

# Supplying the Unconventional Revolution: Workforce Readiness

Executive Summary



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High Road Strategies, LLC, Arlington, VA, is an economic policy research, analysis, assessment and design consultancy, with a focus on industrial, energy, and workforce issues. Its clients include business, labor, non-profit, academic, and government organizations.

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## IHS™ Economics

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This report offers an independent assessment of the workforce readiness challenge confronting the unconventional energy supply chain. This research was prepared for the Energy Equipment and Infrastructure Alliance (EEIA).

EEIA represents the unconventional oil and gas supply chain: equipment manufacturers and distributors, construction contractors, service providers, material suppliers, and logistics companies. EEIA members provide equipment, materials, construction, services, logistics and workers to unconventional oil and gas exploration and production, transportation and processing.

IHS and High Road Strategies are exclusively responsible for this report and all of the analysis and content contained herein. The analysis and metrics developed during the course of this research represent the independent views of IHS and are intended to contribute to the dialogue on the role of the unconventional oil and gas supply chain in promoting employment and economic growth.



## Executive summary

An IHS study, *Sizing the Unconventional Revolution*, found that unconventional energy development is projected to grow steadily through the next decade.<sup>1</sup> This growth will affect dozens of industries beyond the oil and gas sector, distributed across suppliers from every state. Major capital and operating expenditures by unconventional oil and gas producers flow to a lengthy supply chain that generates upstream, midstream, and downstream activity. Many suppliers in these sectors have lengthy supply chains of their own, multiplying the effect of unconventional energy development.

This rapid growth presents new workforce challenges for employers throughout the unconventional energy supply chain because of the rising demand for skilled workers needed for drilling, extraction, and other supply chain activities. Regions with high levels of unconventional energy development now or in the future seek to maintain and enhance the ability of the local workforce to support this activity to maximize economic development benefits. A shortage of qualified workers in the supply chain could limit the amount of unconventional energy development.

To assess the scale, scope, and nature of the workforce readiness challenge confronting this sector, IHS and High Road Strategies, LLC jointly undertook an extensive study of the unconventional energy supply chain's occupational structure, skill needs, and workforce education and training resources. Specifically the project team:

- Identified and examined the principal workforce challenges confronting the unconventional energy supply chain industries;
- Identified the core occupations of the supply chain industries and determined those in greatest demand nationally and in states with major plays; and
- Identified and examined public and private sector workforce training and education programs and initiatives established for the unconventional energy supply chain.

## Methodology and approach

The project team applied quantitative and qualitative methods to assess the workforce challenges. The analyses were carried out for the nation as a whole and for three states with significant unconventional plays—Texas, Pennsylvania, and Louisiana; two states at the early stages of unconventional development—Ohio, and Colorado; and one nonproducing state with significant supply chain activity—Illinois. The analyses drew upon IHS's proprietary economic models and federal employment and occupational statistics (primarily, the Department of Labor's Bureau of Labor Statistics [BLS]), to identify and assess the unconventional energy supply chain's core and high-demand occupations, including employment trends and projections.

The qualitative analysis included interviews of key stakeholders and experts, a survey, and a review of relevant literature and online resources. It was used to help evaluate the statistical employment and occupational data, identify the main workforce challenges, and examine workforce readiness initiatives in response to the challenges.

Specifically, the study involved the following steps:

1. *Identification of core occupations in the unconventional supply chain*, which are those that i) perform essential activities within the economic sectors of the supply chain; ii) can directly affect a sector's level of output if positions remain unfilled; and iii) have specialized education, training, competencies, or skills and experience requirements. The project team identified an initial list of 73 core occupations by applying multiple criteria to the employment by occupation for the North American Industry Classification System

<sup>1</sup> IHS Economics. *Supplying the Unconventional Revolution: sizing the unconventional oil and gas supply chain*. September 2014.

(NAICS) industries that comprise the five unconventional energy core supply chain sectors—construction and well services, capital goods, materials, professional and other services, and logistics.

2. *Interviews and survey of stakeholders*, which the project team drew upon to help identify the workforce challenges, validate and refine the list of core occupations and high-demand occupations (HDOs), and identify and evaluate the effectiveness of workforce development programs to meet perceived skill challenges. About 50 individuals representing over 40 organizations in the unconventional energy sector and/or its supply chain provided input, including business and trade associations; supply chain firms (e.g., construction contractors, equipment manufacturers and dealers, material suppliers, transportation), labor unions, workforce education and training providers, and government agencies.
3. *Literature review*, including numerous reports, documents, and articles, especially state assessments of occupational needs and employment growth for unconventional oil and gas development in Pennsylvania, Ohio, Texas, and Colorado by academic research institutes, state agencies, and some oil and gas industry associations.
4. *Identification of HDOs* based on the findings from multiple sources, including statistical analyses, interview, and survey findings, and the relevant literature. The project team identified and evaluated 24 of the core occupations as being in high demand across the supply chain. This list applies nationally and is reasonably consistent across all the major producing states reviewed in the study.
5. *Employment forecasts for core occupations and HDOs* for each supply chain sector. The project team forecast detailed occupational employment by supply chain NAICS sector, drawing on IHS's estimates of total employment for each supply chain NAICS sector in the United States between 2012 and 2025, and applying data from its Business Market Insights (BMI) database.
6. *Replacement needs for core occupations and HDOS*, which supplement the projections of occupational employment growth for the economic growth of the NAICS supply chain industrial sectors. Replacement needs for an occupation refer to job openings resulting from turnover or retirement or other factors, and are calculated by the Bureau of Labor Standards (BLS) for each year in its long-term occupational forecasts.

## Workforce challenges

The project team identified eight workforce challenges facing the unconventional oil and gas supply chain, which reflect the difficulties many employers have faced in filling a number of high demand occupations, some within specific sectors and many across the supply chain. While this list is consistent across the six states examined and across the nation, the magnitudes of the challenges vary by state, largely in proportion to their stage of development in the unconventional energy sector. The challenges also vary across industry sectors and occupations.

- **Shortage of qualified local workers.** The primary challenge supply chain employers have faced, especially in the early stages of exploration and drilling activity, has been finding enough qualified local workers. Although the training and recruiting of workers from local labor markets has improved, many challenges remain.
- **Technological change.** Technological advances in the unconventional energy sector have helped to drive up the demand for higher-skill occupations in the unconventional energy workforce and also have increased the skill requirements in the supply chain.
- **“Soft skills”** and behavioral barriers. Aside from technical skills, workers must demonstrate that they have “soft skills” and ability to meet behavioral standards. Soft skills include reporting to work on time, knowing how to dress for the workplace, and the interpersonal skills to interact with people and to work on a team. A major challenge is finding workers able to pass drug-screening tests.

- **Operator qualifications.** Confronting oil and gas pipeline contractors is the need for standardizing operator qualifications across the industry, which specify behavioral criteria for workers in the logistics and transportation components of the supply chain, as required by US Department of Transportation regulations.
- **Working conditions and burnout.** Many unconventional energy jobs, especially in upstream occupations and in pipeline, road and other construction work, are physically demanding, requiring long hours and sustained periods of work under harsh weather and environmental conditions away from workers' homes. These stressful working conditions can lead to burnout and high rates of turnover.
- **Attracting youth to skilled trades.** Aside from difficult working conditions, young people are not attracted to careers in laborer and skilled trade positions, in particular because of a common “cultural bias” against these types of jobs in industries such as manufacturing and construction. They prefer a career path requiring a four-year college degree over one needing career and technical education.
- **An aging workforce.** The challenge of maintaining a sufficient workforce in unconventional energy supply chain industries is being made more acute by the looming retirement of aging Baby Boomers working in these fields, or the Great Crew Change, as it is known within the oil and gas industry.
- **Competition for skilled workers.** The rapid growth of demand for oil and gas supply chain jobs and the recovery in the US construction and manufacturing sectors have fostered a fierce competition for workers with comparable skills, leading to increased pressure to “poach” workers from other firms within and outside the particular industry.

## Core occupations

Although almost 600 different detailed occupations are used by the sectors of the unconventional energy supply chain, the project team narrowed the scope of the study to 73 *core* occupations. These include a wide variety of occupations characterized by different levels of required skills, education, and training. Wage and salary levels range from highly educated petroleum and mechanical engineers, to skilled trades workers such as welders, operating engineers and diesel technicians, to construction laborers, service unit operators and roustabouts.

Some of the core occupations are required in multiple sectors across the supply chain including, for example, *construction laborers, operating engineers, industrial machinery mechanics, mobile heavy equipment mechanics, welders, and heavy truck drivers*. Other core occupations tend to be concentrated in only a few sectors, such as *rotary drill operators, petroleum engineers and wellhead pumpers*. At the same time, each of the seven core supply chain sectors tend to employ workers from a relatively small number of core occupations specifically relevant to their supply chain activities. For example:

- Extraction (service unit operators, derrick operators, and roustabouts) and some construction occupations (construction laborers, first-line supervisors) account for the largest shares of the workers employed in well services.

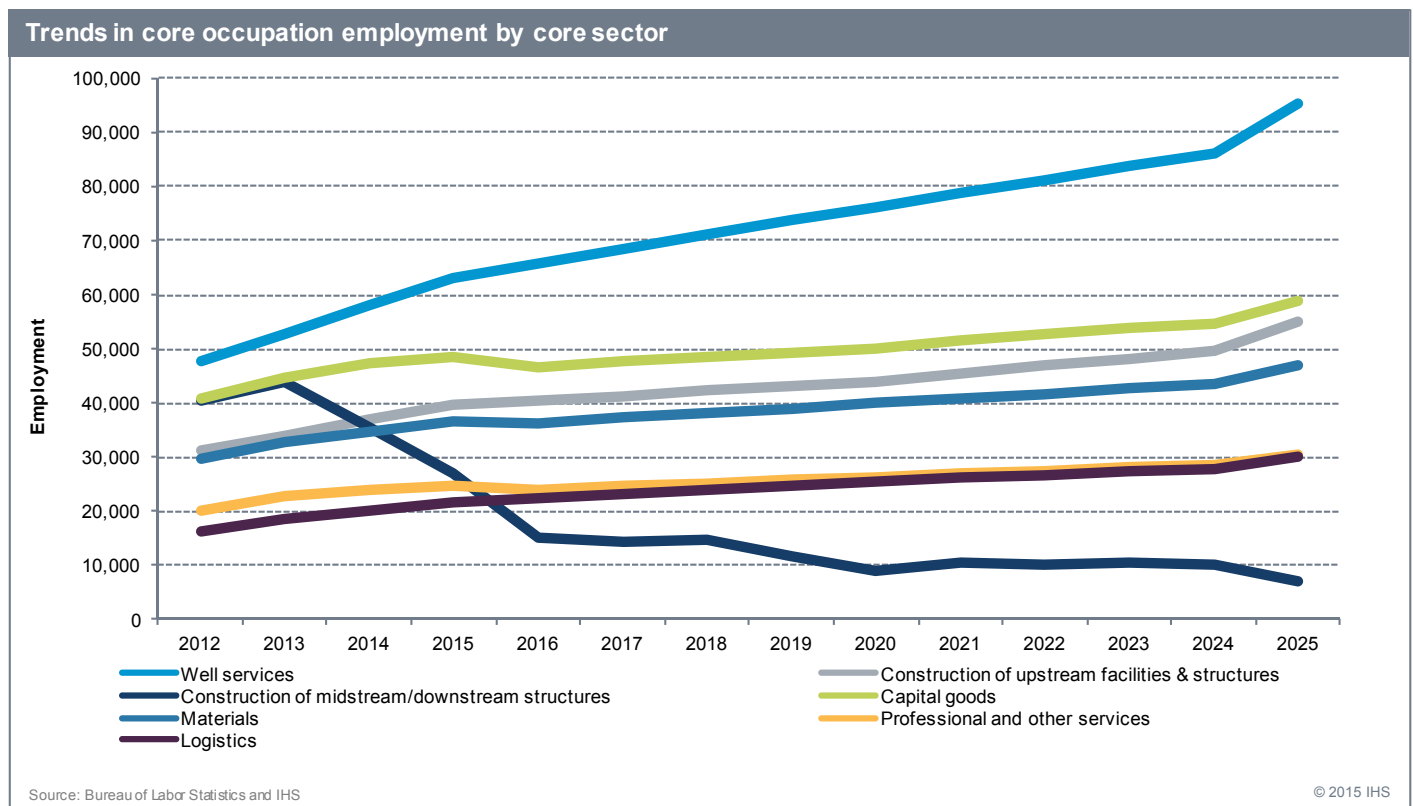


- Construction-related occupations dominate the two main construction subsectors.
- Engineers, scientists and related technicians tend to be concentrated in professional services, though some occupations, especially mechanical engineers, are also important in the capital goods and materials production sectors.
- Production and related occupations (e.g., machinists, welders, industrial machinery mechanics) predominate in capital goods sectors and play an important role, along with some construction occupations such as operating engineers, in the materials sector.
- Heavy truck drivers account for over 90% of logistics sector jobs, though bus and truck mechanics and diesel engine specialists are also important in this sector.

### Core occupation projections, 2012–25

The project team forecast employment for each core occupation that would directly support unconventional energy activity across all the supply chain sectors from 2012 to 2025. It found that total employment for all core occupations would grow by over 40% in the forecast period, from 226,300 jobs to over 324,300 jobs. The patterns of core occupational employment reflect IHS’s economic forecasts of economic activity in the unconventional supply chain sectors (see accompanying chart):

- Core occupation employment in the well services sector is expected to double by 2025, and in the construction subsector, representing construction of upstream facilities and structures, is projected to grow by almost 75% as the number of wells in operation continue to rise.
- Employment in several occupations in the construction sector, which includes building pipelines, manufacturing facilities and other structures is forecast to rise for a short time and then decline in later years because most of the supporting infrastructure will already have been built.





- Core occupation employment is expected to grow at annual rates of 2.9–4.8% in the other core sectors, including capital goods, materials, logistics, and professional services.

Similarly, the employment trends for core occupations grouped by major occupational classification follow projected economic growth for the core sectors:

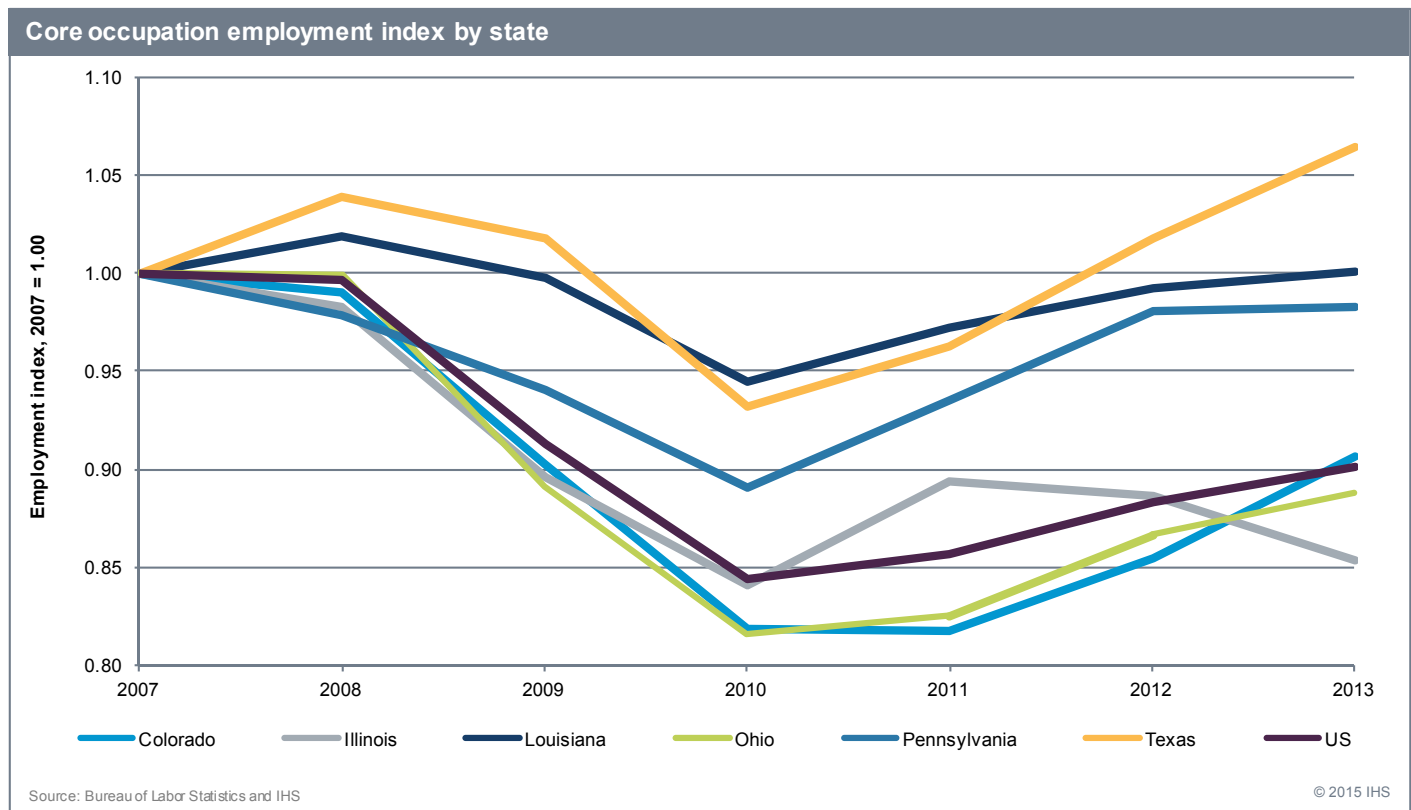
- Extraction jobs, primarily in well services, are expected to grow at the fastest rate—a 5.3% annual average increase.
- Transportation and materials moving, production, and installation, maintenance and repair jobs are forecast to grow at 4.2% and 3.5% annual rates, respectively.
- Core engineering, scientific; and technician employment in the supply sector, are expected to grow at 3% and 4%, respectively, albeit starting from a smaller base.
- Construction trades employment, in contrast, is expected to rise and then fall, showing only modest growth through 2025, reflecting the economic growth trends in the upstream and downstream construction sectors in the supply chain.
- Management occupations, two of three of which are in construction, correspondingly are expected to have a small net decline.

### State trends, 2007–13

Analyzing state-level employment trends for core occupations from 2007 to 2013 shows that employment levels of core occupations and their corresponding shares of total employment vary across the states. The differences are due to both their economic structures and the state of development of their unconventional energy activities. It is important to caution that these trends are for *all* workers employed in the core supply chain sectors, not just workers directly supporting unconventional energy activity. Because of data limitations, it is not possible to separate out the latter from workers in the same occupations and sectors that support nonenergy-related activities.

- Texas, Louisiana, and Colorado have relatively high employment shares in core construction and extraction occupations—about 24–33%—reflecting in part their more extensive conventional and unconventional energy production.
- While employment in construction and extraction are also high in Ohio and Pennsylvania, production jobs in core occupations account for the largest share—about one-third—of total supply chain core employment in these states and in nonproducing Illinois, reflecting their high concentrations of manufacturing.

As seen in the following chart, nationally and in all the states the impact of the Great Recession on employment from 2007 to 2010 is clearly evident in the sharp dips in employment in the core occupations. The growth of unconventional production from 2010-2013 in states with large plays has added jobs more quickly in core occupations in supply chain sectors, which contribute to job growth in these sectors overall and to state economies.



- Texas and Louisiana—two large conventional oil and gas producing states—and Pennsylvania—the nation’s largest unconventional producer—lead in total core occupational employment growth, reflecting earlier and greater growth in unconventional energy activities in large plays.
- Core occupation employment in Ohio’s manufacturing and construction sectors, hit very hard by the recession, fell steeply after 2007 through 2010 but started a gradual rise afterward, in part driven by growing demand for goods and services for the growing Marcellus and Utica shale plays.
- Colorado has had a similar rebound, although only over the past two years, but could rebound faster and surpass 2007 employment levels over the next few years if it is able to fully develop its unconventional energy resources.
- Only Illinois, also a large manufacturing state, shows a downturn in its core occupation employment, suggesting that the aftereffects of the recession still linger.

## High-demand occupations

The project team identified 24 high-demand occupations (HDOs) from the list of core occupations consistently identified as posing the greatest skill shortage challenge for unconventional energy supply chain employers (see accompanying table). HDOs span all the upstream, midstream, and downstream industries comprising the unconventional energy supply chain. Some occupations such as *heavy and tractor-trailer truck drivers*, and *welders* are in high demand throughout the supply chain. Other occupations, such as *construction laborers*, *operating engineers*, *petroleum engineers*, *electrical and electronic engineering technicians*, and *oil and gas service jobs*, are very important only for certain targeted unconventional activities.

HDOs account for nearly three-quarters of total jobs in core occupations engaged in actual unconventional energy supply chain activity, though this share varies for the different core sectors. The share ranges from over

80% of core occupation jobs in well services and construction sectors, to about 60% in the capital goods and materials sectors, to only 47% in the professional services sector, and to almost all core occupation jobs in the logistics sector (mostly heavy and tractor-trailer truck drivers).

The project team also developed profiles for 26 occupations (available in the report's appendix), including most of the HDOs. For each occupation, the profiles describe major activities performed, current employment levels and wages, education and training and certification requirements, and projected employment growth between 2012 and 2025.

### HDO employment trends, 2007–13

A comparison of employment trends from 2007 to 2013 shows that HDO employment dips less in the recession years and grows somewhat faster than the total of all core occupations and markedly faster than the nonhigh-demand occupations among core occupations. (Note that these numbers reflect jobs in associated core supply chain sectors, even if they are not in actual unconventional activities.) Although several economic factors contribute to these trends, especially the post-recession rebound of manufacturing and construction, unconventional energy activity undoubtedly contributes, especially in major producing states.

#### High-demand occupations in the unconventional energy supply chain: 2012

Occupational code	Occupational category	% in supply chain sectors
11-9021	Construction Managers	69.5%
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	51.6%
17-2171	Mechanical Engineers	53.1%
17-2171	Petroleum Engineers	28.3%
17-3023	Electrical and Electronics Engineering Technicians	42.3%
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	65.1%
47-2061	Construction Laborers	67.4%
47-2073	Operating Engineers and Other Construction Equipment Operators	69.4%
47-2152	Plumbers, Pipefitters, and Steamfitters	82.5%
47-5011	Derrick Operators, Oil and Gas	88.3%
47-5012	Rotary Drill Operators, Oil and Gas	80.8%
47-5013	Service Unit Operators, Oil, Gas, and Mining	88.0%
47-5071	Roustabouts, Oil and Gas	85.0%
49-3031	Bus and Truck Mechanics and Diesel Engine Specialists	37.1%
49-3042	Mobile Heavy Equipment Mechanics, Except Engines	66.5%
49-9041	Industrial Machinery Mechanics	39.5%
51-4012	Computer Numerically Controlled Machine Tool Programmers, Metal and Plastic	35.8%
51-4041	Machinists	33.3%
51-4121	Welders, Cutters, Solderers, and Brazers	49.1%
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders	38.0%
53-3032	Heavy and Tractor-Trailer Truck Drivers	68.8%
53-7032	Excavating and Loading Machine and Dragline Operators	70.5%
53-7071	Gas Compressor and Gas Pumping Station Operators	56.6%
53-7073	Wellhead Pumpers	37.8%
<b>Total for all high-demand occupations</b>		<b>61.2%</b>

Source: Bureau of Labor Statistics and IHS

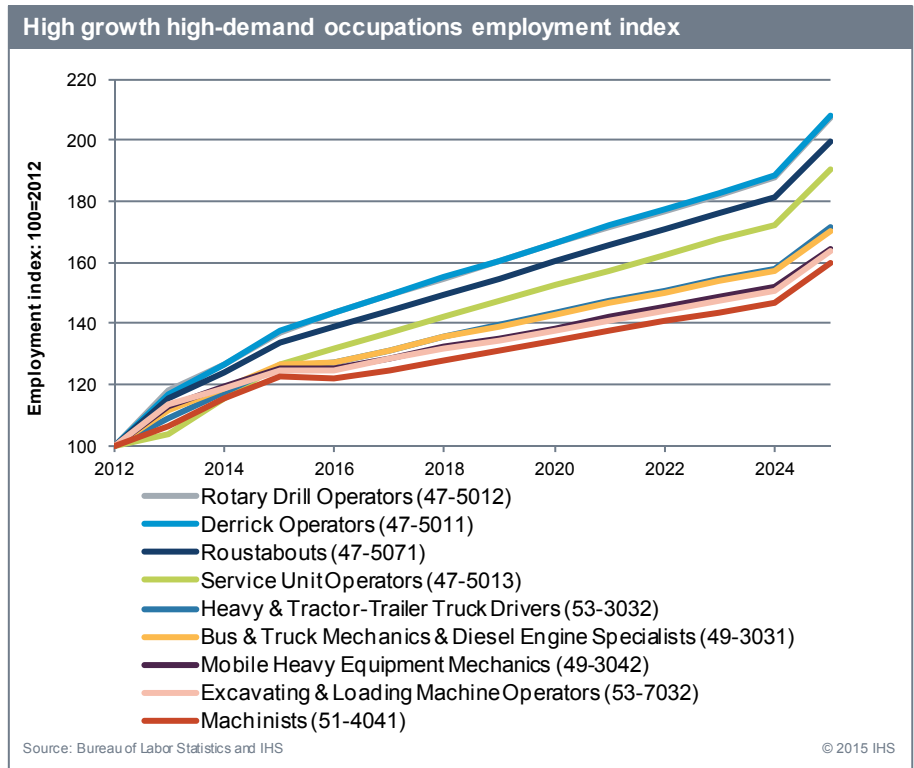
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Similarly, the HDO employment trends parallel the core occupation employment trends in the six selected states. Texas, Pennsylvania, and Louisiana, with relatively higher levels of unconventional energy development, lead the selected states—and the nation as a whole—in the growth and recovery trends for the high-demand occupations, as they did for core occupations. HDO employment in these three states has grown much faster than for most other occupations, in response to the unconventional energy boom. Ohio and Colorado, reflecting their less-developed unconventional energy sectors, have grown more slowly. Illinois again is an outlier, as its HDO employment level has not fully recovered from the recession.

### HDO employment projections, 2012-25

HDO employment projections for 2012–25 parallel the trends for core occupation employment. Total HDO employment is projected to grow by 41.8% from over 167,100 to 237,000 in the forecast period—an addition of nearly 70,000. High-demand occupations predominate, representing at least seven to nine of the top 15 occupations in each unconventional energy supply chain sector. The greatest concentration is in well services, where HDOs account for 12 of the top 15 core occupations.

The employment projections for individual HDOs over the forecast period reflect the relative demand for occupations due to economic growth in supply chain sectors (see accompanying chart for high-growth HDO projections):



- High growth occupations include well service occupations, machinists in capital goods and materials, heavy-truck drivers, bus and truck mechanics, and mobile heavy equipment mechanics in the logistics and materials sectors.
- Industrial machinery mechanics, mechanical engineers and electric and electronics engineering technicians—prominent in the capital goods, materials and professional services sectors—are expected to show modest but steady growth.
- Employment of construction managers and construction laborers first rises and then falls as midstream and downstream construction is completed, though the employment trend for construction laborers rises after 2020, reflecting a resurgence in demand.
- Employment of operating engineers follows a similar trajectory, but shows a steady growth after 2016, reflecting that HDO’s importance in several core sectors.
- Welders present an interesting case, given their important role in construction, as well as in capital goods and materials production: employment dips after 2014, flattens through 2020, before slowly rising through 2025.

## Replacement needs

*Replacement needs* for core occupations is a measure of turnover in the labor force, as workers change employers or occupations, go back to school, retire, or leave the workforce for other reasons. The employment changes in occupations due to economic growth of corresponding supply chain sectors do not reflect the actual numbers of workers that may need to be hired at a given time, because of the turnover in the workforce. Examination of these factors suggests that some high-demand occupations today, especially in the construction sector, may not actually be in high demand by 2025, while others may become in even more high demand because of replacement needs.



Overall, if replacement needs are factored in, supply chain employers could need to fill a total of at least 118,300 new jobs—jobs from economic growth and replacement needs—in HDOs by 2025. Estimated replacement needs for individual HDOs show substantial growth in demand for heavy and tractor-trailer truck drivers, roustabouts, service unit operators, machinists, operating engineers, industrial machinery mechanics, mechanical engineers and welders. The demand growth stems from job openings from economic growth and replacement needs in the forecast period, ranging from a 49% increase for welders to a 143% increase for service unit operators compared with 2012.

- Heavy and tractor-trailer truck drivers will have the largest increase in demand—19,800 jobs due to economic growth and 5,800 openings due to replacement needs.
- Most other HDOs also will have substantial replacement needs in addition to projected job increases due to economic growth.
- Both construction laborer and construction manager jobs are projected to decline by 2025. However, because of replacement needs construction laborer jobs still would have a net increase in demand, but construction manager jobs would still fall because replacement needs would not be sufficient to offset economic-related losses, resulting in a net decline in employment.

## Workforce readiness opportunities

The projected growth of employment in HDOs, due both to economic growth and replacement needs, raises questions about the capacity of the nation's workforce education and training system to meet employers' needs over the next decade. The major unconventional oil and gas producing states will have the greatest challenges to provide the workforce programs needed to support local pools of trained workers in HDOs for oil and gas firms and their supply chain.

A large variety of workforce initiatives have been started, expanded, and strengthened with the goal of increasing the supply of skilled workers to meet current and expected growth in demand for HDOs. These efforts take many different forms involving various combinations of private and public sector participation and operating at the local, state, multistate, and national levels:

- Community college, technical college and university programs as well as union apprenticeships frequently operate in partnership with energy-related companies and business trade associations.
- Most companies do some form of on-the-job training but count on third-party providers (e.g., apprenticeships, community colleges) to provide basic technical knowledge and skills to qualify candidates prior to hiring.
- Consortia of workforce stakeholders—businesses, universities, community colleges, and other education and training providers, both on the national and state level—have come together to monitor and promote policies and programs to address the workforce challenges.

It is beyond the scope of the current study to evaluate the capabilities of these programs to meet the projected demands for workers across the spectrum of HDOs. While there is a general consensus about the serious workforce challenges confronting unconventional supply chain employers, the industry so far appears to be keeping up with the demand. However, it remains unclear whether market forces are sufficient to meet the growing workforce readiness needs of the unconventional energy supply chain over the next decade as it rapidly expands. It is possible support from state and federal policies will be required to optimize the economic growth of the unconventional energy sector, which relies on the availability of a high-skilled, well-trained workforce throughout its value chain.