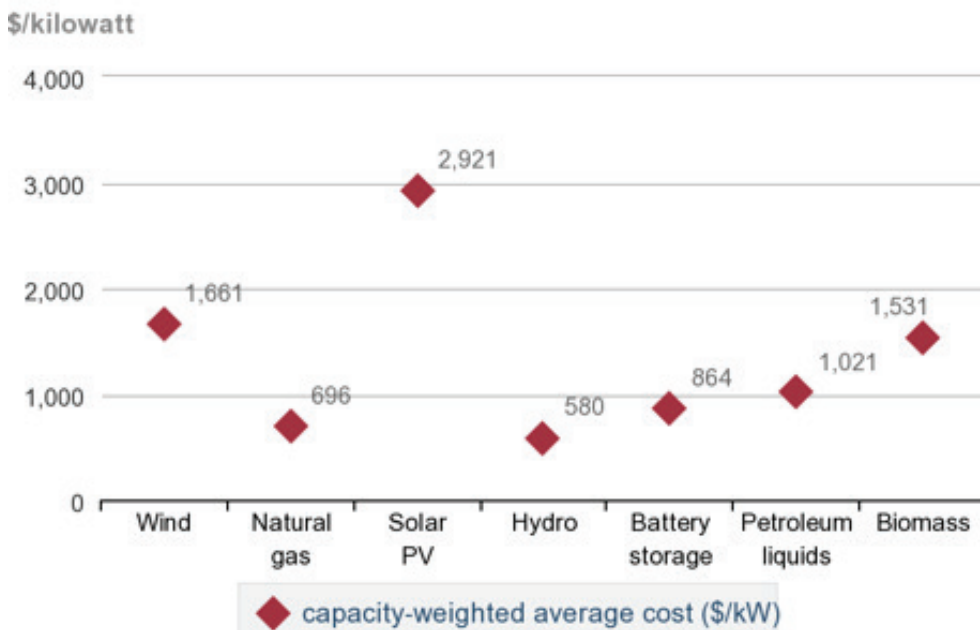
The outlook for growth is long-term according to the EIA's January 2019 Annual Energy Outlook. In the Outlook, the EIA predicts that the natural gas share for electricity generation will increase from 34% in 2018 to 39% in 2050, and the renewables share will increase from 18% in 2018 to 31% in 2050.



Factors Driving Investment and Growth

Construction costs for natural gas fueled power plants are around \$696 per kilowatt (kW) capacity. Weighted average cost are one of the lowest, just behind hydro power. This is significantly less than the most common forms of renewable generating facilities, with solar at \$2,921 per kW, wind at \$1,661 per kW and biomass at \$1,531 per kW, according to the EIA.

Average construction cost



Source: U.S. Energy Information Administration

Wind is a large part of the 2019 and 2020 project spend as developers look to use tax credits before expiration.

While incentives still exist for wind and solar in the U.S., the subsidies are winding down.

Production tax credits for wind will expire at the end of 2019, and the solar tax credit, which is now 30%, will decrease to 10% in 2020.

With 2020 being an election year, many believe it is unlikely that legislation will be developed to extend or create new renewable energy tax credits before the wind incentive expires.

As the tax credits fade, this could open opportunity for more natural gas plants to be built.



Project Updates

Invenergy

Invenergy announced in January 2019 it began operations of its 1,485 MW natural gas-fired Lackawanna Energy Center in Jessup, Pennsylvania, near Scranton.

The \$1.25 billion plant represents one of more than \$3.6 billion in planned Invenergy project completions in 2019, according to Industrial Info. While Invenergy is in the early planning stages for other natural gas-fired projects in Pennsylvania and Rhode Island, the company's focus is on renewable energy, particularly wind power.

Construction on the Lackawanna Energy Center began in early 2016, with Kiewit Power Constructors Company (Lenexa, Kansas) providing engineering, procurement and construction (EPC).

The facility uses General Electric equipment. The plant is planned to replace older units on the PJM Interconnection.

Invenergy also has plans to wrap up several other projects this year, mostly wind power.

Among these is the Santa Rita East Wind Energy Center in Reagan County, Texas.

The 300-MW facility will use 120 General Electric 2.5-MW wind turbine generators. Construction began in the third quarter of last year and is expected to wrap up by the summer of 2019.

Blattner Energy is providing EPC on the project, which has an estimated total investment value (TIV) of \$495 million.

In Iowa, Invenergy completed development of Ida Grove II Wind farm in Ida County in 2019. The project will be built and operated by MidAmerican Energy Company. The 300-MW project will use 130 General Electric wind turbine generators. Construction is planned to kick off in the second quarter. The project has an estimated TIV of \$330 million.

Invenergy began construction on its 161.3-MW Pine River Wind Park near Saint Louis, Michigan in the summer of 2018. When completed, the project will be operated by DTE Energy Company. Construction is expected to wrap up in early 2019. IEA Constructors is providing EPC on the project, which has an estimated TIV of \$325 million.

While Invenergy's projects are primarily geared toward wind, the company plans to wrap up a couple of solar projects this year. The largest of these is a 160-MW solar farm near Camilla, Georgia. Georgia Power, a unit of Southern Company has made a power purchase agreement for all the plant's energy through 2049. Construction is expected to begin soon and be completed by the end of 2019.

Duke Energy starts up Citrus Combined Cycle Natural Gas Station



Image: Duke Energy

Duke Energy's new Citrus Combined-Cycle Natural Gas Station started generating cleaner-burning, highly efficient energy in two phases. The first 820-megawatt power block started running October 26, 2018, and the second 820-megawatt power block came online November 24, 2018.

Duke Energy broke ground on the new facility in March 2016.

The \$1.5 billion station will serve 1.8 million customers in Florida and replace generation from plant retirements, including two 1960s-era coal-fired units and a nuclear plant.

Once the gas-fired generation is completely online, the utility will retire Crystal River coal-fired units 1 and 2, which represents half of the Duke's coal-generation capacity in Florida.

By investing in the new Citrus station, sulfur dioxide, nitrogen oxides and other emissions are expected to drop by 90 percent in comparison to the operation at Crystal River coal-fired units 1 and 2.

Duke Energy announced the decision to retire these units in May 2014 due to changing federal environmental regulations.

The coal-fired units will formally retire in December 2018, and the demolition process is expected to last through 2023.

The new station receives natural gas through the new 515-mile Sabal Trail pipeline. The \$3.2 billion pipeline starts in Alabama, extends through Georgia and ends in central Florida. Duke Energy is a 7.5-percent owner of the pipeline.

Entergy

An Entergy Corp. subsidiary has once again selected two Mitsubishi Hitachi Power Systems (MHPS) gas turbine generation units.

Entergy Texas has selected MHPS to power its 993 MW Montgomery County Power Station (MCPS) near Willis, Texas. The plant is expected to be operational in 2021.

Paul Browning, CEO of MHPS Americas, said the turbine technologies will reduce emissions and save money for Entergy Texas customers.

“The power station will feature proven advanced class gas turbine technology to boost efficiency and reduce emissions,” Browning added. “We also will incorporate MHPS TOMONI™ digital capabilities to enhance connectivity with Entergy Texas. This allows us to use cloud-based big data analytics and machine learning to leverage the massive amounts of data that are generated during plant operations, driving optimum power plant performance, flexibility and reliability.”

In 2017, Entergy Louisiana selected MHPS to provide two M501GAC gas turbines for its 980 MW St. Charles Power Station. St. Charles is scheduled to open this year.

MHPS says the Montgomery County Power Station will be one of the cleanest units in Entergy Texas’ generation fleet. The plant will feature a state-of-the-art emissions control technology that will lower emissions compared to the existing fleet using high-efficiency, combined-cycle natural gas turbines that are projected to save for Entergy Texas customers more than \$1 billion over the next 30 years.

The two turbines to be installed at the Montgomery County Power Station are air-cooled versions of the MHPS G-Series.

Nemadji Trail Energy Center



Image: Invenergy

Dairyland Power Cooperative and Minnesota Power began seeking permits from Wisconsin regulators in January 2019 for plans to build a \$700-million natural gas power plant in Superior.

The La Crosse-based cooperative applied to the Public Service Commission for the 525-megawatt Nemadji Trail Energy Center, which would be jointly owned and operated by Minnesota Power.

If approved, construction would begin in 2021 and the plant would be operational in 2025.

For Minnesota Power, the natural gas plant is part of the company's overall Energy Forward strategy to further diversify its energy mix, enabling the addition of 250 megawatts of newly announced wind energy and reaching an overall renewable energy mix of 45% by 2025.

In the fall of 2018, the Minnesota Public Utilities Commission approved the project.

The plant will support the addition of 200 megawatts of renewable generation and help reduce its reliance on coal-fired electricity to less than half of total capacity by 2026, according to Dairyland.

Dairyland, with \$1.6 billion in generation assets, provides electricity for about 258,000 customers of 41-member cooperatives and municipal utilities in Wisconsin, Minnesota, Iowa and Illinois.

BAE Systems to Replace Coal Power with \$97 Million Natural Gas Facility at Holston Army Ammunition Plant

BAE Systems has received a U.S. Army contract modification valued at \$96.6 million, bringing the total contract value to \$158 million, to design, build, and commission a natural gas-fired steam facility at Holston Army Ammunition Plant (HSAAP), an Army-owned, contractor-operated site located in Kingsport, Tennessee. The modernization project will replace an existing coal-fired power supply and greatly reduce the facility's environmental footprint when the new natural gas plant is commissioned.

The construction of the natural gas facility is part of a long-term, U.S. Army-driven modernization requirement for the HSAAP installation, in part meant for more efficient energy production.

"The new natural gas-fired steam facility will be cleaner, more efficient and reduce emissions while providing a higher degree of reliability – all in support of our mission," said Brian Gathright, vice president and general manager of Ordnance Systems at BAE Systems. "We are currently undertaking several major initiatives at Holston to modernize the installation's operations and reduce environmental impacts. In partnership with the Army, BAE Systems is making these improvements as part of our commitment to the environment and to the health and safety of our employees and surrounding communities."

BAE Systems has been the operating contractor of the Holston Army Ammunition Plant since 1999, developing a wide range of explosives for military and commercial applications. Since January 1999, BAE Systems Ordnance Systems business has provided modernization planning, project management, design, and construction at the Army munitions plant facilities it operates.

The estimated completion date is late 2021.



U.S. Gas Power Generator Projects

Information about the individual electricity generators at U.S. power plants, including the operational status, generating capacity, primary fuel/energy sources used, type of prime mover, location, the month and year of initial operation, and other information is collected by the U.S. EIA.

Preliminary monthly data (most recent available) on the current status of existing, proposed, retired, and canceled or postponed generating units at U.S. electric power plants are published in the EIA-860M database.

The below chart has been sorted to show current planned gas power electricity generator projects in the U.S. Power plants often have more than one generator.

Fuel Outlook: Natural Gas

While U.S. natural gas prices surged at the end of 2018, industry experts believe that natural gas is still the most economical choice. Even with the November 2018 hike, the natural gas price remains low enough for natural gas fired power plants to be more economical than nuclear and coal power plants.

Natural gas prices need to be more than \$7/MMBtu before coal and nuclear are considered economical, according to consultancy Industrial Information Resources.

An early blast of winter weather coupled with U.S. natural gas stockpiles hovering at a 13-year low drove the price of natural gas to \$4.84 per 1,000 cubic feet in mid-November 2018, the highest closing price in more than four years.

Daily Henry Hub natural gas spot price (Jan 2, 2014-Dec 3, 2018)
dollars per million British thermal units

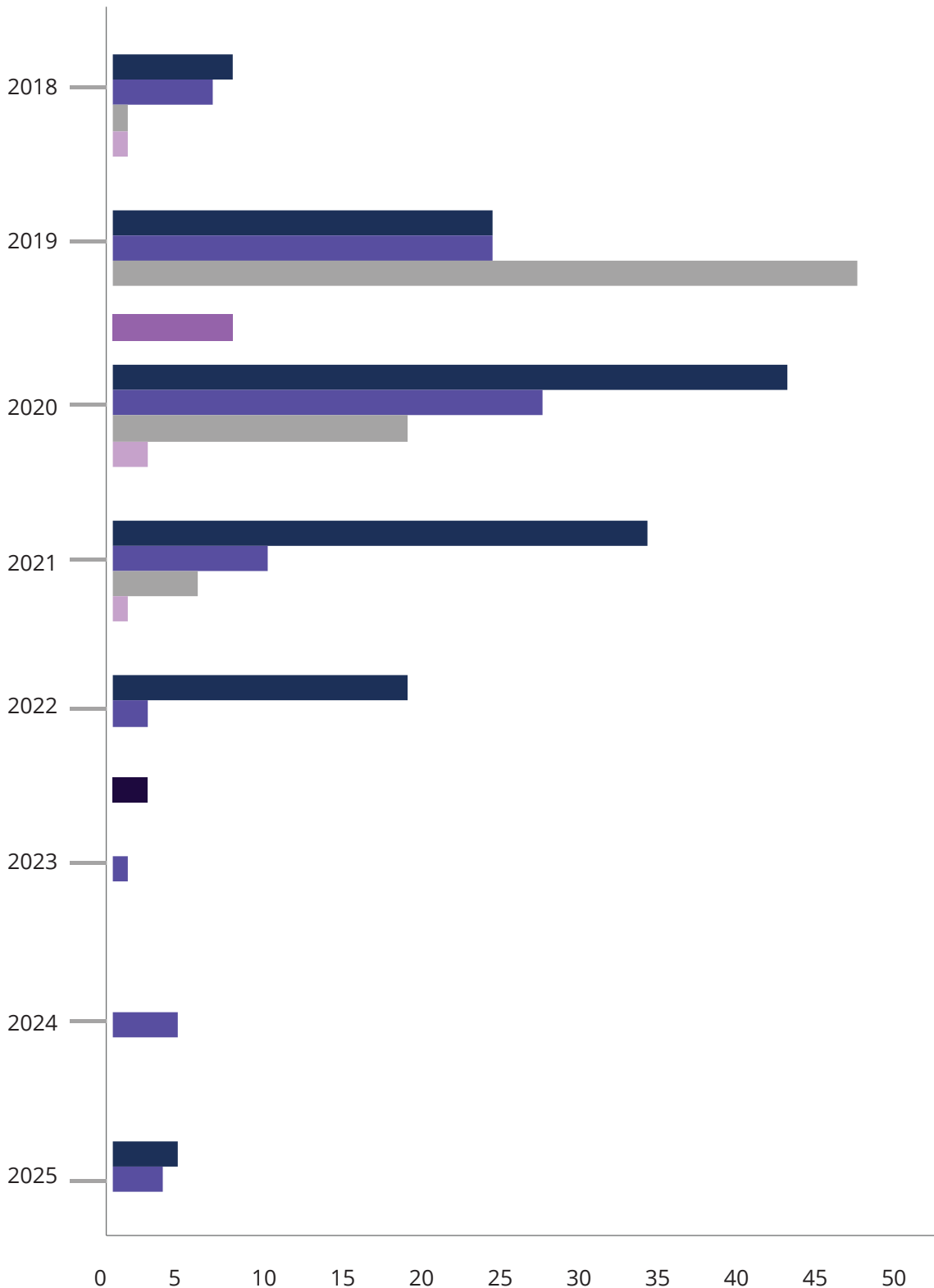


Natural gas is the primary space heating fuel in almost half of all U.S. households, and colder temperatures increase the consumption of natural gas for heating purposes. Data from the National Oceanic and Atmospheric Administration indicate that heating degree days (HDD) that November totaled 14% more than the 10-year (2008–2017) average for November.



Technology Projects by Year Across Sectors

- Natural Gas Fired Combined Cycle
- Natural Gas Steam Turbine
- Natural Gas Fired Combustion Turbine
- Natural Gas with Compressed Air Storage
- Natural Gas Fired Combustion Engine
- Other Natural Gas





HDD are a temperature-based proxy for heating demand, and more HDD indicate colder temperatures. In the U.S. Midwest and Northeast, where heating demand is often the greatest, data indicate that HDD for November were 17% to 28% more than the 10-year average, respectively.

As weather-related natural gas demand increased, relatively low levels of natural gas in storage also likely contributed to price increases. Natural gas inventories ended October at the lowest level since 2005. On November 23, U.S. inventories of natural gas were less than 3.1 trillion cubic feet, or 19% lower than the previous five-year average.

The early winter exposed a storage issue for natural gas supplies in the U.S. that many in the industry have been concerned about. Storage and infrastructure to get the fuel where it needs to be is an evolving issue. Despite the drop in natural gas supplies, warmer weather in December 2018 and much of January 2019 allowed natural gas supplies to recover before another Arctic blast hit much of the U.S. at the end of January 2019.

By the end of January, the price dropped to \$2.81 per 1,000 cubic feet, down more than 40% percent from that 2018 peak and 6% lower than a year ago.

Another factor helping keep natural gas prices stable is strong U.S. production, which has been steadily rising and hit new highs in 2018 according to the EIA. That helps supply quickly recover after periods of high demand.

Dry Natural Gas Demand

In November 2018, for the 19th consecutive month, dry natural gas production increased year to year for the month. The preliminary level for dry natural gas production in November 2018 was 2,646 billion cubic feet (Bcf), or 88.2 Bcf/d. This level was 9.2 Bcf/d (11.6%) higher than the November 2017 level of 79.0 Bcf/d. The average daily rate of dry natural gas production for November was the highest for any month since EIA began tracking monthly dry natural gas production in 1973.

The estimated natural gas consumption level in November 2018 was 2,678 Bcf, or 89.3 Bcf/d. This level was 13.9% (10.9 Bcf/d) higher than the 2,351 Bcf consumed in November 2017. Natural gas consumption for November was the highest level for the month since 2001, when EIA began using the current definitions for consuming sectors.

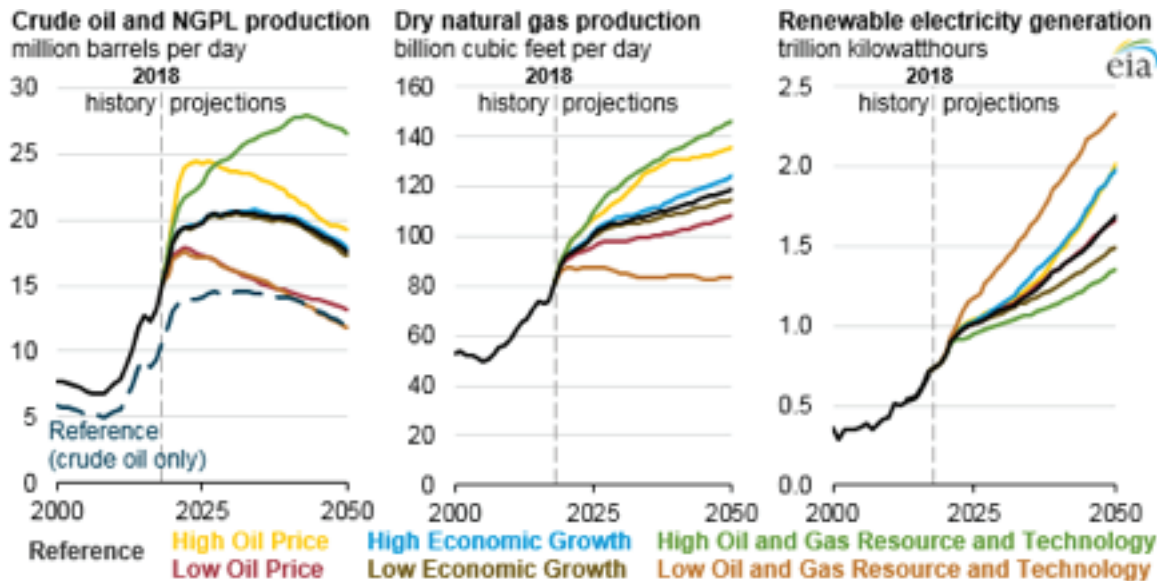
Year-over-year total consumption of dry natural gas in November 2018 increased in all four consuming sectors.

Electric power deliveries were 754 Bcf, or 25.1 Bcf/d, which was up 13.7% compared with 22.1 Bcf/d in November 2017. Electric power deliveries were the highest for the month since 2001, when EIA began using the current definitions for consuming sectors.

Natural Gas Supply

U.S. dry natural gas production will rise to an all-time high of 90.19 billion cubic feet per day (Bcf/d) in 2019 from a record high 83.31 Bcf/d in 2018, according to the Energy Information Administration's (EIA) Short Term Energy Outlook.

In the EIA's Annual Energy Outlook 2019 released at the end of January 2019, the group projected growing oil, natural gas, and renewables production.



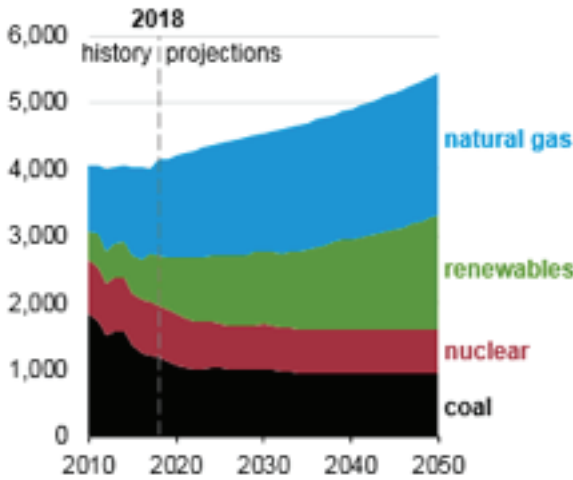
Based on a reference case and six side cases that include different assumptions regarding prices, economic activity, and technology and resource estimates, the Outlook projects continued development of U.S. shale and tight oil and natural gas resources.

Natural gas and natural gas plant liquids (NGPLs) are expected to experience the highest production growth of all fossil fuels, and NGPLs are expected to account for almost one-third of cumulative U.S. liquids production through the 2050 projection period.

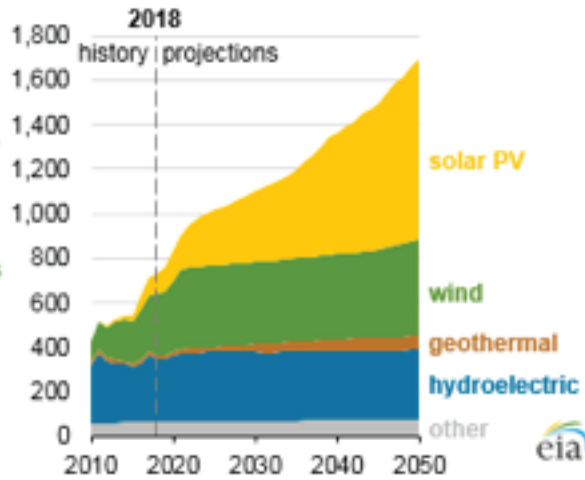
The continued development of tight oil and shale gas resources, particularly those in the East and Southwest regions, will support growth in NGPL production—which reaches 6.0 million barrels/day by 2030—and dry natural gas production. Dry natural gas production is expected to reach 43.4 trillion cubic feet by 2050. In the reference case, growth in drilling in the Southwest region will drive natural gas production from tight oil formations. Because drilling activity in oil formations primarily depends on crude oil prices rather than natural gas prices, the increase in natural gas production from oil-directed drilling is expected to put downward pressure on natural gas prices.



Electricity generation by fuel in the AEO2019 Reference case
billion kilowatthours



Renewable electricity generation in the AEO2019 Reference case
billion kilowatthours



Sustained low natural gas prices and declining costs of renewable power are expected to enable the shares of electricity generated by natural gas and renewables to increase. The natural gas share will increase from 34% in 2018 to 39% in 2050, and the renewables share will increase from 18% in 2018 to 31% in 2050.

Case Study

Invenergy's Lackawanna project
GE Power/Kiewit, Invenergy

Invenergy's Lackawanna project commenced commercial operation in December 2018. The project is notable as the first GE 7HA.02 single-shaft installation. It was completed ahead of schedule and Invenergy and the EPC, Kiewit, have both spoken about the strong nature of the partnership between the companies that made the project possible.

The facility is located just outside of Scranton, Pennsylvania, historically known as the "Electric City" for its early adoption of electric lighting.

The 1,485-megawatt natural gas combined-cycle electric generation facility has the capacity to power more than 1 million American homes. The plant will generate more than \$50 million in revenue for its host community, the Borough of Jessup, Pennsylvania, over the life of the project.

Thirty full-time operations positions were created in addition to the project having provided jobs for over 1,200 workers at peak construction.

With its highly-efficient design and operational flexibility, Lackawanna Energy Center is expected to displace generation from older, dirtier units in the PJM Interconnection, the largest organized power market in the U.S. The facility's Administration and Control Building is LEED-Gold certified, featuring a solar array on the roof and a design that is 60% more energy efficient than similar conventional buildings.

Michael Polsky, Invenergy Founder & CEO said the Lackawanna Energy Center, the largest and most technically sophisticated power plant Invenergy has ever developed.



Invenergy partnered with Kiewit Power Constructors on facility construction.

Construction began in March 2016 and stayed ahead of an aggressive construction schedule despite delays including stoppage due to Winter Storm Stella in the spring of 2017.

The facility features an innovative single-shaft design where each of three 500-megawatt power islands are comprised of a combustion turbine and steam turbine that share a single generator, maximizing facility efficiency while still allowing for the independent operation of each natural gas turbine.

“Designing and building the Lackawanna Energy Center required the largest staff and craft workforce ever assembled by Kiewit Power Constructors Co.,” said Dave Flickinger, Executive Vice President, Kiewit Corporation.

Lackawanna Energy Center generates power from three General Electric 7HA.02 high-efficiency, air-cooled natural gas combustion turbines. In addition to world-class energy efficiency, the H-Class units enable operational flexibility that allows the facility to generate baseload power as well as to respond quickly to variations in energy demand, supporting the continued growth of renewable resources in the region.

Interview with GE Spokesperson:

Timothy Wroe

U.S. and Canada Project Portfolio Manager for GE Power

GE Power’s U.S. and Canada Project Portfolio Manager Timothy Wroe shared insight about project management with the FC-BI Team.

A complete and thorough understanding of the contract is fundamental to properly planning and executing a project at GE, Wroe said.

When a contract is signed, GE’s execution team completes a page-by-page review of the contract, noting any and all areas of concern including anything from technical issues to schedule concerns or logistics questions.

“These areas are carefully evaluated, addressed, and then reviewed with the EPC and end user in a kick-off meeting at the very start of the project, with all pertinent participants physically in the room whenever possible,” Wroe said. “These frank, open discussions at the start improve customer satisfaction and prevent expensive and time-consuming issues during installation and commissioning.”

Open, frequent communication between all parties (end user, EPC, OEM) is essential to GE’s successful projects.

“Each party will invariably need help and flexibility from the other stakeholders and participants throughout the project, and everyone wins with an on-time start of commercial operation (COD) meaning partnership and cooperation are crucial,” Wroe said.

The contractual arrangement can determine the nature of project communication, but GE has found that impeding technical and schedule information between the participants almost always results in delays and extra work.

“Communication is vital to ensuring successful project execution,” Wroe said.

While missing deadlines and budgets are the most common problems for most major projects, GE has a system for meeting these two major obligations.

“This is controlled by two perspectives: delivering what is promised, and regular tracking of progress with predictive metrics including estimates-at-completion (EAC) for engineering hours and expected delivery dates based on Engineering, Sourcing, Supply Chain, and Logistics commitments,” Wroe said.

From the beginning, the GE execution team reviews every page of the contract, and then reviews it with the EPC and end user, preventing expensive scope misses and misunderstandings.

“Regular tracking of our projects consists of more-frequent reviews earlier in the project, when the most questions exist and when the team can have the most impact,” Wroe said. “These weekly reviews with escalated management have been extremely useful in bringing effective resources to bear.”

When the project is in full swing during the manufacturing, installation, and commissioning phases, weekly meetings are held with the broader project team including participants from GE, the EPC, and end user, and quarterly GE project reviews are held with senior management as well.

Case Study

Duke Energy Citrus Combined Cycle Station

Interview with:

Jeffrey Peet

Duke Energy Lead Project Engineer Citrus County Combined Cycle Plant Project Management & Construction

Duke Energy's new Citrus Combined-Cycle Natural Gas Station started generating cleaner-burning, highly efficient energy in two phases. The first 820-megawatt power block started running October 26, 2018, and the second 820-megawatt power block came online November 24, 2018. Duke Energy broke ground on the new facility in March 2016.

The \$1.5 billion station will serve 1.8 million customers in Florida and replace generation from plant retirements, including two 1960s-era coal-fired units and a nuclear plant.

The new station receives natural gas through the new 515-mile Sabal Trail pipeline. The \$3.2 billion pipeline starts in Alabama, extends through Georgia and ends in central Florida. Duke Energy is a 7.5-percent owner of the pipeline.

From the start, the most critical priorities were completing the project safely, on time, on budget and of sound quality, Jeffrey Peet, Duke Energy's Lead Project Engineer for the Citrus County Combined Cycle Plant said.

“During the project, Duke Energy's EPC labor productivity hovered around .3 for most of project, finally closing out around .5, but quality was maintained by performing design reviews and providing adequate oversight through work package hold points and signoffs,” Peet said.

Solid workflows and supportive technology are critical components of a successful capital project, especially utilization of 3D modeling and integrated document control systems. An integrated equipment/material management system would have been extremely beneficial. Ultimately, Peet's philosophy as a lead project engineer is to rely on the very best people to make things work. This means getting the right people involved at the right time, early in the process and if necessary, removing the wrong people. "We have a fantastic multi-discipline design/Subject Matter Expert staff at the corporate office that we can turn to and they support us on-site as needed," Peet said.

Project Management

"The key factors for effective scope creation are to work from a set of proven/updated specifications including lessons learned from past and current projects. It is also important to have Start-up/Commissioning and Plant Operations personnel involved with design and drawing reviews," Peet said.

Successful project execution can't happen unless the Contractor fully understands the project scope and site conditions including the unique challenges with weather, geological conditions and quality of available labor. This happens through frequent communication and research from the start and choosing technically qualified contractors with a focus on safety, quality and experience, not just cheapest cost.

"Our experience has proven that the lowest bidder (outlier) has usually missed or failed to understand vitally important aspects and it will cost the project in the end, so make sure you choose the most technically experienced and qualified contractor. Additional oversight can be used to ensure quality, but not schedule adherence or cost. You can have it Quick, Cheap or Right – pick two," Peet said.

With the right team in place, ongoing communication strategies are important as well as documenting and evaluating lessons learned during and at the completion of the project.

Lessons Learned

Peet said the most challenging part of the project was getting systems turned over in a timely manner from the EPC to Duke's own Start-Up and Commissioning Group. The project team has must reevaluate this transition for the next project to avoid this issue.

"The most challenging part was getting systems turned over in a timely manner from the EPC to our Start-up and Commissioning group to maintain schedule. As the construction schedule slipped, it was the Start-up team whose window was being significantly compressed. The primary factor was because the EPC was doing construction and Duke was performing Start-up in-house," Peet said.

"The reality is that construction rarely ever completes systems, they take them to 90% - 95% complete and Start-up commissions and finishes them. In the future, we may need to consider leaving the Start-up activities with the EPC to better define the lines of responsibility," Peet added.

While many great teams were in place, there were some trouble spots and making the difficult decision to remove those people helped the project team improve productivity and overcome other challenges.

"For our project, Management continuously evaluated project direction and made necessary adjustments to the team to ensure successful project completion. This was critical not only to overcome technical challenges,



but the significant schedule and budgetary challenges as well.” Peet said.

Budget and Construction Costs Estimating

Peet said Duke Energy used a formula to keep on budget.

“It is important to track all costs weekly and compare the productivity factor against the schedule adherence and project completion,” Peet explained.

Another crucial component of the construction process is construction cost estimating.

Understanding how a good construction cost estimator can help your team is essential to anyone who is concerned about how much changes to their project will cost (or save).

“We had a very experienced estimator on site to perform cost estimates – especially for out of scope work to assure the costs were in the ballpark. We could evaluate proposed changes and see how the proposed change either added to the project cost or produced a savings. Our estimator maintained a complete library of all estimates with the corresponding scope changes for future documentation,” Peet said.

“This also ensures that the contractor understands the full scope of each change and the reason for the change (i.e., a customer change vs contractor miss),” Peet added.

Next Plans

Once the gas-fired generation is completely online, the utility will retire Crystal River coal-fired units 1 and 2, which represents half of the Duke’s coal-generation capacity in Florida.

By investing in the new Citrus station, sulfur dioxide, nitrogen oxides and other emissions are expected to drop by 90 percent in comparison to the operation at Crystal River coal-fired units 1 and 2.

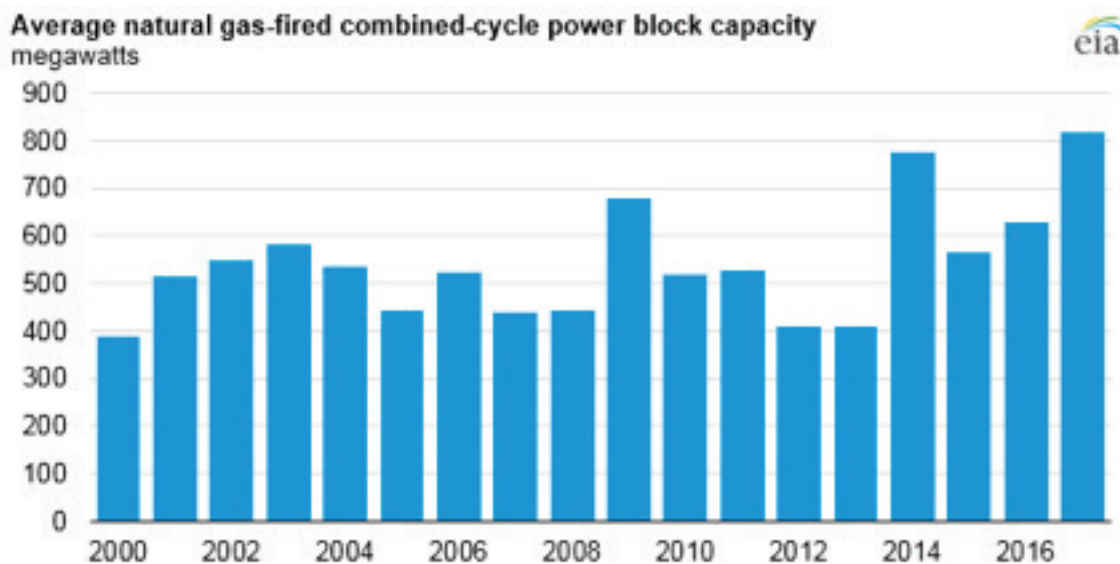
Duke Energy announced the decision to retire these units in May 2014 due to changing federal environmental regulations.

The coal-fired units formally retired in December 2018, and the demolition process is expected to last through 2023.



Construction Market

Power blocks in natural gas-fired combined-cycle plants get bigger



Combined-cycle electric generating systems are combustion and steam turbines that operate in groups commonly referred to as power blocks.

Since 2014, the average size of a natural gas-fired combined-cycle power block has increased significantly, according to analysis by the EIA. The average combined-cycle power block installed between 2002 and 2014 was about 500 megawatts (MW). After 2014, power block capacity increased, reaching an average of 820 MW in 2017.

Power blocks have increased in size as the performance of combined-cycle units has continued to improve, and current and projected natural gas prices and supply provide a competitive advantage for the combined-cycle technology. The most common configuration involves two combustion turbines supporting one steam turbine.

The trend toward larger combined-cycle power blocks can largely be explained by the efficiency gains (lower heat rates) available from larger power blocks. For example, the capacity-weighted average heat rate of power blocks less than 500 MW is 6% higher (or less efficient) than that of power blocks larger than 1,000 MW. Larger power blocks also generally have lower per-unit capital costs, making them more attractive investments.

Smaller power blocks still play an important role in providing electricity. Generators have a minimum output level—known as minimum load—below which continued operation creates risks of instability, inefficiency, and high emissions. Smaller blocks, which inherently have lower minimum loads, are commonly associated with greater flexibility because they can operate through low demand periods without having to shut down.

Workforce issues must take same priority as safety

Chronic shortages of skilled labor are increasing costs and schedules and resulting in declining productivity, lower quality, more accidents and missed objectives. However, an industry program is set to cut costs, risks and spur workforce development.

The workforce issue is not so much a shortage of bodies, as it is a shortage of skills. Even some of those in the field now are not truly qualified for the mega projects, trade organizations say.

Until owners lead, and the industry gives the workforce issue the same attention it gave safety years ago, the issues will simply not be solved, an industry expert told FC-BI.

“It’s the same conversation year after year, decade after decade but we keep marching closer to the demographic cliff in 2029 when all the baby boomers are retired,” said Daniel Groves, director of operations at Construction Users Roundtable (CURT) and CEO of Construction Industry Resources (CIR) said. “Now that we are in the 114th month of growth, this is the sustained challenge driving owners to do something more.”

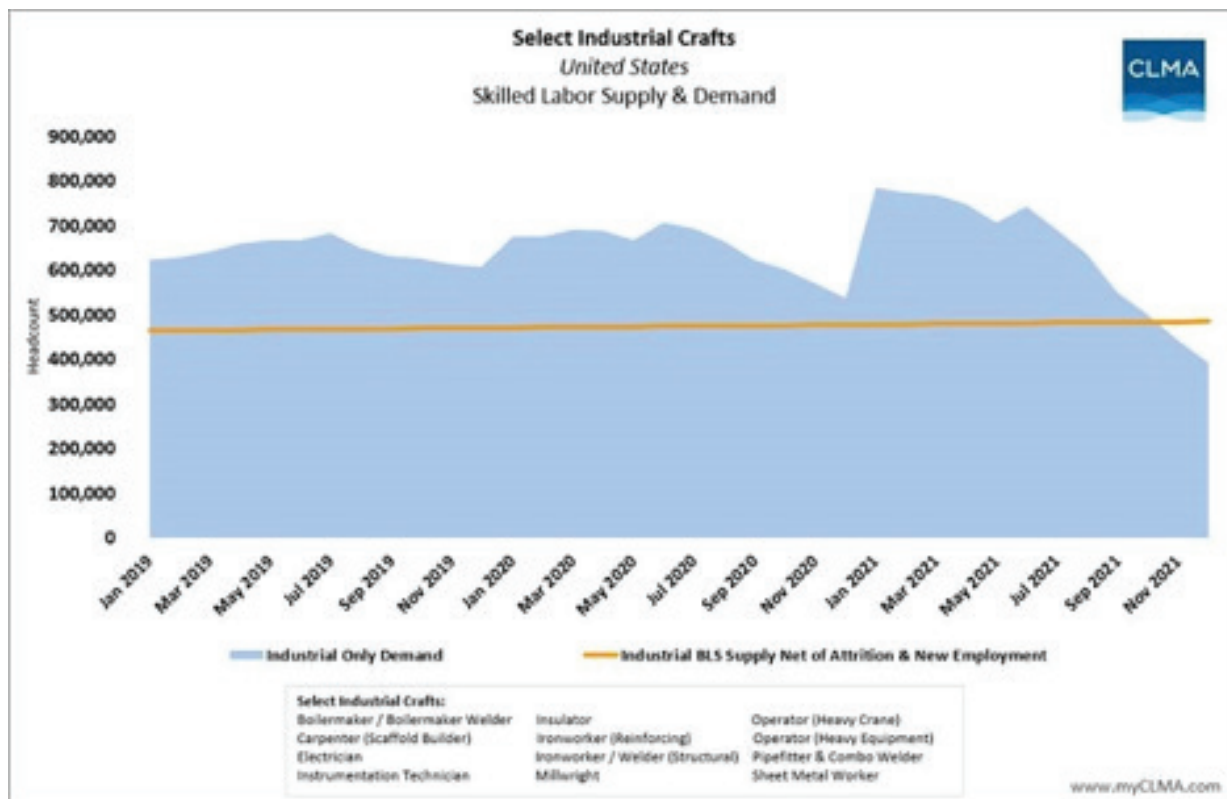


Image: CLMA

CURT and Construction Industry Institute (CII) and many others have been working on trying to improve the workforce development issue for a long time. Using empirical evidence, CURT and CIR have put together a program to do for the workforce what was done for safety. The business case for workforce development and prequalification is buttressed by CII research.

In December, CURT and CIR launched the Skilled Labor Risk Management (LRM) Program, a Construction Labor Market Analyzer (CLMA) service providing complete analysis of project labor risk and contractor workforce development programs.

Current forecasts indicate that skilled labor shortages will increase with a growing economy and current industry age trends.

Several owners including Southern Company will be utilizing this program.



The Issue

The skills gap has reached critical proportions among resourcing the craft labor jobs—technical jobs that require more education and training than a high school diploma, but less than a four-year college degree. Many of these jobs are in construction and manufacturing.

U.S. construction labor demand is expected to outpace labor supply over the next five years, with the total number of unfilled construction jobs growing from 200,000 in 2017 to 856,000 in 2021, according to the U.S. Bureau of Labor Statistics.

According to Forbes magazine, more than 350,000 manufacturing jobs are available now.

“The issue is not a shortage of bodies, so much as it is a shortage of skills,” Groves said. “That is where the challenge is. There are plenty of people in the country. There are not enough people going into the skilled trades.”

For those who have been recruited in, many are not qualified for the job and training is lacking, Groves said.

“Even those who are going into the trades, many are not at the level of skill necessary to effectively and efficiently and productively complete the large chemical and refining and power generation mega projects going on today. These require a tremendous amount of skill.”

Owners are the ones most severely impacted because they are the ones owning and financing the projects.

“It’s owners who are dealing with the challenges of the workforce productivity and the cost of it taking more workers, more cost and more time. So there are significant budget, productivity and schedule challenges that accompany a workforce challenge,” Groves said.

Training Cost Benefits

CII completed a research project to demonstrate the positive cost impact of craft training on labor, turnover, absenteeism, injury and rework by applying construction market survey data to two distinct project scenarios: A typical 24-month capital industrial project and a typical ongoing maintenance/small capital contract.

The evidence shows that if one percent (1%) of the total project labor budget were invested in training, it significantly benefits workers and employers. The project assumptions for purposes of developing the research were based on 527,000 labor hours.



Summary of Expected Training Benefits Identified through CII RT-231 Survey

Expected Training Benefit	Capital Project			Maintenance Project		
	Average	95% Confidence Rating		Average	95% Confidence Rating	
		Low	High		Low	High
Productivity Improvement	11%	6.8%	14%	10%	7.7%	12%
Turnover Decrease	14%	10%	18%	14%	8%	19%
Absenteeism Decrease	15%	10%	19%	15%	8.3%	21%
Injury Decrease	26%	18%	33%	27%	18%	37%
Rework Decrease	23%	17%	29%	26%	18%	35%

Data: CII

Safety

Dating back to the 1980s, CURT recommended that owners prequalify contractors for their projects in the same ways that owners prequalify contractors for safety. Meaning, focus on contractors who have qualified tradespeople and invest in training.

“But it really was not until owners said ‘thou shalt’ that contractors began to change in regard to safety, because obviously it impacted them directly and that is really when the change occurred,” Groves said.

That change for safety in the workplace unleashed in many ways all the innovation that the industry enjoys now around safety. Work sites are much safer than they have ever been, and everyone promotes having fewer incidents.

Meanwhile, the workforce issue continues to grow, and workers are getting less productive due to the lack of skills. In addition, the workforce challenges are resulting in more safety incidents, so improvement on all fronts is an urgent need.

“The impact on budgets is that they are higher, schedules are longer, and safety is impacted. The less skilled the workforce, the less safe the sites are.

The industry must give the workforce issue the same attention it gave to safety, Groves said.

Solution

The LRM solution involves both contractors and owners.

Owners should include workforce development in prequalification and management of contractors on their worksites, according to the LRM program.



CII research demonstrates up to a \$3.00 ROI for every dollar invested in training.

Contractors need to take the initiative to develop their workforce. Every contractor should have a proactive program for workforce development including attracting, recruiting and training future skilled workers. Owners should proactively require contractors to have effective workforce development programs, according to the LRM program.

CURT recommends that "owners should only do business with contractors who invest in training and maintain the skills of their workforce." CII affirms this approach and states that making workforce training a priority can reduce project costs and improve safety.

Eddie Clayton, Contracting & Workforce Development Strategies Manager for Southern Company, and a user of the LRM program, said that his company asks contractors to assess the skills of their new hires to ensure they have the skills necessary to perform the assigned work safely, efficiently and meet quality expectations. However, not all of the contractors can do that, especially when labor shortages are experienced.

"In the near future, only those contractors that are sufficiently engaged in specific areas of workforce development will be qualified to bid on the larger projects," Clayton said. "Performing skill assessments on craft workers will be one of the areas included in the pre-qualification criteria."

"We hope that eventually all contractors will be engaged in workforce development. When that happens, many of our workforce issues will be resolved," Clayton added.

Thorough prequalification takes time and effort. Most owner construction management organizations are limited and very busy on current projects. They do not have the time and bandwidth required to perform the extra work of prequalification of multiple contractors, or collecting the data needed for this purpose. However, unless owners lead, come alongside contractors and are committed, change isn't possible.

Labor Risk Management

CLMA has the capability to provide full service contractor prequalification for owners. The Labor Risk Management (LRM) program uses the proven Construction Workforce Development Assessment (CWDA) process to provide industry standard assessment of all the contractors with minimum impact on owner staff. CLMA will perform all the data collection, assessment and reporting and provide the results to the owner.

When the CLMA Labor Risk Management (LRM) is added to CLMA workforce analytics, Owners will have a complete process for managing skilled workforce shortage risks on their projects, and for assuring their contractors have effective programs for staffing the current projects and for developing future skilled workers, Groves said.

"It is about helping contractors understand what the opportunities are for growing, training and improving the workforce, and making them more productive, and then measuring the results and improving them in order to produce a better workforce," Groves said. "And it's not just about improving the workforce we have now, but also about growing the workforce and making sure we are bringing in new people. That is where innovation has to take place."



Conclusion and Forward-Looking Assessment

Cheap and abundant natural gas supplies, and growing demand to reduce carbon emissions are among the incentives for gas power investment in the U.S.

Solar, wind and natural gas projects will move forward while many coal and nuclear projects will be shuttered. Capital projects and maintenance are increasing in quantity but decreasing in spending. Long term potential growth is likely for hydro-electric, storage, industrial and off grid power.

The big question of the future is how quickly energy storage will come into play.

Lithium-ion (Li-ion), pumped hydro, and new hydrogen storage ideas are the most talked about today.

EPCs, owners and the firms that service them are focusing on how to be the most efficient, cost effective and technologically advanced they can be.

Companies can use the rapid growth to their advantage by adjusting best practices and better defining their growth strategies.

Predictive maintenance, reliability, communication techniques, integrated schedules, and harnessing new technologies while maintaining human connection are a few of the opportunity's companies can use in this time of rapid growth and change.

Networking, communication, and learning are key ingredients to building a strategy for excellence.