BCS Allegient

WORKFORCE ANALYSIS

A Crucial Link in Energy Supply Chain Development

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Introduction

Fortifying supply chains for critical materials and minerals that drive energy production and enable commerce to occur has become a key element of economic policy in the U.S. and other countries. The COVID-19 pandemic spotlighted the fact that even the most extensive and well-developed supply chains can be disrupted, and these disruptions can be multi-factorial and affect the upstream, midstream, and downstream segments differently, both in terms of their length and severity. Indeed, pinch points or disruptions at one or more tiers of a product's supply chain could have ripple effects that lead to a growing backlog of orders, shipment delays (or cancellations), production curtailment, or even full-scale facility closures.

To reduce the likelihood of future supply chain disruptions, and mitigate their impacts should they occur, policy makers in the U.S. and other countries have expended significant efforts to strengthening supply chains by standing up domestic production capacity at the upstream, midstream, and downstream levels using an array of financial incentive programs and policy levers. Since substantial time and financial commitments are needed to ensure these projects are completed and enter service on schedule, identifying, hiring, and training a skilled workforce are as critical as other factors for new manufacturing and energy supply chain capacity to become operational and achieve economic viability.

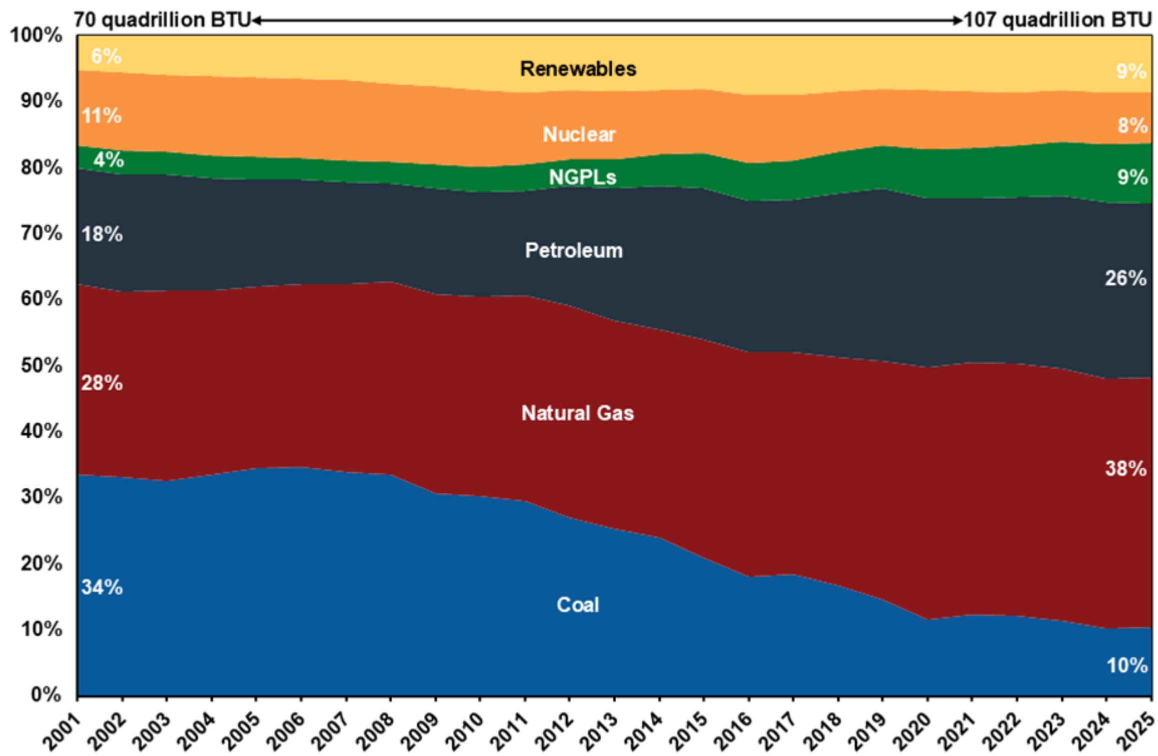
Given the importance of integrating workforce considerations into development of domestic energy and manufacturing supply chains, this article will summarize how market forces have shaped changes U.S. natural gas production. Subsequently, this backdrop will then be used to contextualize the impact that labor market economics can have on building and deploying large-scale energy infrastructure like natural gas transmission pipelines and liquefied natural gas (LNG) export terminals that will be needed to meet anticipated natural gas demand both domestically and globally.

This article is meant to serve as an initial entry into a longer conversation of the vital role that the workforce plays (and will continue to play) in developing, upgrading, and deploying assets for domestic energy supply chains. AI data center capacity growth, electrification efforts, and the economic advancement of people living in emerging markets and industrialized economies alike are expected to lead to a major upturn in global energy demand growth. Future articles in this series will investigate how workforce issues will impact other portions of the domestic supply chains, e.g. manufacturing the components and systems needed to increase nuclear power generating capacity or developing rare earth element (REE) processing and downstream production activities that will be needed as crucial inputs to a variety of energy, technology, and defense-related applications.

What's Supply and Demand Got to Do with It?

Primary energy production[1] in the U.S. has increased rapidly over the past 25 years, rising by nearly 50 percent despite three economic downturns and a once-in-a-century global pandemic (see Figure 1). More importantly, however, has been the shift in production by fuel source over this same period, as technological innovations such as the fracking revolution and directional drilling have fostered massive resource development in oil- and natural gas-rich shale basins, which in turn have enabled the U.S. to become the leading global producer of both fuels.

Figure 1: U.S. primary energy production by fuel source, 2001–2025*



Source: US Energy Information Administration, *Monthly Energy Review* (Feb 2026), author's calculations.
*Note: NGPLs = Natural Gas Plant Liquids; 2025 is an estimate.

In concert with this unprecedented growth in domestic production, natural gas use has expanded significantly among several of its key end markets, particularly for electricity generation. Between 2010 and 2025, natural gas has seen its share of total generation climb from under 25 percent to more than 40 percent. Going forward, although gas-fired generation will likely not see its share of electricity generation increase by this magnitude, the additional volume of

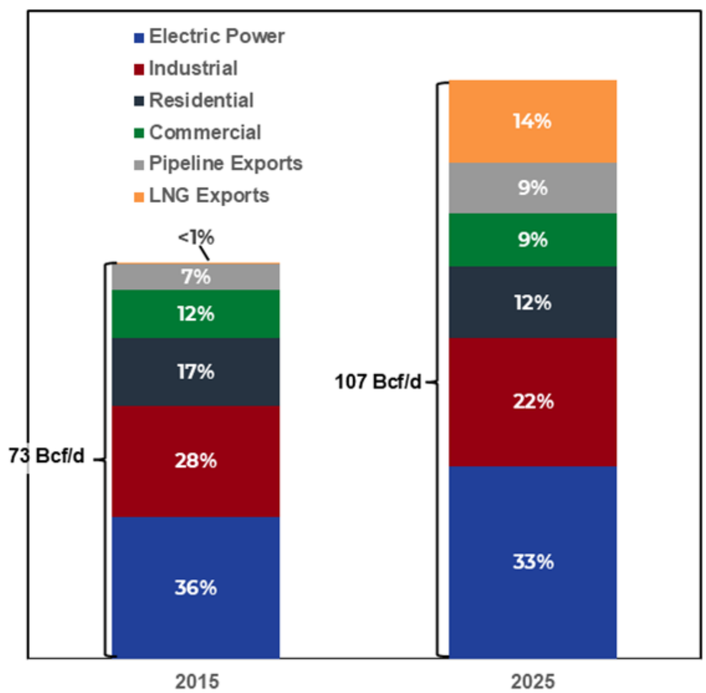
[1] According to the U.S. Energy Information Administration, primary energy production refers to the production of energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy. For example, coal can be converted to synthetic gas, which can be converted to electricity; in this example, coal is the primary energy, synthetic gas is secondary energy, and electricity is tertiary energy.

natural gas needed to power the U.S. economy will increase significantly. According to Bloomberg, the notional level of gas-fired electricity demand that will be needed to power AI data centers that are currently in the development pipeline is equivalent to roughly 18 percent of power sector's natural gas demand from 2024.

Despite the substantial increase in domestic natural gas consumption, the immense growth in production has also enabled the U.S. to become the world's leading exporter of natural gas via LNG. According to the U.S. Energy Information Administration, U.S. exports of LNG increased from an annualized volume of less than 200 billion cubic feet (Bcf) in 2016 to nearly 5.5 trillion cubic feet during 2025. In fact, of the natural gas produced in the U.S., approximately 14 percent was 'consumed' as LNG exports sold predominantly in European and Asian markets in 2025 after accounting for less than 0.5 percent a decade prior.

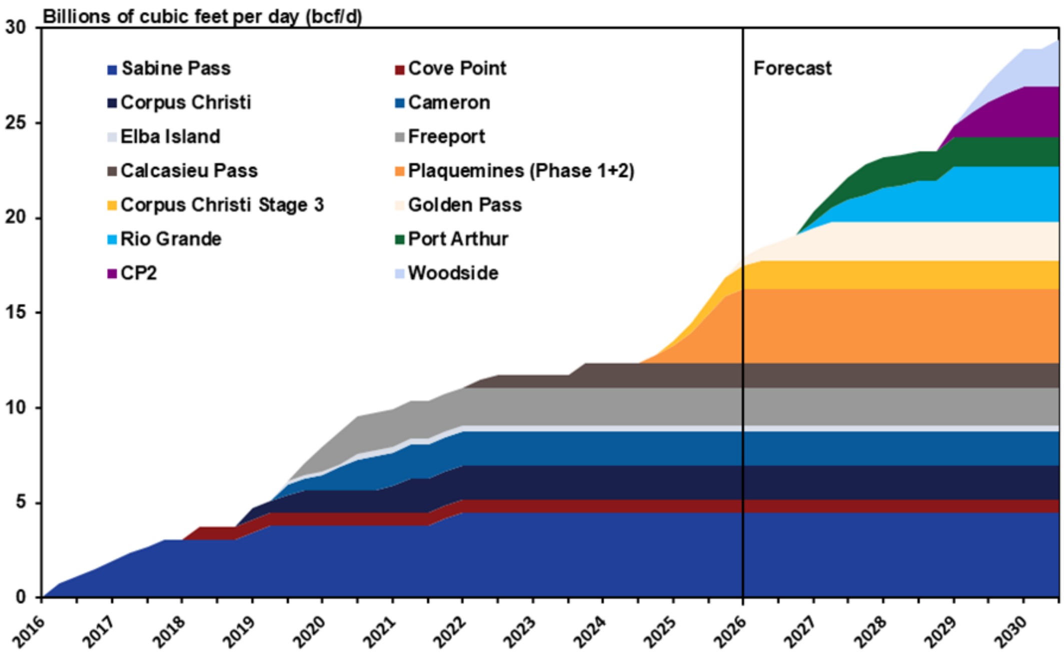
LNG export activity is only expected to increase further in the coming years. Indeed, after Plaquemines LNG became the eighth major LNG export terminal to become commissioned in the U.S. near the end of 2024, stage 3 of Corpus Christi LNG entered service during 2025, bringing 1.5 Bcf/d of additional processing capacity online. Golden Pass LNG began processing feedgas for shipments during the first quarter of 2026 and is expected to make its initial deliveries by early Q2. Although the Lake Charles LNG project was suspended by its developer at the end of 2025, four LNG projects were greenlit by developers during 2025. Barring any additional project delays or cancellations, U.S. LNG export processing capacity is expected to approach 30 Bcf per day by the early 2030s—roughly doubling the overall capacity that was available in 2025.

Figure 2: U.S. natural gas use by sector, 2015 vs 2025*



Source: U S Energy Information Administration
*Note: Left panel excludes gas for plant and lease fuel and pipeline use; Bcf/d = Billions of cubic feet per day.

Figure 3: U.S. liquefied natural gas (LNG) export processing capacity through 2030



Source: U S Energy Information Administration, company regulatory filings, and financial reports.

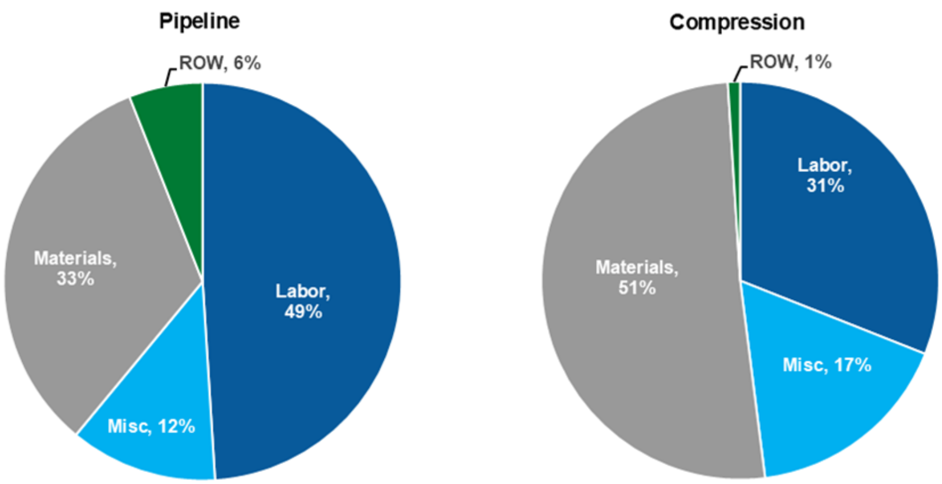
How Does Workforce Factor Into the Equation?

Although a few million miles of natural gas pipelines can be found in the U.S., most of that capacity exists as small diameter lines within local distribution and service networks that deliver gas to local business and residential consumers. At the same time, large-diameter (16” to 48”) transmission lines represent a fraction of overall pipeline mileage but transports tens of billions of cubic feet of natural gas daily produced from Marcellus/Utica, Haynesville, and Permian shale gas wells through to markets that are located hundreds or thousands of miles away.

Given the lengthy process for securing regulatory and permitting approvals for pipeline construction, along with the logistical challenges inherent to installing hundreds of miles (and many tons) of steel line pipe across varying types of terrain, natural gas transmission pipelines are massive infrastructure projects that typically require long lead times and large capital expenditures to pull off. Depending upon the project’s circumstances (e.g., length, location, topography, compression requirements, etc.), total capex for large-diameter intra- and interstate natural gas pipelines can easily total billions of dollars and require several years to complete even after receiving regulatory approval.

Data sources suggest—normalizing pipeline projects based on their overall throughput capacity—that most pipeline projects will cost an average of $200,000 to $400,000 on a per-inch-mile basis. While the line pipe, valves, and other appurtenances are understandably a major cost component, pipeline construction is an inherently labor-intensive activity, making it the leading expenditure category for pipeline projects at 40 to 50 percent of capital cost. Pipeline projects that travel longer distances or are sited in areas with steep terrain face additional cost requirements since compression stations must be constructed at certain intervals to overcome energy losses caused by friction and/or elevation changes. Compression stations are more dependent upon capital equipment during their operation, but labor still accounts for just over 30 percent of the capex needed to build these facilities on average.

Figure 4: Natural gas pipeline project capex cost by component, %*



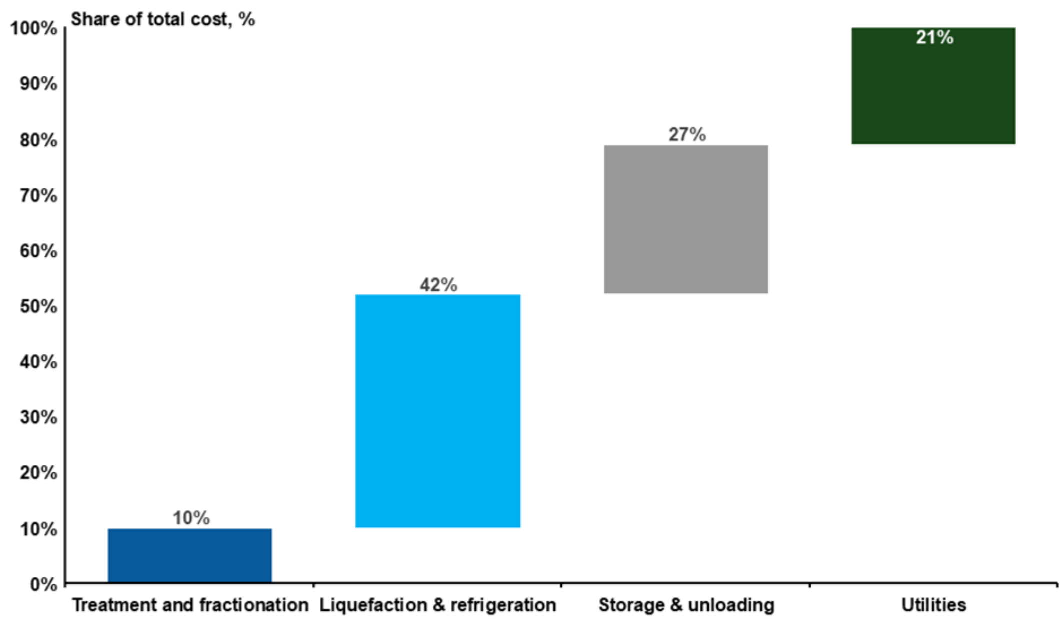
Source: "Economics of Gas Transportation by Pipeline and LNG," in *Palgrave Handbook of International Energy Economics, pp 23-57.* (2022).
*Note: Miscellaneous costs generally cover surveying, engineering, supervision, contingencies, telecommunications equipment, administration and overhead, freight, regulatory filing fees, and taxes; ROW = Right of way.

Massive growth in U.S. natural gas production and opportunities for pricing arbitrage in Asian and European markets have created a favorable backdrop to build LNG export terminals in recent years. Most of these facilities are located along the Gulf Coast and most possess the ability to process between 10 to 20 million tons of natural gas annually shipped by vessels. These terminals are highly capital-intensive operations and feature a wide array of machinery and equipment that is needed to pre-treat, process, liquefy, store, and load liquefied gas onto vessels for transport.

These facilities cost between $500 to $1,000 per ton of processing capacity to build, with the final capex cost influenced by a variety of factors such as site development (greenfield/brownfield), modularity, pipeline requirements, jetty construction, and other factors. As a result, workforce requirements for LNG export terminals can vary widely, with upwards of 10,000 workers being needed on site for larger baseload facilities such as Plaquemines, Sabine Pass, and Freeport during peak levels of construction activity.

Liquefaction and refrigeration equipment accounts for the largest share of total capex costs (see Figure 5). Liquefaction and refrigeration equipment are configured into units on site, typically referred to as trains due to their sequenced functional designs, and require large teams of engineers and trades workers to fabricate, assemble, and test a wide variety of machinery and equipment along with cryogenic processing and storage systems.

Figure 5: Capital cost breakdown for new LNG export terminals



Source: *Source: "Economics of Gas Transportation by Pipeline and LNG," in Palgrave Handbook of International Energy Economics, pp 23-57. (2022).*

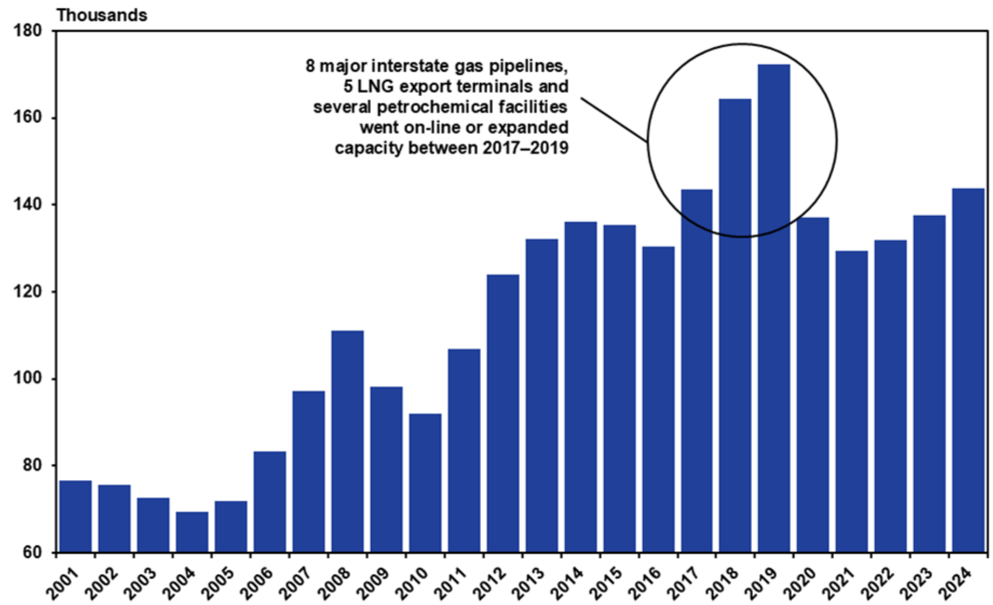
Midstream Energy Infrastructure Workforce and Economics

Given this backdrop for increased natural gas demand in domestic and overseas markets, building the infrastructure necessary to provide robust fuel delivery networks for electricity generation and LNG exports will be essential—and securing the workforce needed to build out these pipelines and LNG processing capacity will be a crucial component. However, the 2025 U.S. Energy and Employment Report (USEER) indicates that 89 percent of construction companies tasked with building midstream natural gas infrastructure have reported hiring to be somewhat or very difficult, with lack of experience, training, or technical skills offered as the most common reason for hiring difficulty.

Skilled trades occupations, such as experienced welders, electricians, machinists, and heavy machinery mechanics, have long been identified through anecdotal reports as challenging positions to fill by firms involved in energy sector infrastructure development. While these roles do remain a challenge, the 2025 USEER indicates midstream energy construction firms reported mid- and upper-level management positions (supervisors, directors, and VPs) were the job roles most difficult to fill through the hiring process. This aligns with other reports that indicate insufficient applicants with project management and supervisory-level experience, even precipitating delays and cost overruns in some cases.

Several factors could contribute to the difficulty (actual or perceived) engineering, procurement, and construction (EPC) firms have in hiring for certain types of occupations that are crucial for midstream energy infrastructure projects such as natural gas transmission pipelines and LNG export terminals. First, while new mines, oil and gas pipelines, LNG terminals, petrochemicals plants, and other energy sector capacity developments are generally long-term projects, the underlying go/no-go decisions for capital investment are influenced heavily by short- and medium-term cyclical changes in the economy or underlying commodity prices.

Figure 6: Employment in oil & gas pipeline and related structures construction



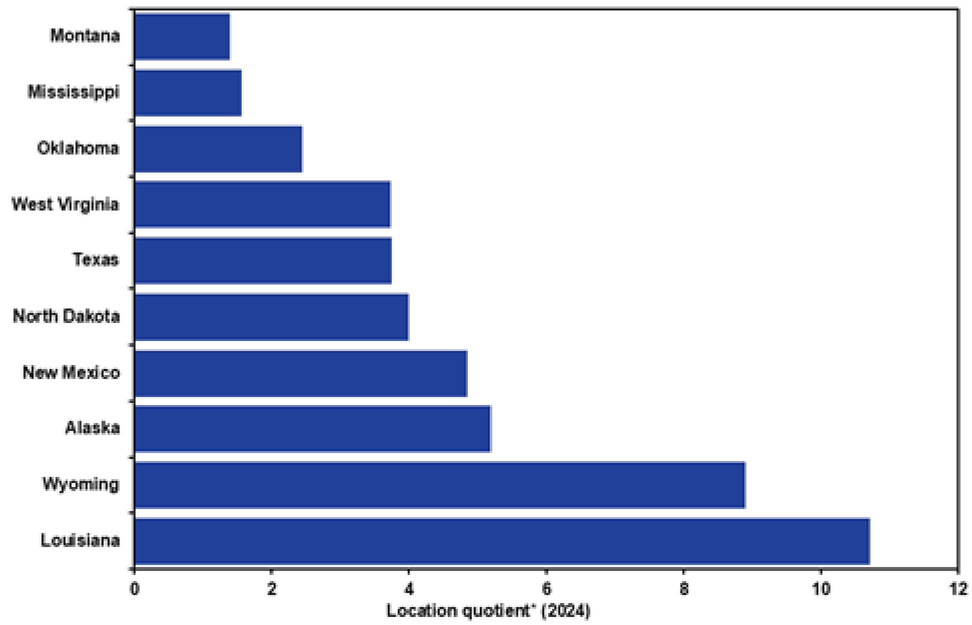
Source: US Bureau of Labor Statistics, Quarterly Census of Employment & Wages.

As a result, construction payrolls tied to energy sector projects can be subject to market risks (upside or downside) that arise from cyclical macroeconomic growth, interest rates, price spreads between commodities and downstream product markets, or other factors. Figure 6 shows a general upward trend in total payrolls over the past two decades or so; however, embedded within this longer-term trend are notable episodes of strong growth, such as the pipeline construction boom in 2018 and 2019, or sluggishness (or outright declines) as seen after each recession and the commodities bear market in the mid-2010s.

Geography can play a role in workforce availability issues for large-scale energy sector construction projects. The Gulf Coast region has been the epicenter of LNG export terminal and pipeline construction activity for much of the last decade. When combined with the region's rich history of energy production and petrochemicals manufacturing, states such as Louisiana, Texas, and Oklahoma have the advantage of deeper labor markets that contain large numbers of skilled technical and tradecraft workers that would be needed by an EPC tasked for a major project.

By comparison, even though states such as Wyoming, Alaska, New Mexico, North Dakota, and West Virginia contain high shares of employment in energy sector construction versus the national average (see Figure 7), EPCs with projects in these areas will often have limited workforce availability for some occupational categories and thus will need to seek qualified candidates locally (through jobs websites, subcontracting firms, trade groups, etc.) or relocate their own workers from other regions on a short- or long-term basis.

Figure 7: States with highest concentration of pipeline and related construction

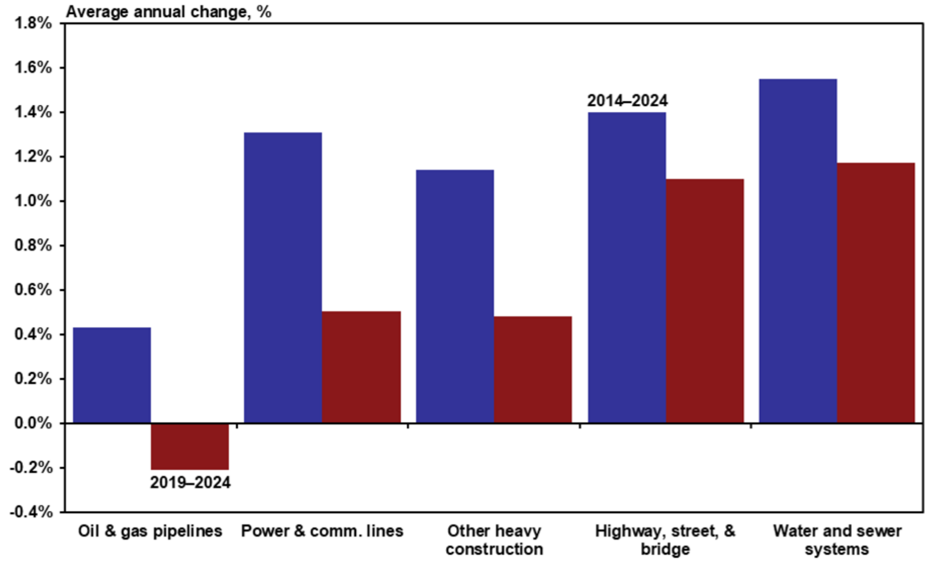


Source: US Bureau of Labor Statistics, Quarterly Census of Employment & Wages.
*Note: Location quotient measures an area's share of total employment in an industry relative to the national average, indicating a state with a location quotient > 1 exceeds the share recorded for the nation overall.

Competitive pressures in the labor market have emerged as a hiring obstacle for energy infrastructure projects. While average annual wages for the construction industry segment that includes natural gas pipelines and LNG export terminals remain higher compared to those paid to workers employed by firms involved with building transportation, electricity, and water systems infrastructure projects, that margin has narrowed significantly over the past decade. In fact, inflation-adjusted wage growth for construction of oil and gas pipelines and related structures was the weakest of any heavy infrastructure construction industry segment over the past decade and was the lone segment to experience an outright decline in real wages since 2019 (see Figure 8).

Taken together, these factors magnify the importance in addressing likely workforce supply constraints that will be encountered as the nation's energy infrastructure is built out over the next decade or so. Indeed, the doubling of LNG export processing capacity and a 5 to 10 percent average annual increase in natural gas transmission pipeline capacity are just one part of the build-out that is expected over the next decade or so. Indeed, investments in new and existing natural gas, nuclear, and renewable generation and transmission capacity will be a must as AI-data-center demand is expected to create additional load growth for already stressed electrical grids in several regions.

Figure 8: Real wage growth by construction sector segment, selected years*



Source: US Bureau of Labor Statistics, US Bureau of Economic Analysis.
*Note: Wage data adjusted for price level using personal consumption expenditures price index.

However, the competition for workers will not end there, as a broad range of investments are expected in domestic mining, processing, and downstream production for many critical minerals and materials over the next 10 to 20 years. While the labor markets for firms building these various manufacturing plants and new capacity for the energy sector industrial base do not overlap completely, EPCs tasked with building these different types of projects have a finite pool of labor to draw from in terms of desired skills and abilities even from a national perspective over the near- and medium-term.

Vocational-based certifications, company-sponsored upskilling and re-skilling training courses, and other workforce development programs require not only time and resources to target and deploy but also need subsequent time to produce enough cohorts of graduates wherein programs can be assessed (and re-tooled, if necessary) for their effectiveness. Without sufficient action and lead time, energy sector infrastructure projects such as natural gas pipelines and LNG export terminals could face sharply higher capex costs and/or unwanted project delays if they cannot identify, recruit, train, and retain labor resources in sufficient numbers to fill open positions.

How Workforce Analysis Can Inform and Bridge the (Supply-Demand) Gap

With the construction and deployment of all these midstream energy infrastructure resources over a relatively condensed timeline, gauging current and expected future workforce demand versus (current and expected future) supply will be critical. While 100-percent forecast accuracy for estimates of the number of welders, machinists, pipefitters, supervisors, project managers, and other occupations needed for an energy sector project would be desirable, that level of accuracy is both impossible and unnecessary for multiple reasons.

First, changes in task composition within a given job role over time, whether through the deployment of new technologies (integration of AI modeling) or shifts in business practices (e.g., modularized construction), and these changes can alter the demand trajectory for an occupation in unpredictable ways. Moreover, since some positions can share several related job task experience and other qualifications, businesses will often relax recruiting practices during episodes when a position is proving difficult to fill—unless specific contractual or position certification requirements must be met. Finally, workforce analyses must make the best use of one or more imperfect data sources that fit a methodological framework to produce useful estimates businesses and policymakers alike can use as a planning tool not only for one specific project, but for longer-term skill development and career pathway opportunities for the current and future workforce.

In terms of data, many sources exist from both public and private providers, but the point mentioned above that none of these data sources are without flaws remains and each source's strengths and weaknesses must be weighed against others. For example, data from the U.S. Bureau of Labor Statistics and U.S. Census Bureau, such as the Occupational Employment Statistics (OES) program, Current Population Survey, American Community Survey, and O*Net Online are public, follow a consistent methodology, and have been used for array research across numerous disciplines.

However, these sources tend to have less detailed data to identify more specialized occupations and thus might require combining other data sets to make ad hoc adjustments.

While this article will rely on publicly available data from the U.S. Bureau of Labor Statistics, private third-party resources such as Lightcast, Chmura, and Revelio have become increasingly popular as they enable researchers to produce detailed and highly-focused workforce-needs assessments. These providers have developed extensive labor market datasets by compiling records from online job listing announcements, resumes, and other resources, allowing for significant customization and occupational detail. At the same time, the depth and detailed coverage of these datasets can also make them costly for researchers with limited resources. In addition, online job ads and resume postings might be less prevalent in certain industries and could provide an incomplete picture of underlying labor market supply and demand trends that have been observed by employers and job seekers.

Focus is placed largely on positions that do not specifically require a four-year college degree, such as skilled trade, crafts, and technical labor positions that can require some combination of on-the-job training, vocational certification requirements, or potentially a two-year degree. Nonetheless, the analysis also includes occupations that provide career pathways and project/people management opportunities for workers, which could serve as in-house solutions for EPCs to back-fill the management and supervisory roles cited in anecdotal reports and surveys as lacking sufficient applicants.

According to the U.S. Bureau of Labor Statistics, construction employment specific to oil and gas pipelines and other related projects[2] averaged approximately 140,000 during 2023 and 2024. Of those workers, approximately 70 percent are employed in roles that can be identified as skilled trade, crafts, and technical labor occupations, or positions that provide up-skilling or promotional career pathway opportunities. As indicated in Figure 9, laborers and operating engineers are the industry's two most common occupations.

While laborers might tend toward the lower end of the industry's skill requirements, they will likely remain in relatively high demand given the overall scale of energy infrastructure development expected to occur in the next decade or so. More fundamentally, however, general laborer positions often serve as a worker's initial exposure to the industry and can be used as a feeder into an apprenticeship for a skilled trade or craft, making up-skilling, training, and career mobility opportunities (along with compensation) critical for retaining these workers.

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[2] See North American Industry Classification System (NAICS) U.S. Census Bureau for a description of this industries' scope of economic activities.

First-line construction trades supervisors rank as the third most frequently listed occupation, highlighting their relative importance to overall staffing needs on energy sector infrastructure projects. With a median age of over 45 years, workers in these roles do tend to be older compared to other occupations in the industry, suggesting the key focus for employers will be balancing management development pathways across early- and mid-career talent already on staff so as to avoid potential shortfalls in the pipeline as late-career workers are promoted or exit the workforce.

As a starting point to ascertain how many workers might be needed to accommodate a strong pace of activity related to natural gas transmission pipelines, LNG export terminals, and other midstream energy projects, 2018 to 2019 was used as a reference period. Indeed, numerous interstate gas pipelines, LNG export terminals, and petrochemicals facilities were under construction or saw major capacity increases in this time frame, causing payrolls for this construction segment to swell to an average of nearly 170 thousand during these two years.

With that set as a baseline, overall employment across the industry would have to increase nearly 21 percent on average from 2024 levels. Some occupations could require faster or slower rates of hiring due to factors such as new technology applications and increased deployment of capital deployment unique to the industry. Another factor to consider is the potential impact that sustained high levels of broader energy infrastructure development could have on job churn and wage inflation, particularly if multiple pipeline and LNG terminal projects in one or more regions have construction timelines that end up overlapping with each other and/or face direct regional labor market competition from, for example, new nuclear or natural gas-fired power plant projects.

Figure 9: Top TCTL/career path positions in pipeline & rel. structures construction*

Title	Employment (2023/2024)	Median Age (2024)	Employment (2018–2019 levels)	Projected U.S. growth (2024-2034)
Construction laborer	34,500	40.1	40,000–42,500	7%
Operating engineer	17,000	43.3	20,000–21,000	4%
Construction trades supervisor	14,700	45.3	17,300–18,100	5%
Pipefitters and steamfitters	5,800	40.1	6,800–7,100	5%
Pipelayers	5,500	37.0	6,400–6,800	-4%
Heavy truck & trailer drivers	5,000	40.6	5,800–6,100	4%
Welders, cutters, & solderers	4,100	40.0	4,800–5,000	2%
Earth drillers (excl. O&G field workers)	2,700	36.0	3,200–3,400	3%
Mobile heavy equipment mechanics	2,300	41.6	2,600–2,800	6%
Carpenters	1,700	41.8	2,000–2,200	4%
Cement masons & concrete	1,300	41.8	1,500–1,600	2%
Roustabouts, oil & gas	1,200	40.0	1,400–1,500	3%
Boilermakers	850	46.0	1,000–1,100	-2%
Electricians	700	40.2	800–900	10%

Sources: US Bureau of Labor Statistics, Occupational Outlook Handbook; author's calculations.
*Note: Expected growth applies to occupation titles across all industries; TCTL = trade, craft, and technical labor.

Conclusions

This article highlights how access to a skilled labor force will play an important part in building out the network of large-diameter natural gas pipelines and LNG export terminals necessary to connect supply from wellheads in the Appalachian, Permian, and other shale basins to domestic and overseas markets. Even with that backdrop, data presented in the article point to a combination of broader macroeconomic issues and national/regional labor market constraints that have hampered the ability to deploy some energy infrastructure projects . Finally, summary results from client research illustrated in the article suggest wholesale efforts to increase hiring, retaining, and developing the workforce will be to avoid deepening shortages for certain key occupations within the energy construction workforce over the next decade or so.

Competitive wages and cultivating/maintaining a pipeline of talented workers through recruitment, training programs, and career pathway development programs are foundational principles in workforce development, but some of the stated or implied energy policy goals by many countries will require significant investment and creative solutions that go well beyond past efforts. At the same time, exogenous supply shocks linked to changing immigration flows or long-term energy disruptions can lead to changes in energy labor markets in the short- and long-term; meanwhile, technological change presents an epistemic risk to future energy workforce demand as hardware and software solutions to shopfloor and fieldwork activities have the potential to alter the capital-labor utilization ratio for businesses in subtle or drastic ways.

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