Supplying the Unconventional Revolution:

Sizing the unconventional oil and gas supply chain

Main report

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For more information, contact:

Brendan O'Neil
Managing Director, Consulting, Economics and Country Risk, IHS
brendan.oneil@ihs.com
(202) 481-9239

For press information, contact:

Jim Dorsey
Senior Manager Media Relations, IHS
jim.dorsey@ihs.com

Jeff Marn
Senior Manager Public Relations, IHS
jeff.marn@ihs.com

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Project directors

- Mohsen Bonakdarpour, Managing Director, Consulting, Economics and Country Risk
- Brendan O'Neil, Managing Director, Consulting, Economics and Country Risk

Project team

- Tabitha Bailey, Director, Consulting, Economics and Country Risk
- Julie Gressley, Consultant, Consulting, Economics and Country Risk
- Scott Hazelton, Managing Director, Consulting, Economics and Country Risk
- Phil Hopkins, Director, Consulting, Economics and Country Risk
- Leslie Levesque, Consultant, Consulting, Economics and Country Risk
- Mihaela Solcan, Consultant, Consulting, Economics and Country Risk

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This report offers an independent assessment of the importance of the unconventional oil and gas supply chain to the US economy. 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 is 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.

All of the gross output and labor income contributions throughout this report are expressed in terms of constant 2012 dollars.

Executive summary

Unconventional oil and gas development in the United States is a wide-reaching economic juggernaut that impacts dozens of industries beyond the oil and gas sector.[1] Furthermore, the impacts are distributed across suppliers from every state irrespective of whether oil and gas resources are native to the state. Major capital and operating expenditures flow to a lengthy supply chain that enables upstream, midstream, and downstream development activity. The unconventional oil and gas supply chain is composed of providers of materials, capital goods, construction and well services, professional and other services, and logistics and represents more than 40% of total unconventional oil and gas related employment over the 2012–25 period analyzed for this report.

In addition to the capital and operating spending stimulus that generates supply chain activity, unconventional oil gas development is also kindling new construction activity in the regions where drilling activity is occurring. While this supplemental construction activity is not a function of upstream operator spending, the ripple effect of the large capital investment is added housing, commercial buildings, and infrastructure vital to upstream operations and employees. Upstream, midstream, and downstream investment has indirectly generated construction activity at a time when the construction sector and its own supply chain is recovering from the worst construction recession since the Great Depression. This IHS analysis quantifies the economic contributions at a level of detail that comprehensively defines the unconventional supply chain effect across many industries and the lower 48 states.

Oil and gas operators in the upstream, midstream, and downstream sectors share a symbiotic relationship with their immense network of suppliers. Suppliers benefit from the enormous investment required for the exploration, production, processing, and transport of oil and gas resources. And it is the suppliers of materials, capital equipment and services that complete the virtuous circle by enabling operators to commercialize otherwise inaccessible hydrocarbons.

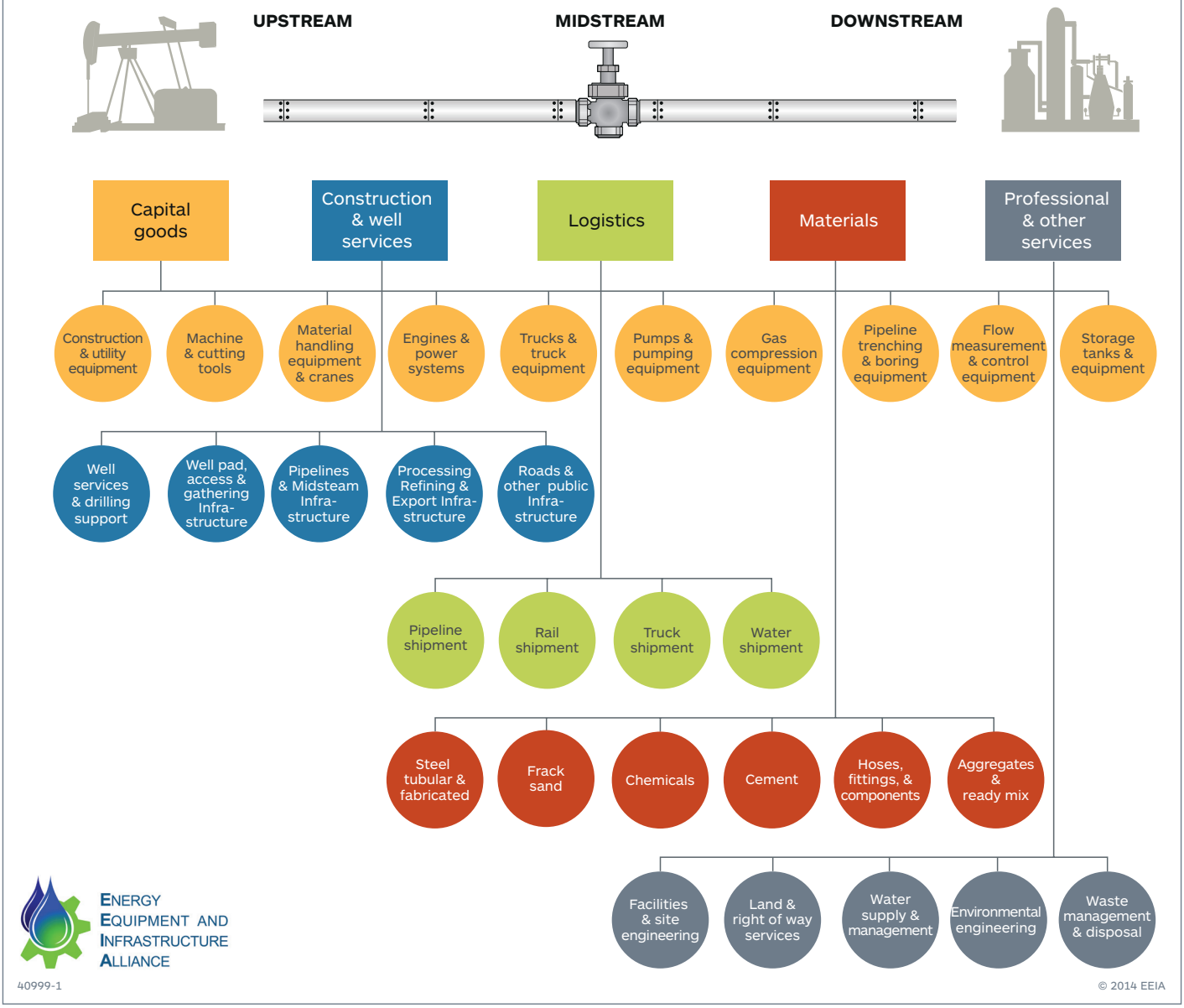
This IHS study is the first comprehensive assessment of the unconventional energy supply chain, focusing on the economic contributions associated with the oil and gas industry's broad network of suppliers and their important roles in advancing unconventional resources development, ultimately enhancing the energy and economic security of the United States. The contributions to the US economy identified in this study demonstrate the critical linkage between energy value chain investment and several sectors likely to experience above-trend economic growth over the next two decades. For example, employment growth in the unconventional oil and gas supply chain will outpace IHS's estimate for total US employment growth over 2012–25 by 2.9% vs. 1.1%.[2] Furthermore, the $79,000 average wage earned by the unconventional supply chain worker exceeds the average annual US wage of $68,000.

The following is a diagram of the unconventional energy supply chain sectors and components that demonstrates the expansive scope of its industries and their pervasive presence throughout the economy.

1 The word "unconventional" applies to oil and gas extracted using the major new technological advances in extraction, such as horizontal drilling and hydraulic fracturing.

2 Source: IHS Economics, August 2014 US macroeconomic forecasts.

The unconventional energy supply chain



Many of the suppliers in the unconventional oil and gas supply chain do not rely exclusively on the oil and gas industry for sustainable business. In response to the decline in domestic oil and gas production from 1970 to 2000, suppliers reduced their exposure to the industry. Yet, amid the sweeping economic chaos of the Great Recession, a resurgent domestic oil and gas industry began massive investment due to the increased commercial viability of hydraulic fracturing and horizontal drilling in shale and other tight oil formations. The result was a renewed focus on supplying the domestic oil and gas industry, particularly at a time when construction, the primary market for suppliers of machinery and materials, was experiencing an extraordinary decline. Today, the question for many suppliers to the domestic oil and gas industry is not whether their business is over-weighted in the sector, but whether they are adequately resourced to fully take advantage of the business opportunities that exist in unconventional oil and gas.

Remarkably, another important effect of the revival in domestic oil and gas production is that unconventional resources are now being developed in areas where little or no conventional energy was previously produced,

and companies with no previous energy-driven business are thriving by supplying this new activity. New businesses have been formed to take advantage of the unique needs of unconventional resource development, such as water management, proppant supply, and engineering services. Investment in unconventional oil and gas development has not only stimulated the Great Revival in domestic production, it has also shaped economic renewal following the Great Recession.

This study investigates three key areas where the unconventional oil and gas supply chain supports economic growth in the lower 48 states. First, the study evaluates the economic contributions of the unconventional oil and gas activity on its supply chain industries in terms of employment, labor income, government revenue, and gross output of goods and services. The rapid expansion in both domestic production capacity of unconventional oil and gas and the associated midstream and downstream energy infrastructure stimulates supply chain activity throughout the energy value chain. Second, the study breaks down the national results into state-by-state findings.

Third, the study examines the incremental levels of construction activity associated with unconventional oil and gas development. In addition to construction activity on drilling sites and pipelines fueled by operator capital and operating expenditures, considerable supplemental construction investment not borne by the operators is necessary to support upstream, midstream, and downstream activity. Examples of related construction activity include road widening and resurfacing to accommodate increased truck traffic and construction of new housing and lodging units in rural areas where the existing housing stock is insufficient to meet growing demand.

Key findings reveal that supply chain segments—capital goods, construction and well services, logistics, materials, professional and other services—have benefitted the most from the unconventional revolution in terms of number of jobs created, labor income, and overall gross output. Over the forecast period, 2012 to 2025, the total number of unconventional supply chain jobs is estimated to increase by 45%, from 524,000 jobs in 2012 to over 757,000 jobs in 2025. These employment estimates account for more than 40% of all jobs supporting unconventional energy activity. Additionally, the gross output estimates for the unconventional energy supply chain account for over 35% of total gross output supported by total unconventional energy activity.

US unconventional energy supply chain contribution*

	2012	2015	2020	2025	CAGR**
Employment (Number of workers)					
Supply chain total	524,413	615,910	638,762	757,802	2.9%
Energy activity total	1,100,573	1,419,214	1,562,229	1,834,306	4.0%
Share of supply chain in employment	47.6%	43.4%	40.9%	41.3%	
Gross output (2012 $M)					
Supply chain total	145,681	173,522	180,620	205,907	2.7%
Energy activity total	345,089	463,538	516,689	582,706	4.1%
Share of supply chain in gross output	42.2%	37.4%	35.0%	35.3%	
Labor income (2012 $M)					
Supply chain total	41,015	48,915	51,381	59,502	2.9%
Energy activity total	97,291	130,593	146,432	168,146	4.3%
Share of supply chain in labor income	42.2%	37.5%	35.1%	35.4%	

* Energy activity total represents the combined direct and indirect contributions of upstream, midstream, and downstream as reported in *America's New Energy Future*, Volume 3.

** Compound annual growth rate from 2012 to 2025.

Source: IHS

Many of the major suppliers to unconventional oil and gas operators have lengthy supply chains of their own, further contributing to the multiplier effect of unconventional development. For example, throughout the upstream and midstream sectors, earth-moving construction machinery is necessary to excavate impoundment ponds, prepare access roads, dig pipeline trenches, and prepare the site of a natural gas processing plant. Thus while the original equipment manufacturers benefit from unconventional development, so do the steel plate producers, metal fabricators, and machine tool shops that create the inputs for finished machinery that end up on upstream and midstream worksites.

The sectors within the unconventional supply chain were assigned to one of five core groups:

1. **Capital goods**: Off-highway equipment and industrial machinery are widely used throughout the unconventional value chain, including construction and access machinery; pumps and compressors; power generators; power boilers and heat exchangers; and component suppliers to equipment manufacturers. Also related to this group are equipment distributors and rental companies.

2. **Construction and well services**: Construction activity is present through all aspects of the unconventional energy value chain as well as the supplemental construction within oil and gas producing regions that is not associated with oil and gas operator capital and operating expenditure. Suppliers within this group include general and specialty contractors, and building trades. Well services include well drilling and other oil and gas field support services performed on a contract basis.

3. **Logistics:** The logistics transportation system supporting unconventional energy activity consists of road, rail, water, and pipeline transportation. While truck transportation has been a principal mode of the unconventional energy supply chain, logistics, pipeline, water, and railway traffic are expected to increase in the coming years.

4. **Materials**: This group includes various raw materials producers such as steel and nonferrous metals; sand, gravel, and other aggregates; chemicals; and other value-added services such as metal fabrication and distribution. Key materials include oil country tubular goods and other pipe products, cement for well-casing, and sand and chemicals associated with hydraulic fracturing. These raw materials are also critical inputs for finished and semi-finished supply chain goods such as the gears and forgings in machinery.

5. **Professional and other services**: Typically associated with operational expenditures, the wide range of professional and other services include environmental engineering; occupational health and safety; architectural and civil engineering services; and financial, insurance, and real estate services.

Top-10 sectors: US unconventional energy supply chain employment* (Number of workers)

		2012	2015	2020	2025	CAGR**
23[t]	Construction of Other New Nonresidential Structures	58,806	74,333	82,577	103,299	4.4%
5413	Architectural, Engineering, and Related Services	57,770	67,878	67,523	77,603	2.3%
213112	Support Activities for Oil and Gas Operations	54,757	72,351	87,337	108,828	5.4%
23[tt]	Construction of New Nonresidential Manufacturing Structures	74,362	50,343	16,709	13,414	-12.3%
212321	Construction Sand and Gravel Mining	28,228	36,434	42,197	49,944	4.5%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	27,460	36,225	42,287	50,435	4.8%
4841	General Freight Trucking	24,139	32,079	37,724	44,545	4.8%
4238	Wholesale Machinery and Equipment	17,449	24,339	28,903	33,742	5.2%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	18,155	21,832	21,818	25,382	2.6%
3312	Steel Product Manufacturing from Purchased Steel	14,662	16,192	15,175	17,814	1.5%
Top-10 total		**375,788**	**432,008**	**442,250**	**525,006**	**2.6%**
US total		**524,413**	**615,910**	**638,762**	**757,802**	**2.9%**

*The ranking for all years are based on employment in 2014.

** Compound annual growth rate from 2012 to 2025.

t Construction of upstream facilities and structures.

tt Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Source: IHS Economics

Appendix C of this report contains more detailed definitions of the range of specific products and services that are included within the industry descriptions.

IHS findings also demonstrate heightened infrastructure, residential and commercial construction activity necessary to support or facilitate unconventional development in regions where activity is either underway or anticipated in the forecast period. Beyond the construction investment typically made by upstream and midstream operators, non-operator construction investment will range between $2.8 billion and $3.6 billion annually over the forecast period. This activity includes public and private investment associated with new construction in road improvements, wastewater treatment, and lodging that is needed to accommodate increased vehicle traffic, resource usage, and workers. This supplemental construction investment translates to additional construction-related jobs over and above the construction impacts identified within operator capital expenditures in the upstream, midstream, and downstream sectors. These supplemental construction-related jobs are estimated to have peaked in 2013 with about 16,800 jobs, then decline over time to about 10,000 jobs in 2025. The residential segment within this supplemental construction activity will account for more than 75% of the total supplemental construction over the forecast period.

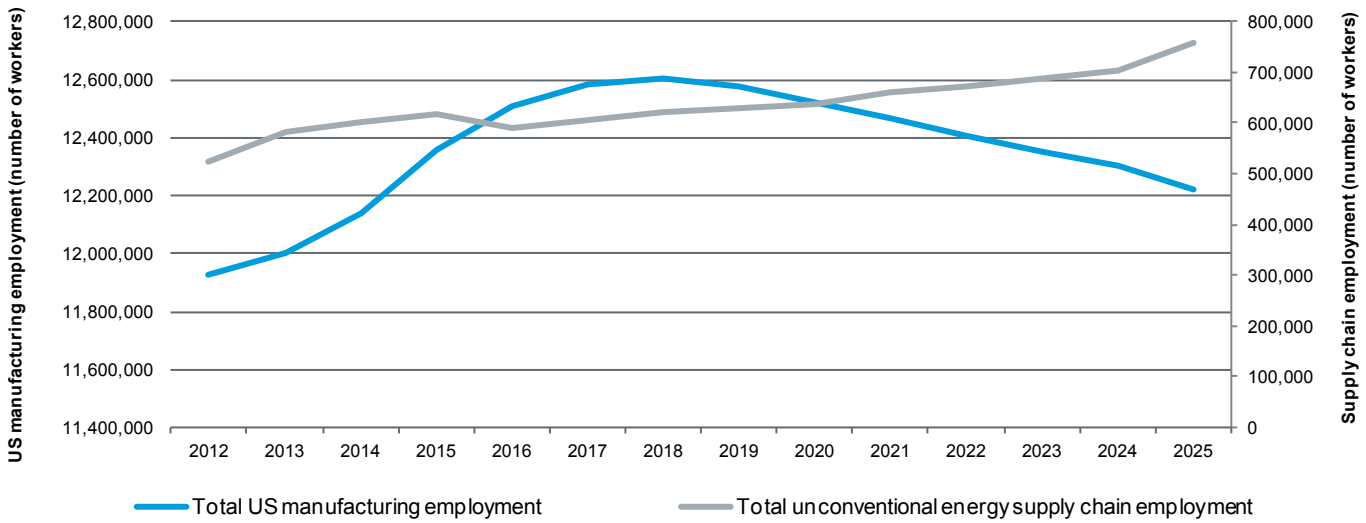
The study projects impressive growth rates in employment for several industries. For instance, Cutting Tool and Machine Tool Accessory Manufacturing (NAICS 333515), the largest capital goods sector of the supply chain, is expected to increase the number of workers tied to the unconventional energy supply chain from 27,000 workers in 2012 to more than 50,000 in 2025. This represents a compound annual growth rate of about 5% from 2012 to 2025. These growth rates are impressive by historical standards for this sector. According to the Bureau of Labor Statistics, the sector lost workers at an average compound rate of about 3% each year during 2001–12, falling from almost 36,000 workers in 2001 to about 25,000 in 2012.

National level key findings

IHS expects capital and operating expenditures to grow substantially between 2012 and 2025 supporting unconventional oil and natural gas production and expanding the upstream, midstream, and downstream value chain. The impact on employment, gross output, and labor income is expected to be significant throughout the supply chain:

- Total employment across the supply chain is estimated to grow at an annual compound rate of about 3%, from about 524,000 jobs in 2012 to 757,000 jobs in 2025, an increase of about 45%. This represents a much faster growth rate than the pace projected for total US employment in manufacturing, which is forecasted to increase at a compound growth rate of only 0.2% from 2012 to 2025, an overall increase of only 2.5%. While US manufacturing employment has been declining over the long term, manufacturing sectors within unconventional supply chain are bucking this trend.

Total US manufacturing employment vs. unconventional energy supply chain employment



Source: IHS Economics

- The total supply chain-related gross output will increase from nearly $146 billion in 2012 to almost $206 billion in 2025. In the context of a $15–21 trillion US economy over this period, this translates into roughly 0.5% of total gross output in any given year of the forecast. Moreover, total supply chain-related gross output represents roughly 5% of total manufacturing output over the forecast years.

- The labor income generated by employment across the supply chain will grow from $41 billion in 2012 to close to $60 billion in 2025, representing, on average, approximately 36% of total labor income generated by unconventional oil and natural gas activity.

- The supply chain is spread across 56 North American Industry Classification System (NAICS) sectors, which represent between 40% and 47% of total employment supported by all unconventional energy activity.[3]

- Employment attributed to upstream, midstream, and downstream unconventional oil and natural gas activity will support more than 1.1 million direct and indirect jobs in 2012, growing to some 1.8 million in 2025.

3 The North American Industry Classification System (NAICS, pronounced "Nakes") was developed under the direction and guidance of the Office of Management and Budget (OMB) as the standard for use by Federal statistical agencies in classifying business establishments for the collection, tabulation, presentation, and analysis of statistical data describing the US economy. Use of the standard provides uniformity and comparability in the presentation of these statistical data. NAICS is based on a production-oriented concept, meaning that it groups establishments into industries according to similarity in the processes used to produce goods or services. NAICS replaced the Standard Industrial Classification (SIC) system in 1997.

- Total government revenues generated by the unconventional energy supply chain will increase from more than $13 billion in 2012 to more than $16 billion in 2015 and to about $23 billion in 2025.
- Average income per employee in the supply chain industries is estimated at about $79,000 between 2012 and 2025.

Supply chain core group key findings

- Two of the core groups, construction and well services and capital goods, account for more than 55% of total economic benefits supported by unconventional energy supply chain activity.
- In terms of employment, the top sector within the capital goods group is Cutting Tool and Machine Tool Accessory Manufacturing (NAICS 333515), followed closely by Wholesale of Machinery and Equipment (NAICS 4238). Employment supported by unconventional energy activity in these two sectors is estimated to increase by 87%, from about 45,000 workers in 2012 to more than 84,000 workers in 2025.
- Construction and well services activities associated with the unconventional energy supply chain is represented by four sectors: Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures); Construction of Other New Nonresidential Structures (part of NAICS 23—construction of upstream facilities and structures); Drilling of Oil and Gas Wells (NAICS 213111); and Support Activities for Oil and Gas Operations (NAICS 213112). Through 2025, these four sectors are estimated to support on average 216,000 jobs per year related to unconventional energy activity.
- Within the materials group, Construction Sand and Gravel Mining (NAICS 212321) is the largest sector of the unconventional energy supply chain in terms of employment, gross output, and labor income contributions. The employment contribution in this sector is expected to almost double from 28,000 workers in 2012 to nearly 50,000 workers in 2025. Similarly, labor income in this sector will increase from $2.5 billion in 2012 to $4.3 billion in 2025. Gross output will increase from about $6 billion to more than $10 billion over the forecast horizon.
- Within the professional and other services group, the Architectural, Engineering, and Related Services (NAICS 5413) sector is projected to increase its number of workers associated with the unconventional energy supply chain activity from more than 57,000 in 2012 to about 77,000 in 2025, representing a compound annual growth rate of 2.3%
- Among the supply chain sectors in the logistics group, General Freight Trucking (NAICS 4841) experiences the largest employment contributions stemming from unconventional energy activity. The number of workers in this sector is estimated to increase from 24,000 in 2012 to more than 44,000 in 2025.
- In Heavy Duty Truck Manufacturing, both gross output and employment are expected to double between 2012 and 2025 from $1.1 billion to $2.3 billion and 3,000 workers to 6,000 workers, respectively.

State level key findings

- Unconventional energy supply chain jobs account for 2% of total state employment in Texas, Louisiana, and Oklahoma throughout the forecast period. Supply chain employment accounts for 1% of total state employment in Arkansas, Colorado, and Pennsylvania.
- In 2012, the supply chain industries across the producing states contributed about $126 billion to total US gross output; by 2015 this will grow to over $146 billion, stabilizing at nearly $170 billion by 2025. The supply chain industries in the nonproducing states are estimated to generate $19 billion in gross output in 2012, nearly $27 billion in 2015, and $36 billion by 2025.

- The top-10 producing states account for more than 70% of the energy supply chain contributions in terms of employment, labor income, and gross output. The top-10 producing states over the forecast period are: Texas, Louisiana, Pennsylvania, Colorado, North Dakota, Ohio, Oklahoma, California, Arkansas, and Utah.
- The top supply chain industries in terms of employment contributions across the oil and gas producing states are concentrated in Construction (part of NAICS 23), Support Activities for Oil and Gas Operations (NAICS 213112), General Freight Trucking (NAICS 4841), and Architectural, Engineering, and Related Services (NAICS 5413).
- The top supply chain industries that support the largest number of jobs across the nonproducing states are concentrated in the capital goods core group.

Introduction

The unconventional oil and natural gas revolution was made possible by a series of technological innovations including hydraulic fracturing and horizontal drilling.[4] The converging forces of technology, risk capital, and global demand have catapulted the United States into position as the world's largest natural gas producer. In its *World Energy Outlook* for 2013, the International Energy Agency estimated that the United States will reclaim the title as the world's largest crude oil producer within this decade. US natural gas production reached almost 65 billion cubic feet (Bcf) per day in 2013, up from 52 Bcf per day five years ago. Oil production increased from 5 million barrels per day (MMb/d) in 2008 to 7.4 MMb/d in 2013.[5] Moreover, since 2008, the rapid rise in affordable and abundant oil and natural gas resources has not only enhanced US energy self-sufficiency, but has also helped revive the manufacturing sector, particularly the domestic producers of petrochemicals that have lower feedstock costs than global competitors.

The unlocking of unconventional oil and gas resources has been accompanied by tremendous capital investment and operating expenditures across the energy value chain. This IHS analysis demonstrates how these expenditures in the upstream, midstream, and downstream segments of the energy value chain significantly contribute to the US economy in areas such as steel and nonferrous metals, capital equipment, construction services, professional services, and transportation. The economic contributions from unconventional oil and gas development are assessed in this report by the number of jobs supported and their associated incomes, the value of goods and services produced and the resulting tax revenues paid to federal, state, and local governments. The core focus of the report is on the economic contributions throughout the extensive supply chain that enables development of unconventional oil and gas resources.

This iteration of IHS Economics' contribution analysis for unconventional oil and gas sizes in detail the supply chain impacts from upstream, midstream, and downstream unconventional oil and gas related activity. The national contribution of the unconventional supply chain is determined from the integration of the bottom-up production and capital spending profiles from IHS Energy research. These findings will present detailed characteristics of the upstream activities that include well construction, drilling, completion, facilities and gathering, and the myriad suppliers that support this development. The analysis is consistent with the approach used in IHS's *America's New Energy Future* study (ANEF), which examined the effects of unconventional oil and natural gas on the US economy and the manufacturing sector. The results at the state level are provided in the second part of the study, while the third part analyzes in detail the construction activity associated with the unconventional energy activity.

The quantitative findings of this study represent a point in time estimate and are based on the same production and capital expenditure assumptions employed in the *America's New Energy Future* series of studies. Capital expenditures at the upstream phase of oil and gas production are undertaken for well construction, drilling, well completion, facilities, and gathering.

US upstream capital expenditure
(Current $M)

	2012	2015	2020	2025	2012-25*
Total unconventional oil and gas activity					
Drilling capital expenditure	28,027	41,463	57,680	78,261	205,432
Completion capital expenditure	46,873	67,194	92,322	121,089	327,479
Facilities capital expenditure	6,701	9,568	12,620	16,282	45,170
Gathering system capital expenditure	5,701	8,063	9,919	12,034	35,717
Total upstream capital expenditure	87,301	126,288	172,542	227,667	613,798

*2012-25 represents the total for all years.

Source: IHS Energy

4 The word "unconventional" applies to oil and gas extracted using the major new technological advances in extraction, such as horizontal drilling and hydraulic fracturing.

5 Energy Information Association (EIA), Annual Energy Outlook 2014.

As development of unconventional oil and gas resources evolves, numerous dynamics could shape the outlook for production and energy value chain development including, but not limited to:

- Federal, state, and local policy and regulations
- Changes to the current ban on crude oil exports
- Approvals for constructing new liquefied natural gas terminal capacity
- Technological innovations
- Workforce and supply chain capacity constraints
- Geopolitical events

Any change in the forces that drive the oil and gas sector investment would have an impact on the level of capital and operating expenditures that flow through the unconventional oil and gas supply chain.

Report structure

This report contains four sections:

- **Unconventional oil and gas supply chain: National assessment** presents the economic contributions that the unconventional energy supply chain are making to the US economy in terms of employment, gross output, labor income, and government revenues.
- **Unconventional oil and gas supply chain: State assessment** presents the economic contributions broken down at the state level. This section discusses in detail the key oil and gas producing and nonproducing states as well as the top sectors within each core group of the unconventional energy supply chain.
- **Unconventional oil and gas supply chain: Supplemental construction assessment** sizes the construction activity that is related to the unconventional energy but not captured in upstream, midstream, and downstream operator supply chain spending, such as residential, commercial, industrial, and infrastructure construction.
- **Conclusion** provides the key conclusions of the report.

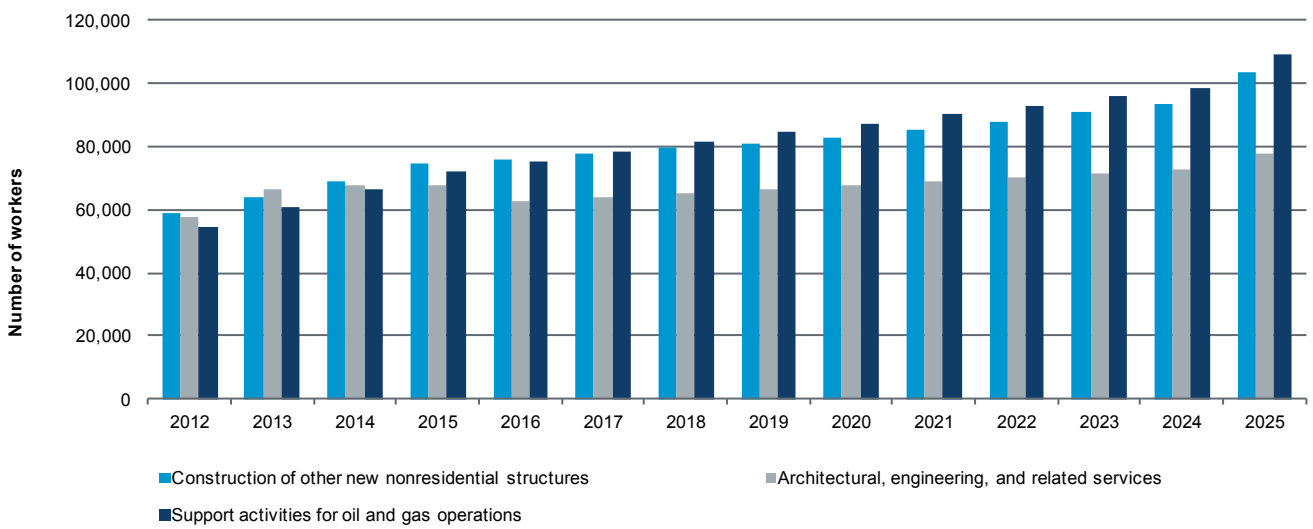
Several appendices also explain the methodologies, research, and data relied upon for our analysis. The appendices also present more detailed results from our study.

Unconventional oil and gas supply chain: National assessment

Summary of key results: National assessment

- The employment contribution across the supply chain industries is expected to increase at an annual compounded growth rate of 2.9% between 2012 and 2025, going from 524,000 jobs in 2012 to more than 757,000 jobs in 2025.
- Labor income per employee in the supply chain industries averages $79,000 throughout the forecast period, 2012–25.
- The economic value of the supply chain industries, as measured by gross output, accounts for roughly 0.5% of US total gross output throughout the forecast period.
- Average worker productivity across the supply chain is estimated at approximately $278,000 per year throughout 2012–25.
- Cutting Tool and Machine Tool Accessory Manufacturing (NAICS 333515) is the largest capital goods sector of the supply chain. Employment supported by the unconventional supply chain in this sector ranges between 27,000 and 50,000 workers over the 2012–25 forecast period; contributions to gross output range between $4.5 billion and $7.8 billion, while labor income is estimated between $1.8 billion and $3.3 billion. Construction Sand and Gravel Mining (NAICS 212321) is the most dynamic sector in the materials group, benefiting the most from the unconventional activity in terms of gross output, number of workers, and labor income. Employment is estimated to increase from more than 28,000 workers in 2012 to almost 50,000 workers in 2025. Gross output is forecast to increase from $6 billion to more than $10 billion, while labor income will increase from $2.5 billion in 2012 to $4.3 billion in 2025.
- Architectural, Engineering, and Related Services (NAICS 5413) is the top sector in terms of number of workers and gross output produced within the professional and other services group. The number of

Supply chain sectors with the largest employment contributions



Source: IHS Economics

workers supported by the unconventional energy supply chain is estimated to increase from almost 58,000 in 2012 to more than 77,000 in 2025. Over the same period, gross output will increase from $8.3 billion to almost $10 billion while labor income will increase from $4.7 billion to $6.2 billion.

- Within the construction and well services group, employment and output in Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures) are expected to decline in the second half of the forecast period as necessary structures and infrastructure are completed. Support Activities for Oil and Gas Operations (NAICS 213112), however, will strongly grow employment and output, tracking upstream unconventional investment, which is expected to increase over the forecast period.

As new energy resources transform America's energy landscape, unconventional oil and gas activity is already bringing important benefits to the US economy. US crude oil production is up 50% since 2008 and natural gas production has increased by nearly a third since 2005, with shale gas increasing from 2% of output in 2002 to 37% today. Unconventional natural gas accounts for almost 65% of US natural gas production; this includes shale gas as well as natural gas from tight sands formations and coal bed methane. The rapid rise in production created a surplus of natural gas, driving down prices, which in turn contributed to a revival of the US manufacturing sector, especially the energy-intensive chemicals complex.[6]

By the end of the decade, IHS Energy expects 75% of US natural gas production to originate from unconventional sources. Natural gas demand in the coming decades is expected to be driven primarily by the power generation sector and by natural-gas intensive industries such as petrochemicals.

Technological advancements involving hydraulic fracturing used in the production of natural gas have been successfully transferred to unconventional oil formations. Unconventional or "tight" oil is crude oil and condensate produced from low permeability reservoirs, such as shale formations. According to IHS Energy, US production of unconventional oil is expected to increase from 2.07 MMb/d in 2012 to 5.43 MMb/d in 2025.[7]

As production of unconventional oil and natural gas expands over the next decades, economic investment by the oil and gas industry will also expand. The data and assumptions required to estimate the various economic contributions of unconventional oil and natural gas activity include upstream production profiles and the expected capital expenditures of upstream, midstream, and downstream energy companies. Capacity requirements for midstream and downstream activities such as oil pipelines and storage and natural gas processing plants are determined by upstream production. The capacity expansion necessary to support the unconventional oil and natural gas revolution estimated by IHS are detailed in the appendices.

Structure

The first section of the national assessment identifies the unconventional energy supply chain sectors. The main supplier industries were found among 56 North American Industry Classification System (NAICS) sectors, which were segmented into the following five broad groups: capital goods, construction and well services, logistics, materials, and professional and other services.

The second part of this section presents the economic contributions of the unconventional energy supply chain. The analysis presents aggregate and detailed results, at up to the 6-digit NAICS level, of the impact of the unconventional oil and gas activity on key supply chain industries.

6 EIA Annual Energy Outlook 2014.

7 Unconventional oil as used in this IHS report represents oil and condensate recovered from tight oil, shale gas and tight gas plays.

Defining the unconventional oil and natural gas supply chain

The unconventional oil and natural gas supply chain is far-reaching. Previous IHS analysis focused on a more aggregate definition of the unconventional supply chain whereas this analysis captures supply chain participants in more discrete component parts, namely 4-, 5-, and 6-digit NAICS codes (versus 2- and 3-digit NAICS codes measured in previous studies). The first step in preparing both the economic impact assessment, and subsequently the workforce analysis, was to identify 56 economic sectors up to the 6-digit NAICS code level that comprise the unconventional energy supply chain. IHS identified the supply chain sectors using information from multiple sources, including: 1) our extensive research of unconventional energy analysis in which we have assessed the purchasing relationships between the unconventional energy sector and the sectors that either supply goods and services to it, or purchase its energy products for use as inputs; 2) our experience in conducting other studies analyzing the economic impacts of energy development; 3) proprietary IHS databases and analysis across the energy value chain and supply chain sectors; 4) a literature review; and 5) discussions with representatives and members of the Energy Equipment & Infrastructure Alliance.

The sectors within the unconventional supply chain were assigned to one of five core groups:

1. **Capital goods**: Off-highway equipment and industrial machinery are widely used throughout the unconventional value chain, including construction and access machinery; pumps and compressors; power generators; and power boilers and heat exchangers. This group includes component suppliers to equipment manufacturers as well as equipment distributors and rental companies.

2. **Construction and well services**: Construction activity is present through all aspects of the unconventional energy value chain as well as the supplemental construction within oil and gas producing regions that is not associated with oil and gas operator capital expenditure and operating expenditure. Suppliers within this group include general and specialty contractors and building trades. Well services include well drilling and other oil and gas field services performed on a contract basis.

3. **Logistics:** The logistics transportation system supporting unconventional energy activity consists of road, rail, water, and pipeline transportation. While truck transportation is, and will continue to be, the main part of the unconventional energy supply chain logistics system, pipeline, water, and railway traffic are expected to increase in the coming years.

4. **Materials**: Within this group fall various raw materials producers such as steel and nonferrous metals; sand, gravel, and other aggregates; chemicals; and other value-added services such as metal fabrication and distribution. Key materials include oil country tubular good and other pipeline products, cement for well casing, and sand and chemicals associated with hydraulic fracturing. These raw materials are also critical inputs for finished and semi-finished supply chain goods such as the gears and forgings in machinery.

5. **Professional and other services**: Typically associated with operational expenditures, the wide range of professional and other services include environmental engineering; occupational health and safety; architectural and civil engineering services; and financial, insurance, and real estate services.

Unconventional energy supply chain sectors by core group (NAICS code)

Capital goods	
3331	Agriculture, Construction, and Mining Machinery Manufacturing
4231	Motor Vehicle and Motor Vehicle Parts
4238	Wholesale Machinery and Equipment
332410	Power Boiler and Heat Exchanger Manufacturing
332420	Metal Tank (Heavy Gauge) Manufacturing
333112	Lawn and Garden Tractor and Home Lawn and Garden Equipment Manufacturing
333515	Cutting Tool and Machine Tool Accessory Manufacturing
333611	Turbine and Turbine Generator Set Units Manufacturing
333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing
333613	Mechanical Power Transmission Equipment Manufacturing
333618	Other Engine Equipment Manufacturing
333911	Pump and Pumping Equipment Manufacturing
333912	Air and Gas Compressor Manufacturing
333922	Conveyor and Conveying Equipment Manufacturing
333991	Power-Driven Handtool Manufacturing
334419	Other Electronic Component Manufacturing
334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables
334514	Totalizing Fluid Meter and Counting Device Manufacturing
334516	Analytical Laboratory Instrument Manufacturing
334519	Other Measuring and Controlling Device Manufacturing
336112	Light Truck and Utility Vehicle Manufacturing
336120	Heavy Duty Truck Manufacturing
336510	Railroad Rolling Stock Manufacturing
Construction and well services	
23[t]	Construction of New Nonresidential Manufacturing Structures
23[tt]	Construction of Other New Nonresidential Structures
213111	Drilling Oil and Gas Wells
213112	Support Activities for Oil and Gas Operations
Logistics	
483	Water Transportation
4821	Rail Transportation
4841	General Freight Trucking
486	Pipeline Transportation
Materials	
444	Retail Building Material and Garden Supply Sector
3312	Steel Product Manufacturing from Purchased Steel
4233	Wholesale Lumber and Construction Materials
4235	Wholesale Metal and Mineral
4236	Wholesale Electrical Goods
4237	Wholesale Hardware, Plumbing, and Heating Equipment
4246	Wholesale Chemical and Allied Products
212321	Construction Sand and Gravel Mining
325120	Industrial Gas Manufacturing
325180	Other Basic Inorganic Chemical Manufacturing
327310	Cement Manufacturing
327320	Ready-mix Concrete Manufacturing
327331	Concrete Block and Brick Manufacturing
331110	Iron and Steel Mills and Ferroalloy Manufacturing
331315	Aluminum Sheet, Plate, and Foil Manufacturing
332996	Fabricated Pipe and Pipefitting Manufacturing
Professional and other services	
2213	Water, Sewage and Other Systems
4931	Warehousing and Storage
5241	Insurance Carriers
5413	Architectural, Engineering, and Related Services
5419	Other Professional, Scientific, and Technical Services
532412	Construction, Mining and Forestry Machinery and Equipment Rental and Leasing
562219	Other Nonhazardous Waste Treatment and Disposal
811310	Commercial and Industrial Machinery and Equipment (Except Automotive and Electronic) Repair and Maintenance

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Results are presented by these core supply chain groupings at the national level later in this section. Results by core groups will be presented at the state level in a later section.

Economic contribution assessment

This section of the report will present the economic contribution assessment of the supply chain industries due to the unconventional energy activity value chain including upstream, midstream, and downstream sectors. The results will be presented in aggregate for employment and labor income, and each of them will be analyzed in the context of the national economy across the supply chain of the unconventional activity. The results will be presented for the sum of the direct and indirect contributions, which are defined as follows:

Direct Impacts: The direct contribution is the effect of the core industry's output, employment, and income. For example, unconventional oil and gas direct contributions in upstream, midstream processes, and downstream elements are generated by increased capital expenditures and production or operating expenditure. These activities directly contributed not only through production activity (operating activity), but also through broader expenditures on capital goods and facilities. These sectors are directly involved in unconventional oil and natural gas activities, such as upstream exploration and production companies, midstream processing and pipeline transportation companies, downstream local distribution companies, and their onsite construction service providers. The total number of jobs directly attributable to unconventional oil and gas are in exploring, producing, transporting, storing and delivering oil and gas to consumers or in providing critical supplies or onsite services to the industry.

Indirect Impacts: Purchasing patterns of unconventional oil and gas indirectly contribute to all of its supplier industries. Changes in demand from the direct industries lead to corresponding changes in output, employment, and labor income throughout their supply chains via inter-industry linkages. The affected supplier activities span the majority of US industries.

Methodology

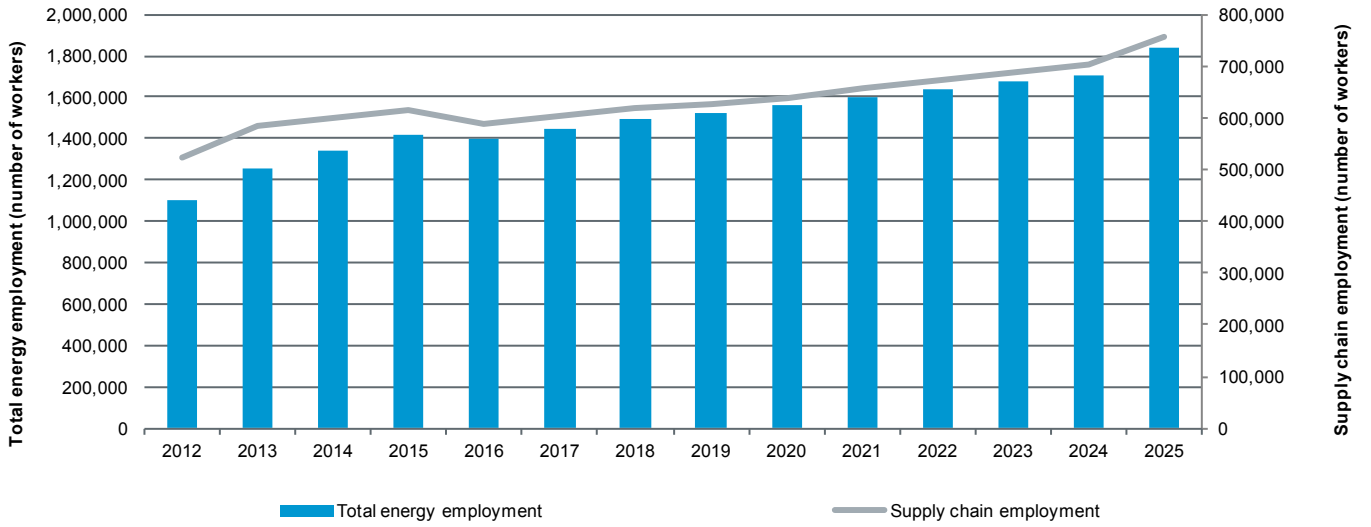
Using data and analysis from proprietary databases and the IMPLAN model, IHS evaluated the changes in upstream and midstream activities within the context of a customized industrial structure of the US economy. The data categories in the model were tailored based on the unique mix of equipment, materials, and services that characterize the unconventional oil and gas value chain, for which IHS developed modified production functions that are customized for unconventional activity. The economic impact is measured in terms of jobs created or sustained and employee wages and compensation. IHS linked the static IMPLAN model to its dynamic US macroeconomic model in order to augment the static determination of employment impacts and income effects with a comprehensive dynamic modeling methodology. Both models were run using the initial set of input assumptions to produce direct and indirect contributions. A baseline macroeconomic forecast of the US economy was used to assess the contribution of the unconventional oil and natural gas value chain.

Economic contribution assessment results

Employment contributions

The employment contribution across the supply chain industries is expected to increase at an annual compound growth rate of 2.9% between 2012 and 2025, going from 524,000 jobs in 2012 to more than 757,000 jobs in 2025.

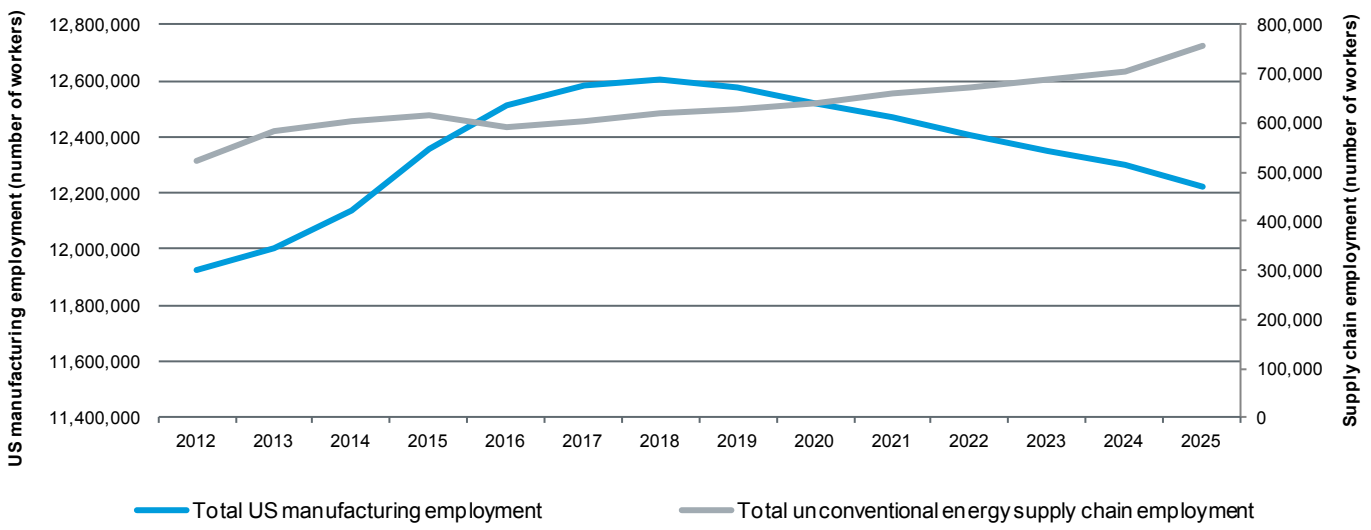
Total employment supported by unconventional activity



Source: IHS Economics

While US manufacturing employment has declined over the last several decades, these findings suggest that the manufacturing sectors within the unconventional supply chain are bucking this trend.

Total US manufacturing employment vs. unconventional energy supply chain employment



Source: IHS Economics

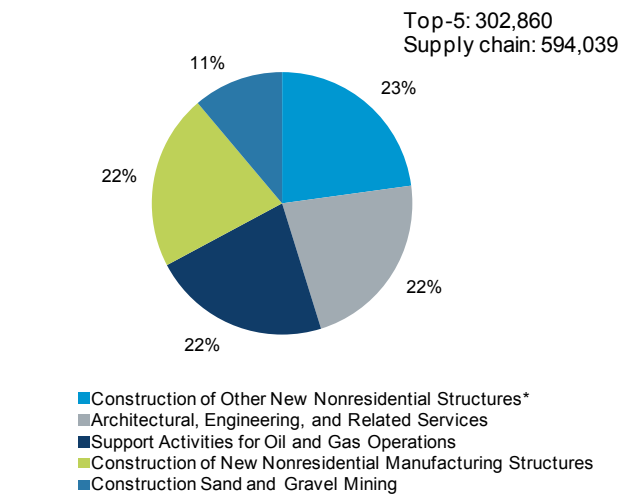
The top five supply chain industries that gained the largest number of jobs from unconventional activity are concentrated in the construction and well services and materials core groups:

- Construction of Other New Nonresidential Structures (part of NAICS 23—construction of upstream facilities and structures)
- Architectural, Engineering, and Related Services (NAICS 5413)
- Support Activities for Oil and Gas Operations (NAICS 213112)
- Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures)
- Construction Sand and Gravel Mining (NAICS 212321)

IHS estimates that in 2014 these top-5 industries will account for more than 300,000 jobs, or 60% of the total number of jobs across the supply chain supported by the unconventional oil and gas industry.

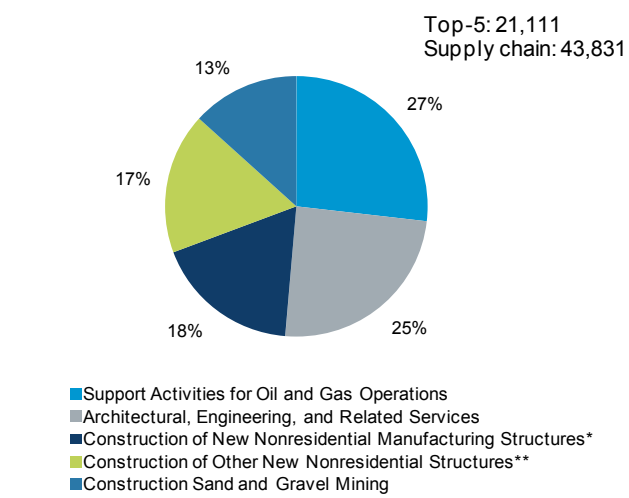
IHS found more than 1.1 million US jobs attributable to the direct and indirect contribution from the entire unconventional oil and natural gas value chain in 2012. By 2015, the resulting employment is expected to increase to more than 1.4 million jobs, and by 2025, to 1.8 million. The supply chain employment represents between 40% and 47% of the total employment from unconventional activity, which includes the upstream, midstream, and downstream segments, from 2012 to 2025.

Employment distribution of top-5 sectors, 2014



Source: IHS Economics

Labor income distribution of top-5 sectors, 2014



Source: IHS Economics

Top-15 sectors: US unconventional energy supply chain employment*
(Number of workers)

		2012	2015	2020	2025	CAGR**
23[t]	Construction of Other New Nonresidential Structures	58,806	74,333	82,577	103,299	4.4%
5413	Architectural, Engineering, and Related Services	57,770	67,878	67,523	77,603	2.3%
213112	Support Activities for Oil and Gas Operations	54,757	72,351	87,337	108,828	5.4%
23[tt]	Construction of New Nonresidential Manufacturing Structures	74,362	50,343	16,709	13,414	-12.3%
212321	Construction Sand and Gravel Mining	28,228	36,434	42,197	49,944	4.5%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	27,460	36,225	42,287	50,435	4.8%
4841	General Freight Trucking	24,139	32,079	37,724	44,545	4.8%
4238	Wholesale Machinery and Equipment	17,449	24,339	28,903	33,742	5.2%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	18,155	21,832	21,818	25,382	2.6%
3312	Steel Product Manufacturing from Purchased Steel	14,662	16,192	15,175	17,814	1.5%
213111	Drilling Oil and Gas Wells	12,917	17,526	21,176	26,558	5.7%
2213	Water, Sewage and Other Systems	12,769	16,243	18,046	21,474	4.1%
332410	Power Boiler and Heat Exchanger Manufacturing	13,860	10,712	4,159	3,876	-9.3%
333912	Air and Gas Compressor Manufacturing	10,079	13,318	15,566	18,566	4.8%
332996	Fabricated Pipe and Pipefitting Manufacturing	9,219	11,497	12,673	14,872	3.7%
Top-15 total		**434,632**	**501,304**	**513,870**	**610,352**	**2.6%**
US total		**524,413**	**615,910**	**638,762**	**757,802**	**2.9%**

*The ranking for all years are based on employment in 2014.

** Compound annual growth rate from 2012 to 2025.

t Construction of upstream facilities and structures.

tt Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Source: IHS Economics

Labor income contribution

IHS estimated labor income for *all unconventional oil and gas activity* at more than $97 billion in 2012, or about $88,000 per employee. This increases to nearly $92,000 in 2015 and just over $93,700 in 2020, and then flattens out for the reminder of the forecast period. The supply chain industries also have relatively high labor income. Labor income per employee in the supply chain industries averages roughly $79,000 throughout the forecast period.

US unconventional energy supply chain contribution per employee

	2012	2015	2020	2025
Gross output (2012 $)				
Supply chain total	277,799	281,733	282,766	271,716
Energy activity total	313,554	326,616	330,738	317,671
Labor income (2012 $)				
Supply chain total	78,210	79,419	80,439	78,520
Energy activity total	88,400	92,018	93,733	91,667

Source: IHS Economics

Top-15 sectors: US unconventional energy supply chain labor income*
(2012 $M)

		2012	2015	2020	2025	CAGR**
213112	Support Activities for Oil and Gas Operations	5,075	6,680	8,027	9,696	5.1%
5413	Architectural, Engineering, and Related Services	4,695	5,504	5,481	6,203	2.2%
23[t]	Construction of New Nonresidential Manufacturing Structures	4,299	2,899	957	766	-12.4%
23[tt]	Construction of Other New Nonresidential Structures	3,399	4,280	4,733	5,730	4.1%
212321	Construction Sand and Gravel Mining	2,561	3,293	3,796	4,351	4.2%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	1,883	2,475	2,875	3,320	4.5%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	1,861	2,225	2,217	2,502	2.3%
4238	Wholesale Machinery and Equipment	1,365	1,886	2,212	2,543	4.9%
213111	Drilling Oil and Gas Wells	1,365	1,845	2,219	2,693	5.4%
3312	Steel Product Manufacturing from Purchased Steel	1,377	1,519	1,400	1,593	1.1%
4841	General Freight Trucking	1,276	1,690	1,978	2,287	4.6%
2213	Water, Sewage and Other Systems	1,323	1,677	1,855	2,136	3.8%
332410	Power Boiler and Heat Exchanger Manufacturing	1,116	875	334	295	-9.7%
333912	Air and Gas Compressor Manufacturing	947	1,247	1,451	1,676	4.5%
333911	Pump and Pumping Equipment Manufacturing	594	780	904	1,043	4.4%
Top-15 total		**33,135**	**38,874**	**40,439**	**46,836**	**2.7%**
US total		**41,015**	**48,915**	**51,381**	**59,502**	**2.9%**

*The ranking for all years are based on labor income in 2014.

** Compound annual growth rate from 2012 to 2025.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Employment contributions are spread across the entire supply chain of the unconventional oil and gas industry. For instance, an oil drilling company needs to buy or rent heavy machinery and equipment. To meet this demand, heavy machinery and equipment manufacturers will hire more workers and buy additional parts from their suppliers such as hydraulic motors, cylinders, pumps, and engines. In turn, these suppliers will have to expand to meet this demand from upstream operators. All these changes in spending and the associated number of workers are considered indirect effects.

The main supplier industries are summarized by the following five core groups:

- Capital goods
- Construction and well services
- Logistics
- Materials and supplies
- Professional services

Gross output contributions

The unconventional supply chain contributed nearly $146 billion to the US economy in 2012 and will contribute nearly $206 billion by 2025, as measured by these industries' gross output. Gross output is an industry's value of goods and services produced.

The economic value of the supply chain industries, as measured by gross output, accounts for roughly 0.5% of US total gross output throughout the forecast period.

Worker productivity across the unconventional supply chain is computed as the ratio of total gross output to employment. This indicates the relative contribution of each industry; a higher productivity measure implies a higher efficiency and a higher contribution to total US gross output. Support services for oil and gas operations in the supply chain industries contribute the most to total US gross output. Average worker productivity across the supply chain is estimated at around $278,000 per year throughout the forecast period 2012–25.

Top-15 sectors: US unconventional energy supply chain gross output*
(2012 $M)

		2012	2015	2020	2025	CAGR**
213112	Support Activities for Oil and Gas Operations	21,415	28,271	33,851	40,217	5.0%
23t	Construction of New Nonresidential Manufacturing Structures	13,990	9,794	3,113	2,477	-12.5%
3312	Steel Product Manufacturing from Purchased Steel	9,901	10,739	9,526	10,588	0.5%
213111	Drilling Oil and Gas Wells	8,646	11,657	13,977	16,641	5.2%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	8,506	10,402	10,715	11,976	2.7%
5413	Architectural, Engineering, and Related Services	8,376	9,578	8,941	9,868	1.3%
23tt	Construction of Other New Nonresidential Structures	8,139	10,237	11,324	13,463	3.9%
212321	Construction Sand and Gravel Mining	6,164	7,895	9,058	10,174	3.9%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	5,348	6,290	6,461	7,254	2.4%
333912	Air and Gas Compressor Manufacturing	5,197	6,819	7,900	8,957	4.3%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	4,571	5,977	6,909	7,819	4.2%
325120	Industrial Gas Manufacturing	3,468	4,610	5,411	6,144	4.5%
4841	General Freight Trucking	3,273	4,230	4,827	5,461	4.0%
332410	Power Boiler and Heat Exchanger Manufacturing	3,426	2,678	1,048	942	-9.5%
4238	Wholesale Machinery and Equipment	3,023	3,975	4,339	4,857	3.7%
Top-15 total		**113,443**	**133,151**	**137,400**	**156,838**	**2.5%**
US total		**145,681**	**173,522**	**180,620**	**205,907**	**2.7%**

*The ranking for all years are based on gross output in 2014.

** Compound annual growth rate from 2012 to 2025.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Top-5 sectors: US unconventional energy supply chain
Worker productivity - gross output per employee (2012 $)

		2012	2015	2020	2025
3312	Steel Product Manufacturing from Purchased Steel	675,309	663,219	627,700	594,360
213111	Drilling Oil and Gas Wells	669,355	665,145	660,029	626,609
3331	Agriculture, Construction, and Mining Machinery Manufacturing	468,551	476,471	491,124	471,826
213112	Support Activities for Oil and Gas Operations	391,091	390,741	387,596	369,543
23t	Construction of New Nonresidential Manufacturing Structures	188,136	194,546	186,301	184,640
Supply chain total		**277,799**	**281,733**	**282,766**	**271,716**
Energy activity total		**313,554**	**326,616**	**330,738**	**317,671**

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and and manufacturing structures.

Source: IHS Economics

Government revenue

Activity in the unconventional energy supply chain will contribute to the amount of federal, state, and local personal and corporate taxes paid by the supply chain firms and their employees. IHS estimates that total government revenues generated by unconventional supply chain activity will increase from more than $13 billion in 2012 to more than $16 billion in 2015 and about $23 billion in 2025.

US unconventional energy supply chain government tax revenue
(Current $M)

	2012	2015	2020	2025	CAGR*
Federal personal and corporate taxes	7,417	9,126	10,450	12,690	4.2%
State and local taxes personal and corporate taxes	5,710	7,177	8,298	10,038	4.4%
US supply chain government revenue total	13,127	16,303	18,748	22,728	4.3%

*Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Economic contribution assessment by core group

As previously discussed, we identified and analyzed 56 NAICS sectors affected by the unconventional oil and gas supply chain. These sectors were divided into the following five core groups for analysis:

- Capital goods
- Construction and well services
- Logistics
- Materials
- Professional services

This section analyzes these core groups in terms of their contributions to employment, gross output, and labor income.

Capital goods

Capital goods are ubiquitous throughout the supply chain and are the most illustrative example of how unconventional oil and gas spending impacts all 48 producing and nonproducing states analyzed in this study. These impacts run throughout the energy value chain and reach deep into the various equipment sectors responsible for the manufacturing of capital goods.

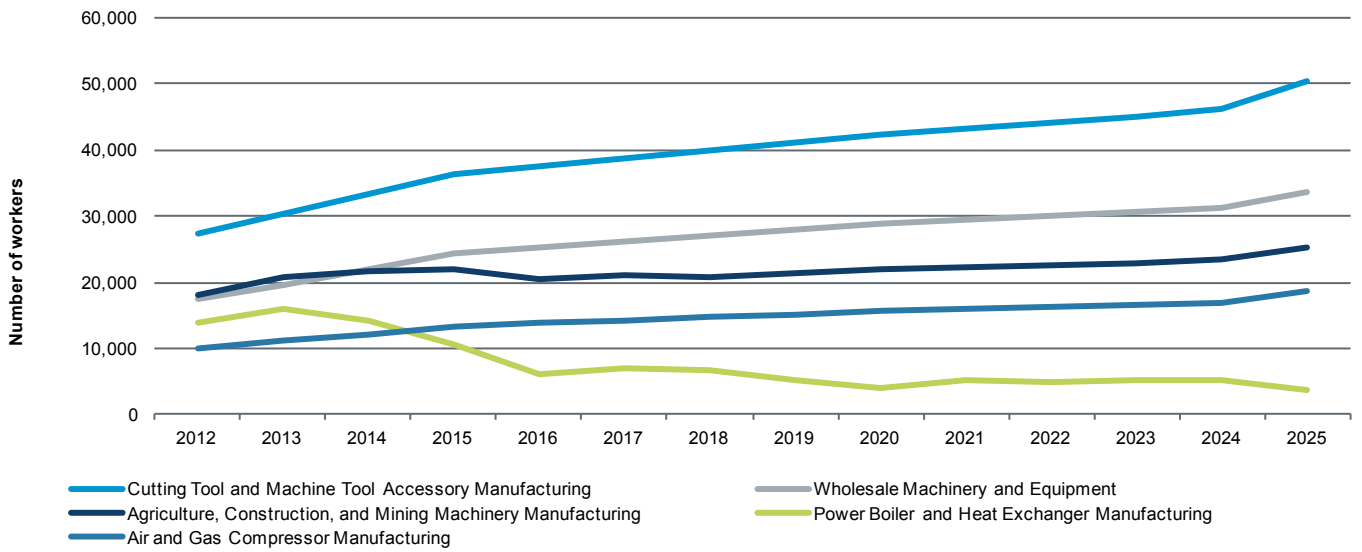
Cutting Tool and Machine Tool Accessory Manufacturing (NAICS 333515), the largest capital goods sector of the supply chain, is forecast to increase from 27,000 workers

in 2012 to more than 50,000 in 2025. This sector, together with Agriculture, Construction, and Mining Machinery Manufacturing (NAICS 3331), is the largest contributor in terms of labor income; their combined contribution is estimated at almost $3.7 billion in 2012 and $5.87 billion in 2025.

Wholesale Machinery and Equipment (NAICS 4238) is projected to increase employment supported by the unconventional activity from a little more than 17,000 workers in 2012 to about 34,000 in 2025, or a compound annual growth rate of 5%.

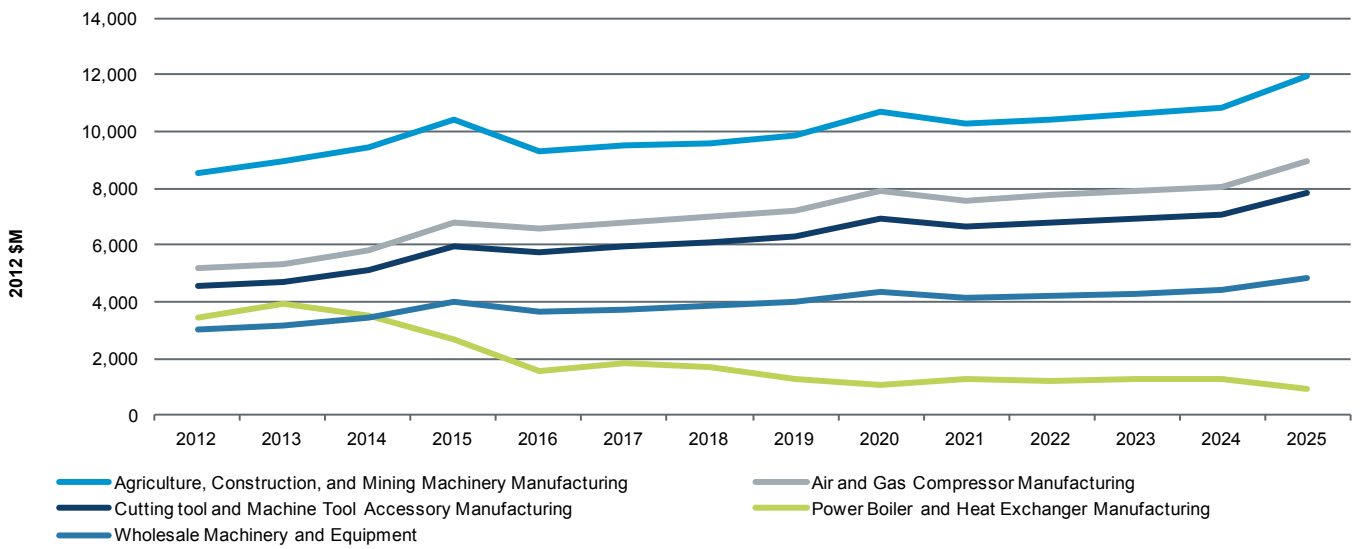
Unconventional oil and gas activity is creating demand for these goods not only in the upstream operations but also within the transport of oil and gas. For example, railcars producers are currently faced with a two-year backlog, and IHS expects heavy truck demand from the oil and gas industry to drive overall truck growth higher for 2014. While prior IHS studies of unconventional oil and gas impacts did not examine the economic effects on railcar and work producers, the intrinsic importance of these sectors to the supply chain warrant a deeper look at how the unconventional revolution is affecting the manufacturers of these capital goods that support oil and gas logistics.

Capital goods: Top-5 supply chain sectors employment



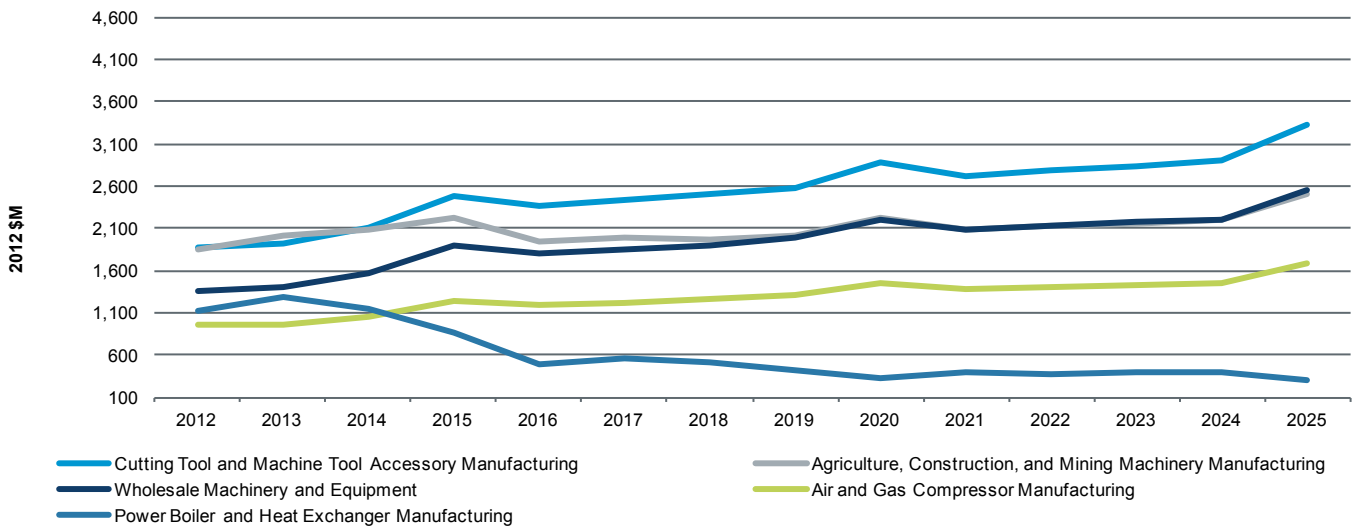
Source: IHS Economics

Capital goods: Top-5 supply chain sectors gross output



Source: IHS Economics

Capital goods: Top-5 supply chain sectors labor income



Source: IHS Economics

Railcar manufacturing

The flexibility of rail transport and lagging development of pipeline infrastructure has led to a surge in crude oil shipments by rail. Most crude-by-rail movements in the United States originate in North Dakota and are directed toward refineries on the Gulf Coast and East Coast. In 2008, US Class I railroads originated 9,500 carloads of crude oil. In 2013, the industry originated an estimated 400,000 carloads, according to the Association of American Railroads. In early 2014, the Bakken Shale oil output was more than 1.1 million barrels per day (mbd), up from 727,220 in April 2013; according to the North Dakota Pipeline Authority, approximately 60% of crude oil production was transported by rail, or about 700,000 barrels per day. In addition to crude oil transport, railroads also carry the supplies needed for hydraulic fracturing, including frack sand, steel tube, chemicals, and post-extraction waste.

Railcar manufacturers have responded to the increased demand for tank railcars by increasing production and opening new manufacturing shops. Using research by IHS Energy on the North American fleet of tank cars allocated to crude oil, we estimated the value of the additional tank cars that will be manufactured in the United States to support crude-by-rail movement over the next 5 years. IHS Energy estimates that after 2017, the incremental demand for tank cars will primarily be related to annual scrapping replacement of around 2.5% on average of the entire fleet each year.[8]

The production of tank cars was allocated to the US manufacturing facilities of the top-four North American manufacturers, which represent more than 90% of the new builds in the United States: Trinity Industries, Greenbrier, American Rail Industries, and UTLX—Tank Car Union. The incremental investments in tank cars have direct and indirect economic impacts on the US economy. Contributions to US employment supported by rail manufacturing activity are estimated at more than 4,000 jobs in 2014 and 2015, dropping to 2,000 jobs in 2016 and leveling off at around 550 jobs thereafter.

US Railroad Rolling Stock Manufacturing contribution

	2012	2015	2020	2025
Employment (Number of workers)	4,745	4,334	555	576
Labor income (2012 $M)	370	338	45	47
Gross output (2012 $M)	1,682	1,541	220	228

Source: IHS Economics

8 The Federal Pipeline and Hazardous Materials Safety Administration and Federal Railroad Administration have issued a Notice of Proposed Rulemaking that proposes changes to the operation and tank car design requirements for carrying crude oil and ethanol on the rails. For this analysis, IHS employed a status quo assumption for tank car design requirements.

"Unconventional oil and gas development is having a tremendous positive impact on the growth of both rail car manufacturing and demand for rail transport capacity. Crude by rail has seen unprecedented growth, and the projections are for continued major increases. Rail shipments of oil and gas production supplies such as frack sand and pipe are adding even more to demand. This is a brand new business that didn't exist in 2009, and now it is one of the industry's biggest drivers. In fact it is picking up a good bit of the slack created by lower coal shipments. We also see energy-related rail transport between the U.S. and both Canada and Mexico as a strong growth area." Tony Hatch, ABH Consulting

Heavy trucks manufacturing

IHS expects continued growth within the commercial truck sector through 2025. Expansion of oil and gas development and increased construction activity are two key end markets that will sustain commercial truck demand, particularly the heavy-duty truck segment. The unconventional supply chain uses commercial trucks in myriad ways, from the transport of drilling raw materials such as water and sand to trucks modified to carry the other capital goods used in extraction and processing.

Using our proprietary databases Business Market Insight (BMI) and Equipment Market Monitor (EMM), we estimated the manufacturing investments in transportation equipment for heavy truck supported by the US oil and gas industry. The BMI provides data on manufacturing of heavy-duty trailers and trucks by state while EEM provides data on the end market for heavy-duty trucks and trailers. We proceeded to estimate the manufacturing investments for heavy trucks and trailers by state in two steps.

First, we estimated the share of the heavy truck and truck trailer equipment used by the oil and gas industry as well as the industries supporting the drilling activities in total industry by state using EEM. Second, the shares by state higher than 1% were applied to total heavy trucks and trailers manufacturing from BMI. We used the IMPLAN model framework to establish a system of linked state economies to estimate the economic contributions of the investment outlook in trucks and truck trailers manufacturing. The seven states (California, Kentucky, Louisiana, Ohio, Oklahoma, Pennsylvania, and Texas) identified by the BMI and EEM databases as containing the main manufacturing facilities were directly impacted by inputting the values of the manufacturing investment over the period analyzed. The remaining lower-41 states experience only indirect (supply chain) effects as determined by the multi-regional analysis of the IMPLAN model.

Not surprisingly, the leading states for heavy truck and trailer manufacturing are the states that are home to the nameplate makers within the industry. For example, Peterbuilt assembly is located in Denton, Texas; Mack Trucks is located in Macungie, Pennsylvania; and Navistar is located in both Oklahoma and Texas.

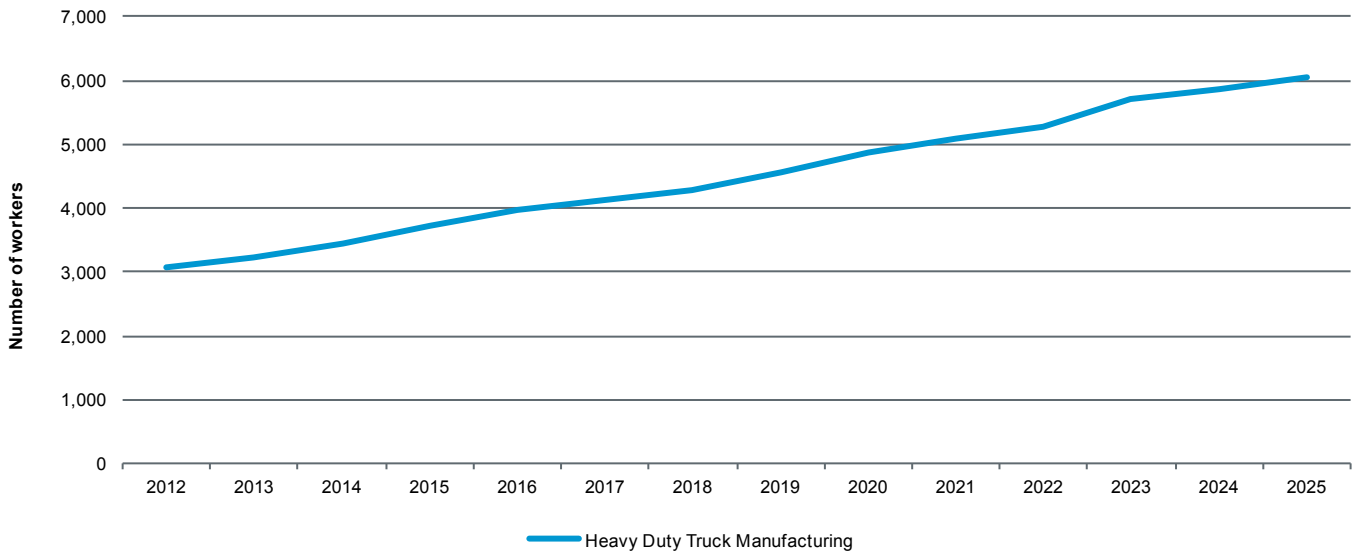
US Heavy Duty Truck Manufacturing contribution

	2012	2015	2020	2025
Employment (Number of workers)	3,088	3,741	4,862	6,061
Labor income (2012 $M)	280	364	364	455
Gross output (2012 $M)	1,163	1,425	1,853	2,323

Source: IHS Economics

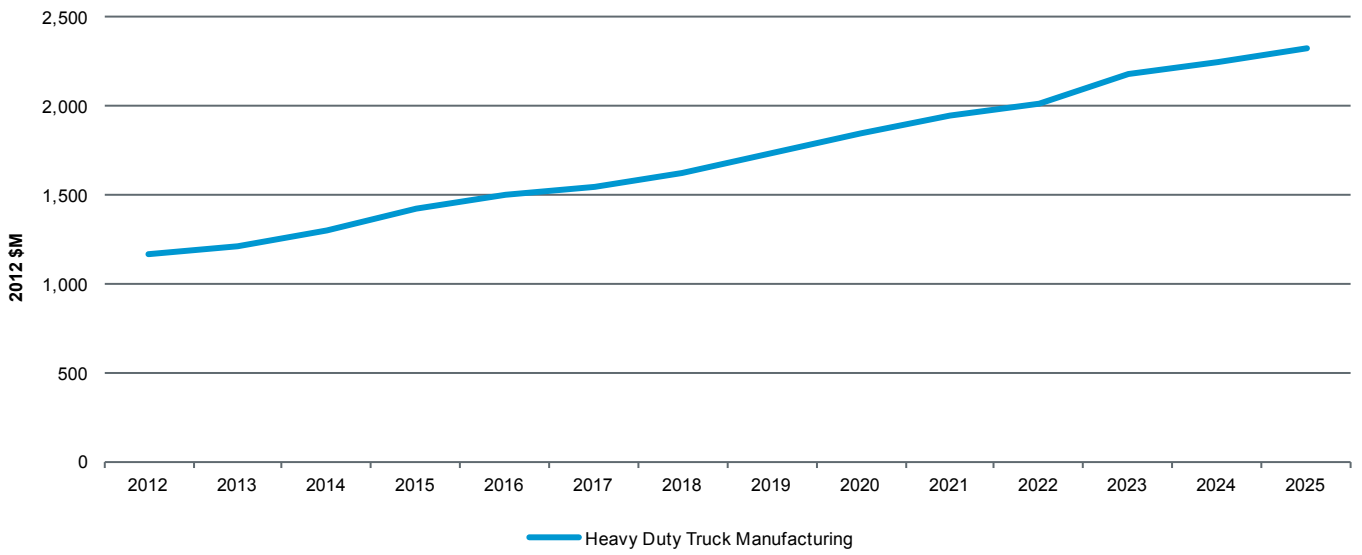
The contribution of the heavy-duty truck manufacturing in terms of total employment is estimated to increase from more than 3,000 jobs in 2012 to about 6,000 jobs in 2025. In terms of gross output, the contributions across the country will increase from $1.1 billion in 2012 to more than $2.3 billion in 2025.

Capital goods: Heavy Duty Truck Manufacturing Employment



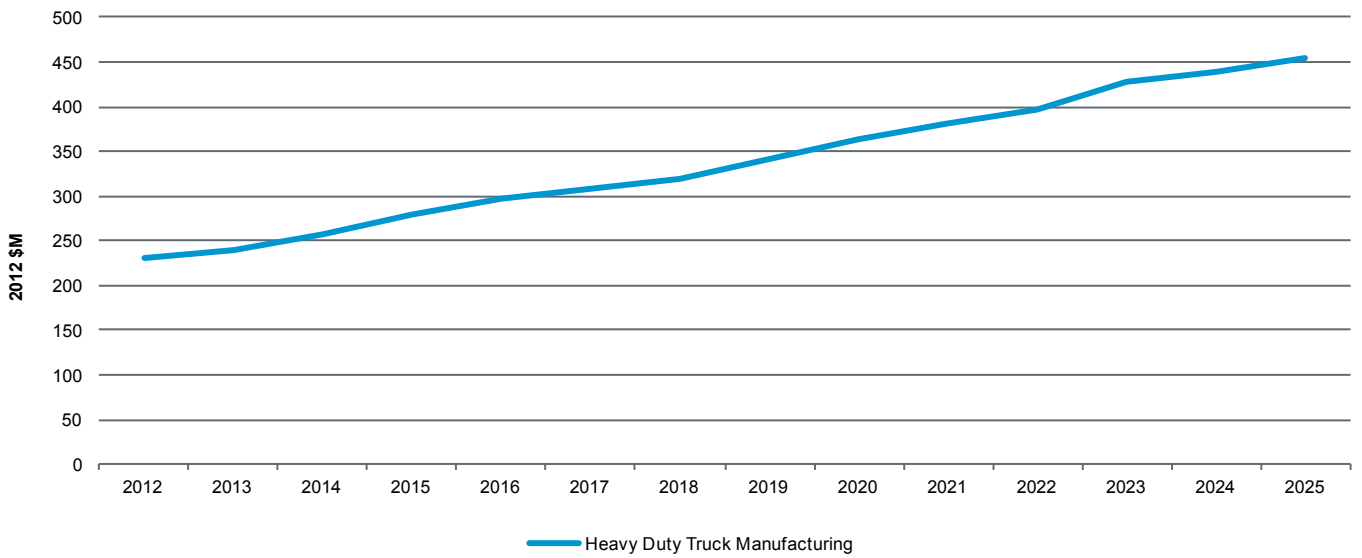
Source: IHS Economics

Capital goods: Heavy Duty Truck Manufacturing Gross output



Source: IHS Economics

Capital goods: Heavy Duty Truck Manufacturing Labor income



Source: IHS Economics

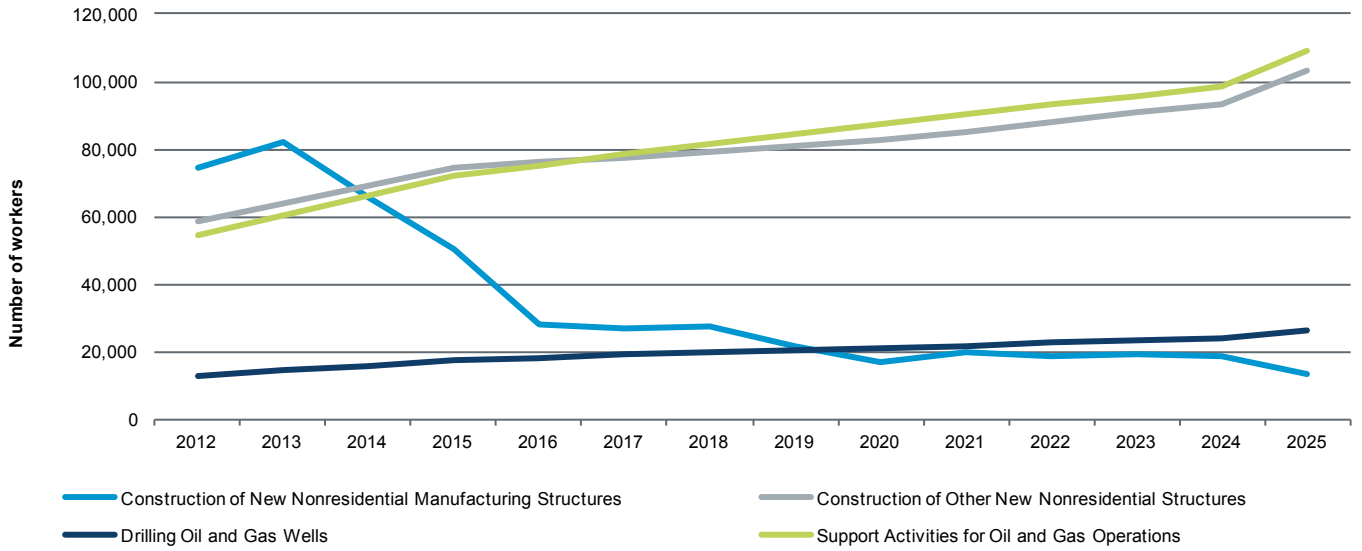
Construction and well services

The construction and well services group includes only four unconventional supply chain sectors: Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures), Construction of Other New Nonresidential Structures (part of NAICS 23—construction of upstream facilities and structures), Drilling Oil and Gas Wells (NAICS 213111), and Support Activities for Oil and Gas Operations (213112).

Although strong at the beginning of the forecast period, employment and output in Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures) are expected to decline later in the forecast period as necessary structures and infrastructure are completed. The expansion in construction activity peaks in the first half of the forecast period; however, investment in construction and the subsequent economic contributions it generates will continue at a high level throughout the rest of the period, albeit at a slower pace. On the other hand, Support Activities for Oil and Gas Operations (NAICS 213112) will experience strong employment and output growth. This is not surprising, since the sector is highly correlated to upstream unconventional activity, which is expected to

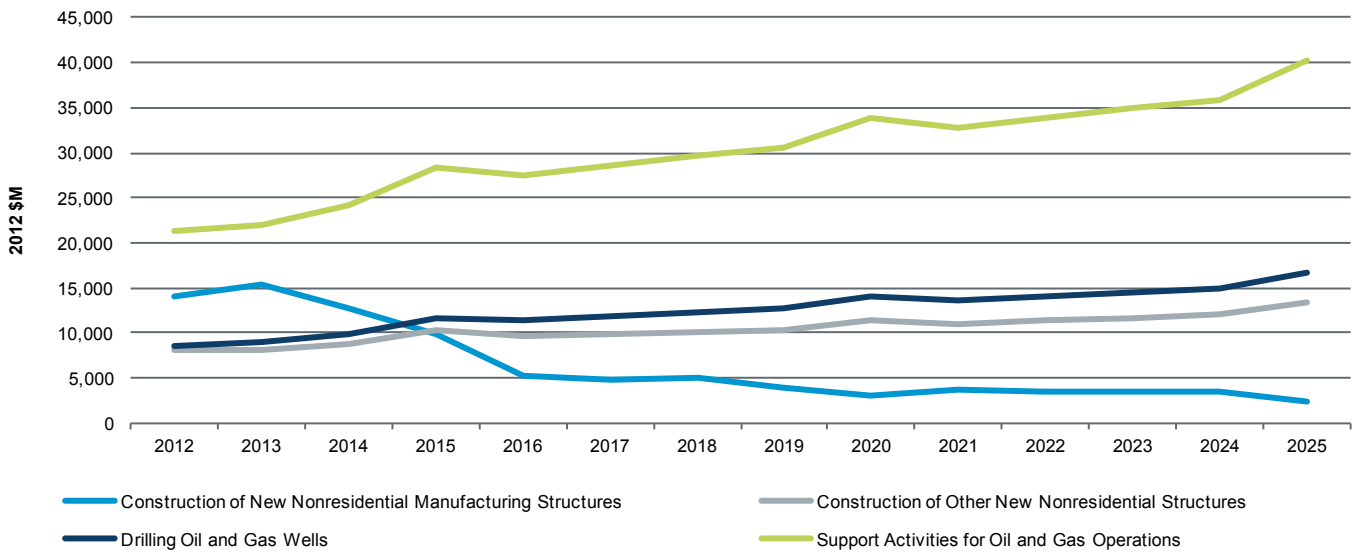
increase. Between 2012 and 2025, total employment in Support Activities for Oil and Gas Operations (NAICS 213112) will increase from 54,000 workers to more than 108,000 workers, a 5% annual growth rate. The sector is expected to add almost $19 billion in gross output over the forecast period.

Construction and well services
Supply chain sectors employment



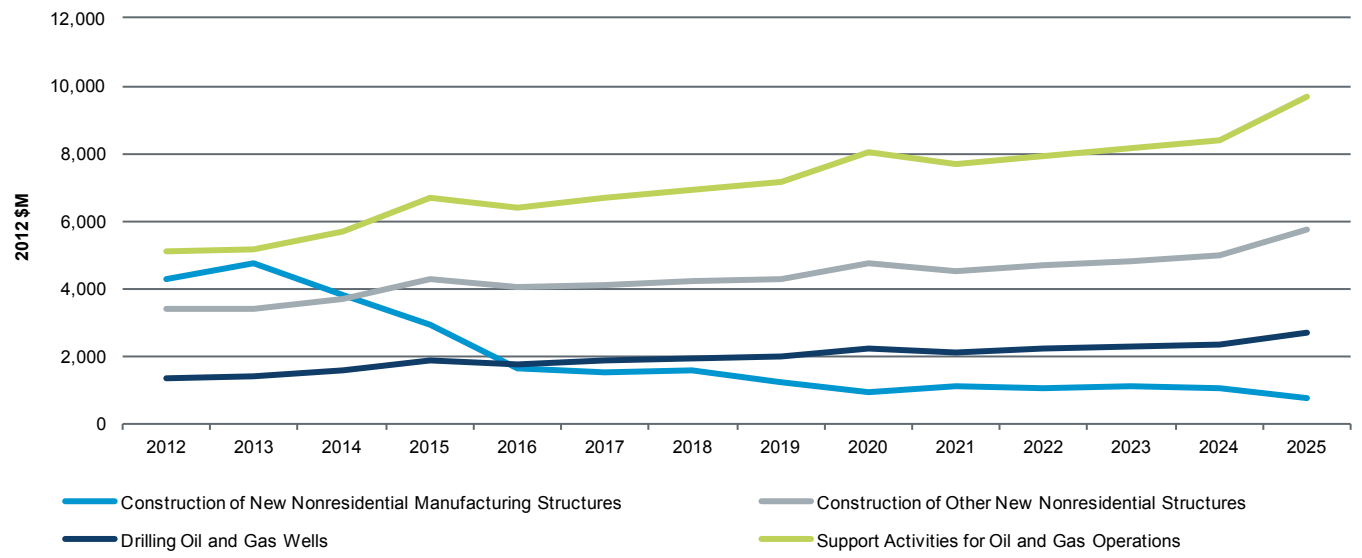
Source: IHS Economics

Construction and well services
Supply chain sectors gross output



Source: IHS Economics

Construction and well services
Supply chain sectors labor income



Source: IHS Economics

"In recent years North Dakota has had a strong economy while much of the U.S. has struggled. Part of this is due to the strong performance of established industries in the state like ranching, grain farming and coal. However, the development of the Bakken Shale formation has been the fundamental driving force in the rapid and sustained growth of the State's capital stock and specifically in the amount of rental equipment working in North Dakota. We have experienced multiple years of double digit growth in our rental fleet that is only constrained by our access to capital. Simply put, the sky is the limit!" Mark Gilbertson, Owner, Fargo Rentall, Fargo, ND, and Chairman of the American Rental Association Construction and General Tool Shared Interest Group.

Construction activity related to the unconventional energy supply chain is represented by two NAICS sectors, both part of NAICS 23:

1. Construction of Other New Nonresidential Structures, which represents construction of upstream facilities and structures; and

2. Construction of New Nonresidential Manufacturing Structures, which represents construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

The economic contributions of these two construction sectors peak during the first half of the forecast period; once required capacity has been added, construction activity related to unconventional activity will increase at a slower rate through 2025. Total employment in the unconventional energy supply chain construction sectors is estimated at more than 133,000 workers in 2012 and is expected to reach more than 116,000 workers in 2025. Gross output and labor income contributions will follow a similar pattern; output will reach almost $16 billion in 2025, while labor income is expected to reach $6.5 billion in 2025.

US unconventional energy supply chain construction and well services: Gross output
(2012 $M)

	2012	2015	2020	2025
Construction services				
Upstream construction	8,139	10,237	11,324	13,463
Construction of pipelines	4,655	2,073	889	754
Construction of rail	539	288	49	39
Construction of marine structures	659	531	123	69
Construction of storage facilities	297	625	149	97
Construction of LNG export facilities*	1,138	2,492	558	402
Construction of manufacturing structures	6,702	3,785	1,345	1,116
Construction services total	**22,129**	**20,031**	**14,437**	**15,940**
Well services				
Drilling Oil and Gas Wells	8,646	11,657	13,977	16,641
Support Activities for Oil and Gas Operations	21,415	28,271	33,851	40,217
Well services total	30,061	39,928	47,828	56,858
US total	**52,190**	**59,959**	**62,265**	**72,798**

*Estimates based on current projects in Texas and Louisiana and do not include proposed projects that are subject to additional approvals.

Source: IHS Economics

US unconventional energy supply chain construction and well services: Employment
(Number of workers)

	2012	2015	2020	2025
Construction services				
Upstream construction	58,806	74,333	82,577	103,299
Construction of pipelines	25,882	10,342	4,872	4,158
Construction of rail	2,498	1,343	232	193
Construction of marine structures	3,559	2,783	647	366
Construction of storage facilities	1,729	3,518	861	549
Construction of LNG export facilities*	6,514	14,268	3,121	2,248
Construction of manufacturing structures	34,179	18,089	6,975	5,900
Construction services total	**133,167**	**124,676**	**99,286**	**116,713**
Well services				
Drilling Oil and Gas Wells	12,917	17,526	21,176	26,558
Support Activities for Oil and Gas Operations	54,757	72,351	87,337	108,828
Well services total	67,674	89,878	108,513	135,386
US total	**200,842**	**214,554**	**207,799**	**252,099**

*Estimates based on current projects in Texas and Louisiana and do not include proposed projects that are subject to additional approvals.

Source: IHS Economics

Unconventional energy supply chain construction and well services: Labor income
(2012 $M)

	2012	2015	2020	2025
Construction services				
Upstream construction	3,399	4,280	4,733	5,730
Construction of pipelines	1,443	595	274	234
Construction of rail	160	89	14	12
Construction of marine structures	217	181	41	23
Construction of storage facilities	95	208	49	32
Construction of LNG export facilities*	359	792	176	126
Construction of manufacturing structures	2,026	1,034	403	340
Construction services total	**7,698**	**7,179**	**5,690**	**6,496**
Well services				
Drilling Oil and Gas Wells	1,365	1,845	2,219	2,693
Support Activities for Oil and Gas Operations	5,075	6,680	8,027	9,696
Well services total	6,440	8,525	10,246	12,389
US total	**7,698**	**7,179**	**5,690**	**6,496**

*Estimates based on current projects in Texas and Louisiana and do not include proposed projects that are subject to additional approvals.

Source: IHS Economics

Logistics

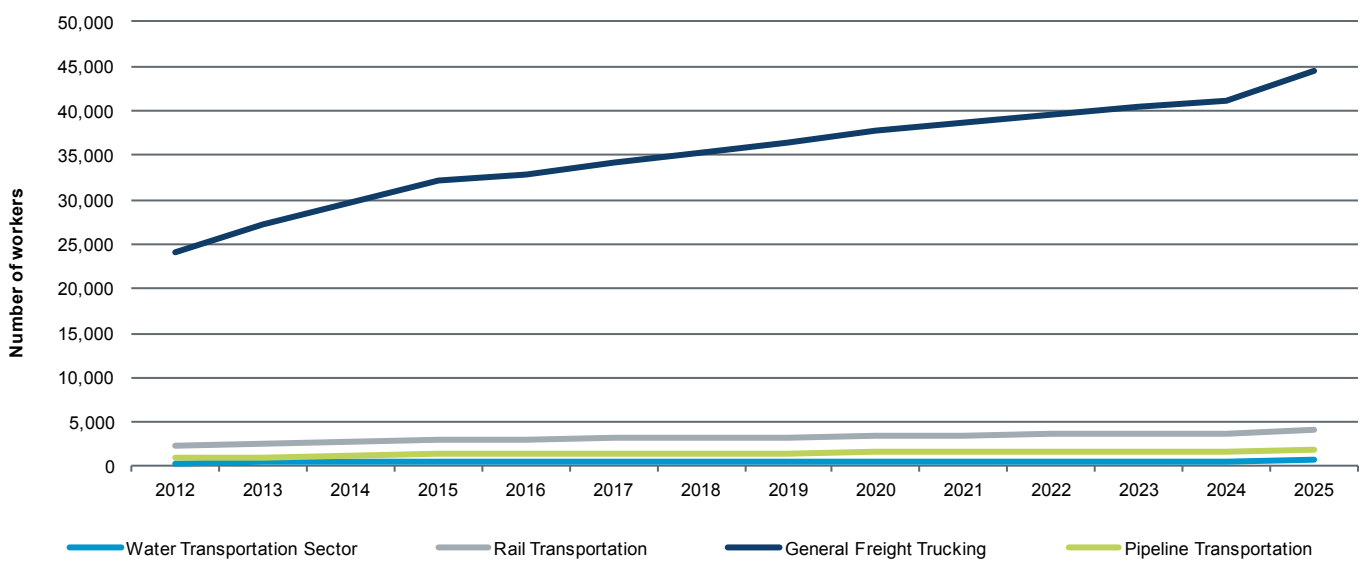
Within the logistics core group, the General Freight Trucking (NAICS 4841) sector gains the largest employment contributions stemming from the unconventional value chain activity. The total number of workers is estimated to increase from more than 24,000 in 2012 to 32,000 workers in 2015, then reach almost 45,000 workers by 2025. General Freight Trucking's contribution to gross output is estimated to increase from $3.2 billion in 2012 to $5.4 billion by 2025.

Unconventional revolution's effects on the trucking industry

The falling price of natural gas has led some trucking companies to substitute vehicles that run on natural gas for those that run on the more expensive diesel fuel. Clean Energy Fuels has a network of 115 LNG truck fueling stations built along interstate highways, as part of America's Natural Gas Highway initiative. Like railroads, trucks are also involved in hauling fresh water, fracturing sand, waste products, pipe, road base, and heavy equipment.

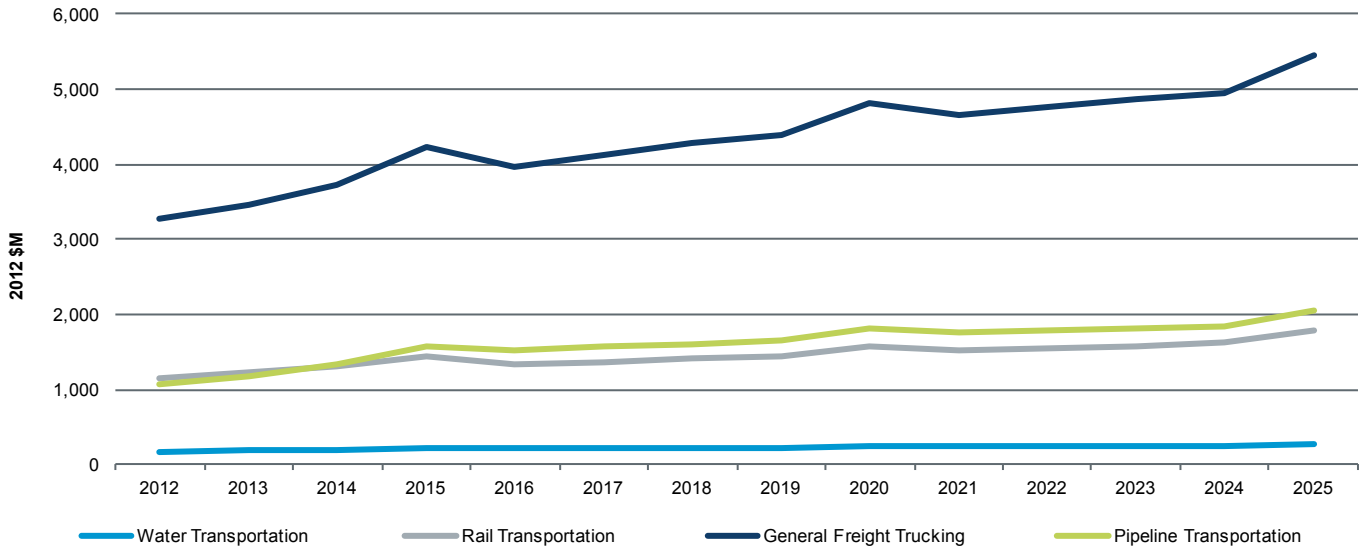
Pipeline Transportation (NAICS 486) is the second most dynamic sector in the logistics group, followed closely by Rail Transportation (NAICS 4821). Employment and gross output in the Pipeline Transportation (NAICS 486) sector are expected to increase at an annual average compound rate of 5% from 2012 to 2025. Gross output will increase at a slightly lower rate of about 3% between 2012 and 2025.

Logistics
Supply chain sectors employment



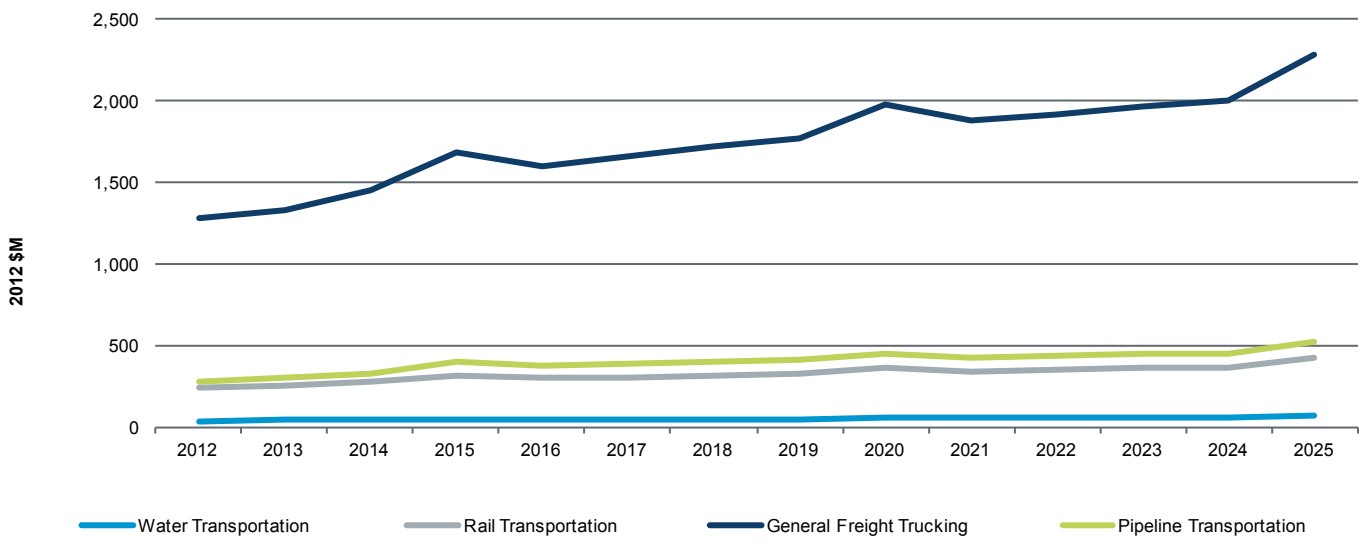
Source: IHS Economics

Logistics
Supply chain sectors gross output



Source: IHS Economics

Logistics
Supply chain sectors labor income



Source: IHS Economics

Materials

Within materials, the sectors with the largest contributions from the unconventional energy supply chain in terms of employment, labor income, and gross output are: Construction Sand and Gravel Mining (NAICS 212321), Steel Product Manufacturing from Purchased Steel (NAICS 3312), Iron and Steel Mills and Ferroalloy Manufacturing (NAICS 331110), Fabricated Pipe and Pipefitting Manufacturing (NAICS 332996), and Other Basic Inorganic Chemical Manufacturing (NAICS 325180).

Unconventional revolution benefits the chemicals industry[9]

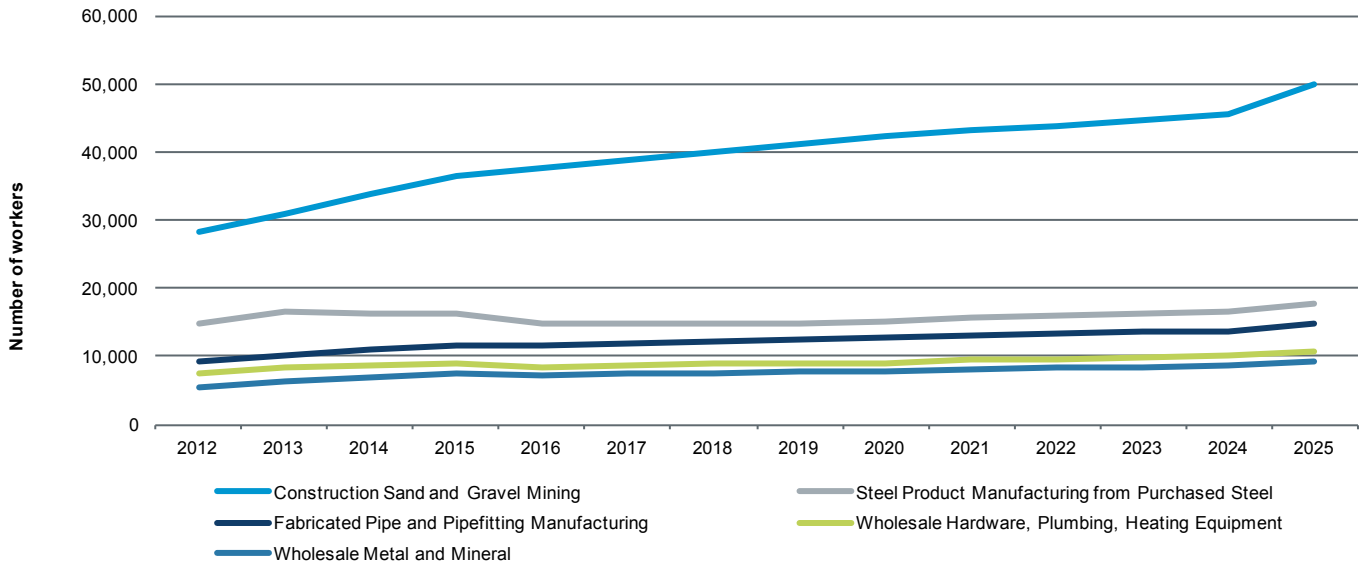
The chemicals industry has benefitted immensely from the unconventional revolution since it uses natural gas for both energy and as raw material. The co-products of the extraction process, such as ethane, butane, and propane, are used as feedstock for to the petrochemicals manufacturing process. The chemicals industry produces a variety of derivatives and products that ultimately become raw materials (e.g. polymers) for multiple manufacturing sectors. The unconventional revolution has attracted more than $5.7 billion in investments by German chemical giant BASF in North America since 2008, including a formic acid plant in Louisiana.

The companies operating in the wholesale trade sectors in Metals and Minerals (NAICS 4235) and Hardware, Plumbing, and Heating Equipment (NAICS 4237) are expected to increase employment steadily at an average compound annual growth rate of about 3% over the forecast period. The number of workers supported by the unconventional activity across these two sectors will increase from an average of 6,400 in 2012 to almost 10,000 in 2025.

Relative to the rest of the supply chain sectors in the materials group, the Construction Sand and Gravel Mining (NAICS 212321) sector is the most dynamic, benefiting the most from the unconventional activity in terms of gross output, number of workers, and labor income. Total employment in this sector supported by the unconventional oil and natural gas is projected to increase from 28,000 workers in 2012 to nearly 50,000 workers in 2025. Gross output in Construction Sand and Gravel Mining (NAICS 212321) is expected to increase at a compound annual rate of 4%, going from $6 billion in 2012 to more than $10 billion in 2025.

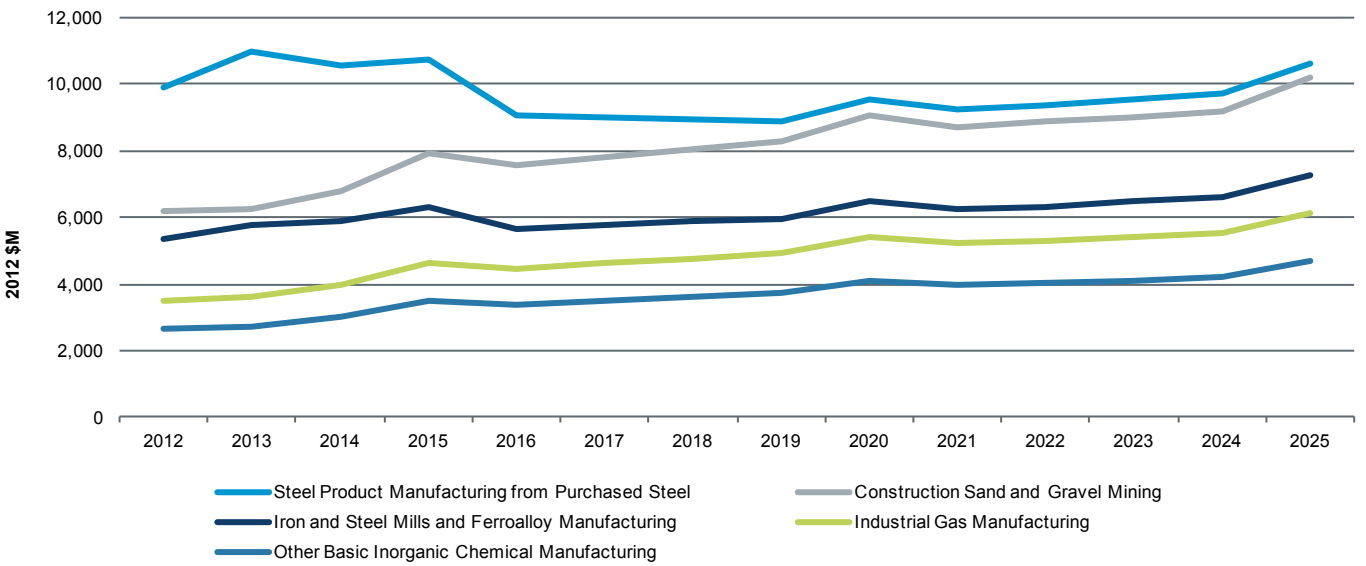
9 The Washington Post (04/01/2013), http://www.washingtonpost.com/world/europe/european-industry-flocks-to-cheap-us-gas/2013/04/01/454d06ea-8a2c-11e2-98d9-3012c1cd8d1e_story.html

Materials
Top-5 supply chain sectors employment



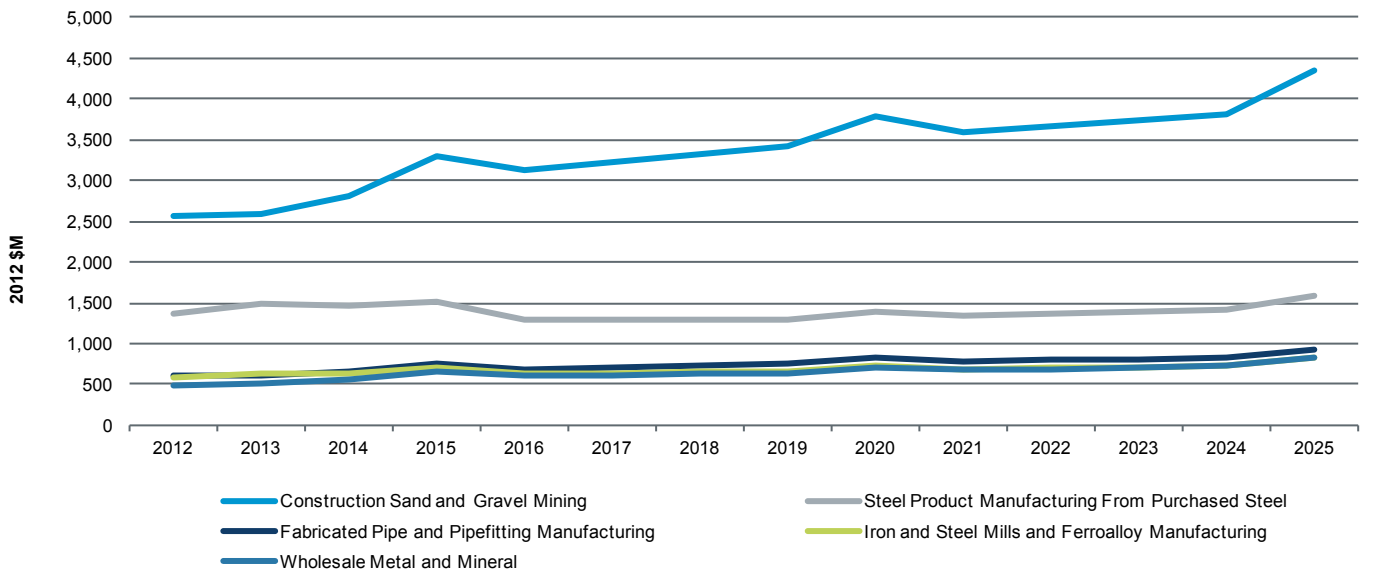
Source: IHS Economics

Materials
Top-5 supply chain sectors gross output



Source: IHS Economics

Materials
Top-5 supply chain sectors labor income



Source: IHS Economics

Professional and other services

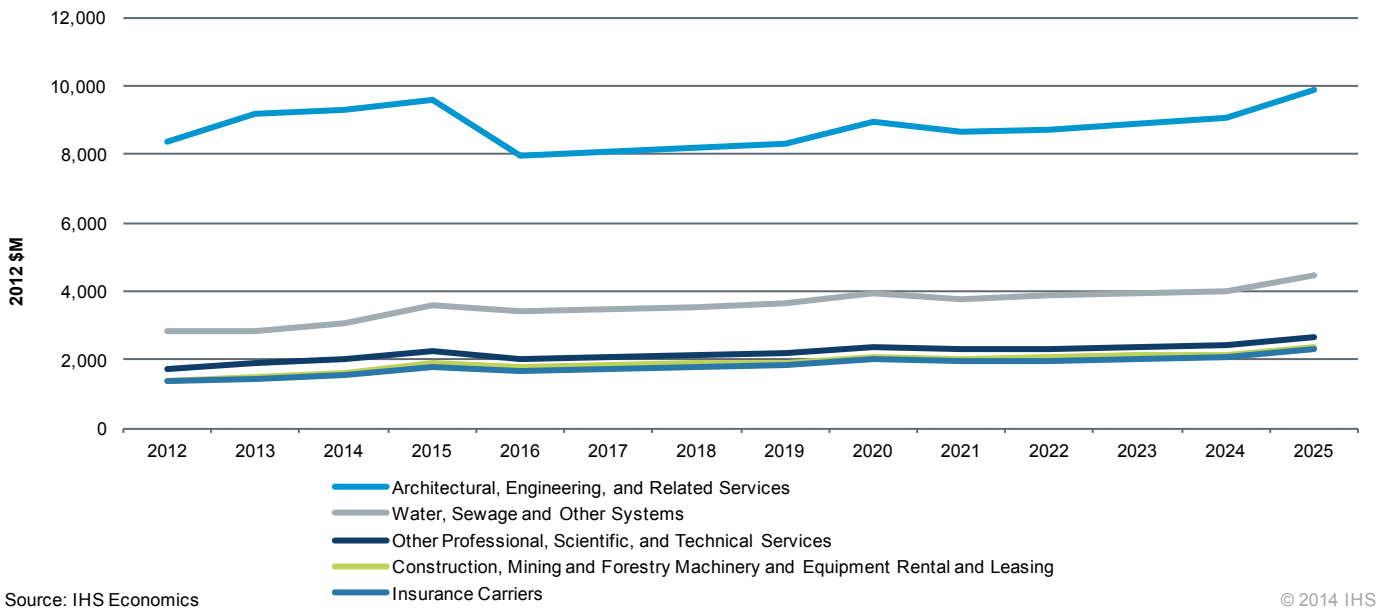
Architectural, Engineering, and Related Services (NAICS 5413) is the top sector in terms of number of workers and gross output produced within the professional and other services group. Between 2012 and 2015, the number of workers is estimated to increase by about 20,000, from about 57,000 workers in 2012 to more than 77,000 by 2025. Architectural, Engineering, and Related Services (NAICS 5413) is expected to add about $1.4 billion to total output, increasing at an annual growth rate of about 1.3% between 2012 and 2025. Average labor income per employee will reach more than $77,000 over the forecast period. The rate of growth of the economic contributions (in terms of employment, gross output, and labor income) to this sector supported by the unconventional energy supply chain is much higher between 2012 and 2015 (4% on average) than over 2016–25 (1%). The higher rate of growth at the beginning of the forecast is correlated to the high investment levels over the same period in construction activity, which slows down post-2016.

The second ranked sector within professional and other services in terms of employment and gross output is Water, Sewage, and Other Systems (NAICS 2213). Labor income per employee in this sector is estimated to reach more than $97,000 on average, the highest among the industries classified in the professional and other services group. Employment in Water, Sewage, and Other Systems (NAICS 2213) supported by the unconventional

energy activity will increase from almost 13,000 workers in 2012 to more than 21,000 in 2025, or an annual growth rate of about 4%.

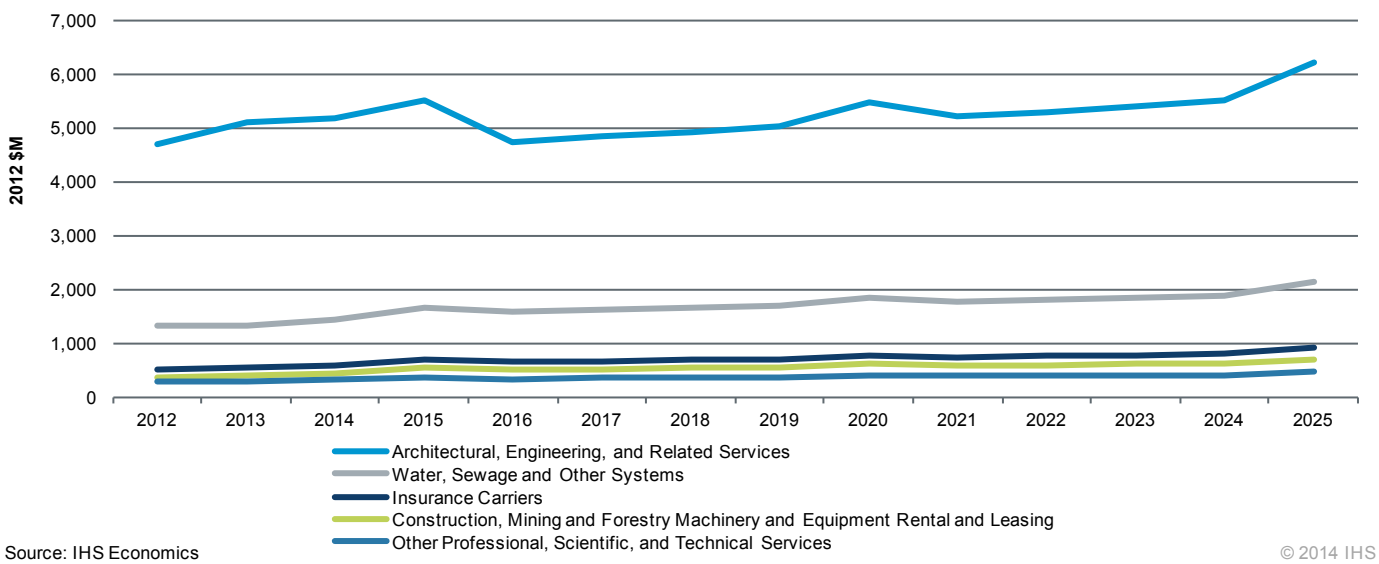
The rest of the industries ranked in the top 5 are expected to follow a similar trend in terms of employment, output, and labor income contributions generated by the unconventional activity. The industries are: Other Professional, Scientific, and Technical Services (NAICS 5419), Construction, Mining and Forestry Machinery and Equipment Rental and Leasing (NAICS 532412), and Insurance Carriers (NAICS 5241). Total employment is expected to increase at 4% or 5% annually over the forecast period, while output will increase a slightly lower rate, ranging between 3% and 4% per year.

Professional and other services
Top-5 supply chain sectors gross output



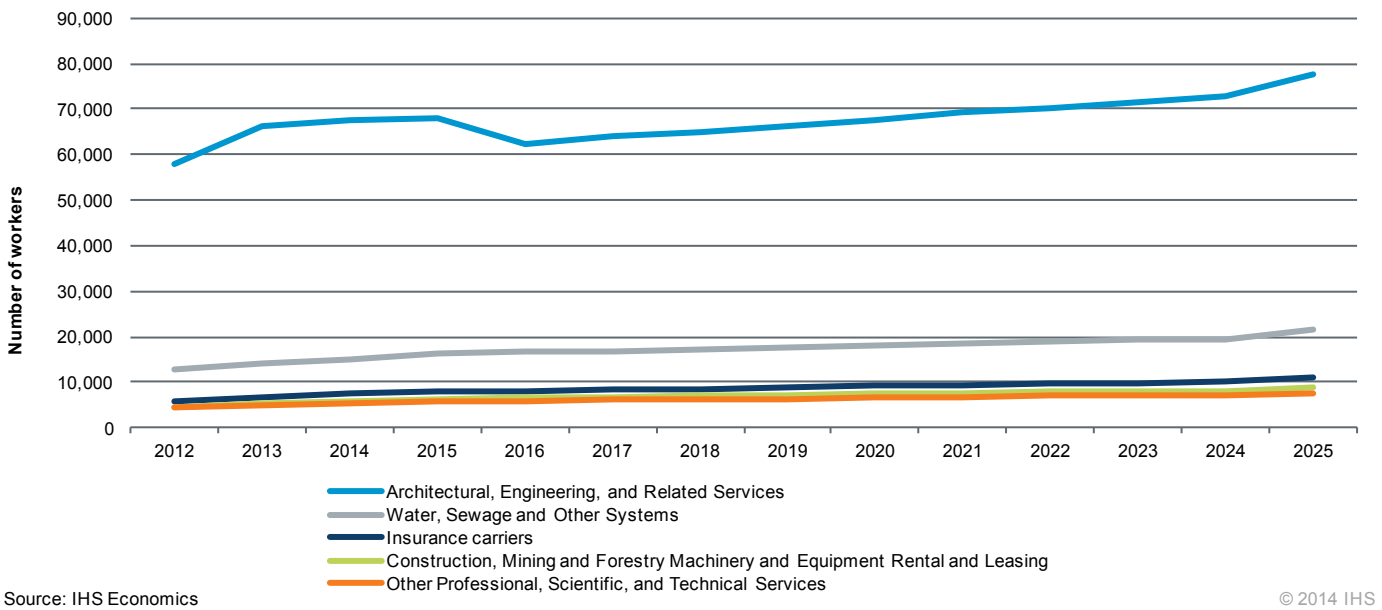
Source: IHS Economics

Professional and other services
Top-5 supply chain sectors labor income



Source: IHS Economics

Professional and other services
Top-5 supply chain sectors employment



Source: IHS Economics

Our analysis of the economic contributions supported by the unconventional oil and gas activity in the next chapter reveals the geographical diversity of the unconventional energy supply chain. While the largest economic benefits are accrued by the supply chain sectors located in the producing states (especially Texas), considerable employment, gross output, and labor income are being and will continue to be supported across the supply chain sectors in the rest of the states, including nonproducing ones.

Unconventional oil and natural gas supply chain: State assessment

Summary of key results: State assessment

- Producing states are expected to generate an average of 536,000 unconventional oil and gas supply chain jobs each year between 2012 and 2025; nonproducing states are forecast to support about 99,000 jobs a year over the same period. Unconventional energy supply chain sectors employment in producing states is expected to increase by approximately 2.5% annually while employment in the sectors located across the nonproducing states is expected to grow at 6% annually on average.
- The top supply chain industries in terms of employment contributions across the producing states are concentrated in Construction (part of NAICS 23), Support Activities for Oil and Gas Operations (NAICS 213112), General Freight Trucking (NAICS 4841), and Architectural, Engineering, and Related Services (NAICS 5413).
- The top supply chain industries that support the largest number of jobs across the nonproducing states are concentrated in the capital goods core group.
- Unconventional energy supply chain jobs account for 2% of total state employment in Texas, Louisiana, and Oklahoma over the entire forecast horizon. Supply chain employment accounts for 1% of total state employment in Arkansas, Colorado, and Pennsylvania.
- In 2012, the supply chain industries across the producing states contributed about $126 billion to total US gross output; by 2015 this will grow to over $146 billion, stabilizing at nearly $170 billion by 2025. The supply chain industries in the nonproducing states are estimated to generate $19 billion in gross output in 2012, nearly $27 billion in 2015, and $36 billion by 2025.
- The top-10 producing states account for more than 70% of the energy supply chain contributions supported by the unconventional oil and gas industry in terms of employment, labor income, and gross output. The top-10 producing states are: Texas, Louisiana, Pennsylvania, Colorado, North Dakota, Ohio, Oklahoma, California, Arkansas, and Utah.

Unconventional oil and natural gas activities are reshaping economies for states with and without oil and gas production. IHS has identified 16 states with significant active or expected production of unconventional oil and natural gas, but the reach of the industry's supply chain can be traced to nearly every state. The most visible supplier activities associated with oil and gas exploration and development include site preparation, drilling, and construction. However, the unconventional supply chain touches many more manufacturing and nonmanufacturing sectors resident in every state. These industries include steel, cement, chemicals, water, and construction and transportation equipment. The purpose of this state level analysis is to reveal geographic insight of how the unconventional oil and natural gas supply chain supports economic activity in individual states.

The results of this study indicate the degree to which suppliers across the United States benefit from unconventional oil and gas activity. While producing states account for the largest share of economic gains in terms of employment and output—with Texas, Pennsylvania, North Dakota, and Louisiana at the top—IHS analysis indicates the top supply chain sectors are present in all states.

Structure

The first part of this section compares the overall economies of the producing states against nonproducing states. Historical employment and output trends in the US economy were analyzed to understand the rapid growth of unconventional activity and to demonstrate the effect of its emerging potency since the Great Recession. IHS forecasts sustained growth of the industries identified as components of the supply chain a decade into the future.

The second part of this section traces the supply chain components to producing and nonproducing states and identifies historical and future trends in growth. Our analysis shows that while the supply chain economic contributions tend to be concentrated across the producing states, the nonproducing states also benefit. For instance, across nonproducing states, the largest contributions to the supply chain are service sectors, such as engineering and wholesale trade, which exist primarily across the southern and northeastern states. Furthermore, most of the supply chain contributions across the Midwestern nonproducing states are concentrated in the construction, transportation equipment, and equipment manufacturing sectors. The largest contributions to the supply chain sectors across the producing states are concentrated in the construction sector and support activities for oil and gas operations, followed by professional services and rail and truck transportation services.

The third part of this section breaks out state-level snapshots of employment and output for six key states integral to the unconventional supply chain. This section compares employment contributed by unconventional activities against total state employment, putting the reach of unconventional activities in perspective for each state.

Methodology

A two-step approach was employed to analyze the state-level contributions of unconventional oil and gas activity to the supply chain industries. First, IHS Energy estimated future investment and production in unconventional oil and gas plays across US states. In IHS's *America's New Energy Future* series, the direct contributions of the upstream and midstream unconventional oil and gas related activities were captured in terms of operating expenditures and capital expenditures at the state level. The next step required IHS Economics to use a system of inter-industry linkages, based on the IMPLAN modeling framework, to evaluate the impacts generated by the production and capital spending at the state level. This detailed information was used as an input to our customized proprietary modeling framework, tracing a complete account of how the unconventional activity extends to supporting industries located across US states. The following upstream and midstream sector activities were determined to be the major contributors to unconventional supply chain economic activity:

- Oil and natural gas extraction
- Oil and natural gas drilling
- Support activities for oil and natural gas
- Construction of facilities, related technology for hydraulic fracturing and completions, and construction of pipeline

The economic impacts on the unconventional supply chain industries are measured in terms of jobs created or sustained, gross output contribution, and employee wages and other compensation.

Producing vs. nonproducing states

This analysis was undertaken on a state-by-state basis. First, we present top-line results by producing and nonproducing states. Then, we present the results for each of the top-10 producing and top-10 nonproducing states. More detailed results are presented in the appendices.

Each state was placed into one of the two following categories:

1. Producing states have current, emerging, or forecasted production of unconventional oil and natural gas

2. Nonproducing states do not have substantial current or prospective production of unconventional oil and gas.

Producing states are defined as those that are part of the 20 largest unconventional oil and natural gas producing plays in the US Lower 48, such as the Bakken and Marcellus shale plays. Producing states also include those that are part of an emerging oil or natural gas play that is expected to have sizeable unconventional oil and/or natural gas production in the forecast horizon. The 16 producing states are Arkansas, California, Colorado, Kansas, Louisiana, Mississippi, Montana, New Mexico, North Dakota, Ohio, Oklahoma, Pennsylvania, Texas, Utah, West Virginia, and Wyoming.

Nonproducing states are not part of the 20 largest unconventional oil and natural gas producing plays in the US Lower 48 and are not part of an emerging oil or natural gas play in the 2012 to 2025 forecast horizon. These states may be part of plays that are currently producing oil and/or natural gas, but nevertheless are classified as a nonproducing state because current production is relatively small and the prospect for future unconventional production is unknown. The 32 nonproducing states are Alabama, Arizona, Connecticut, Delaware, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, Nevada, New Hampshire, New Jersey, New York, North Carolina, Oregon, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, Washington, and Wisconsin. Some of these, such as Illinois, Indiana, Michigan and New York may over time move into the producing states category.

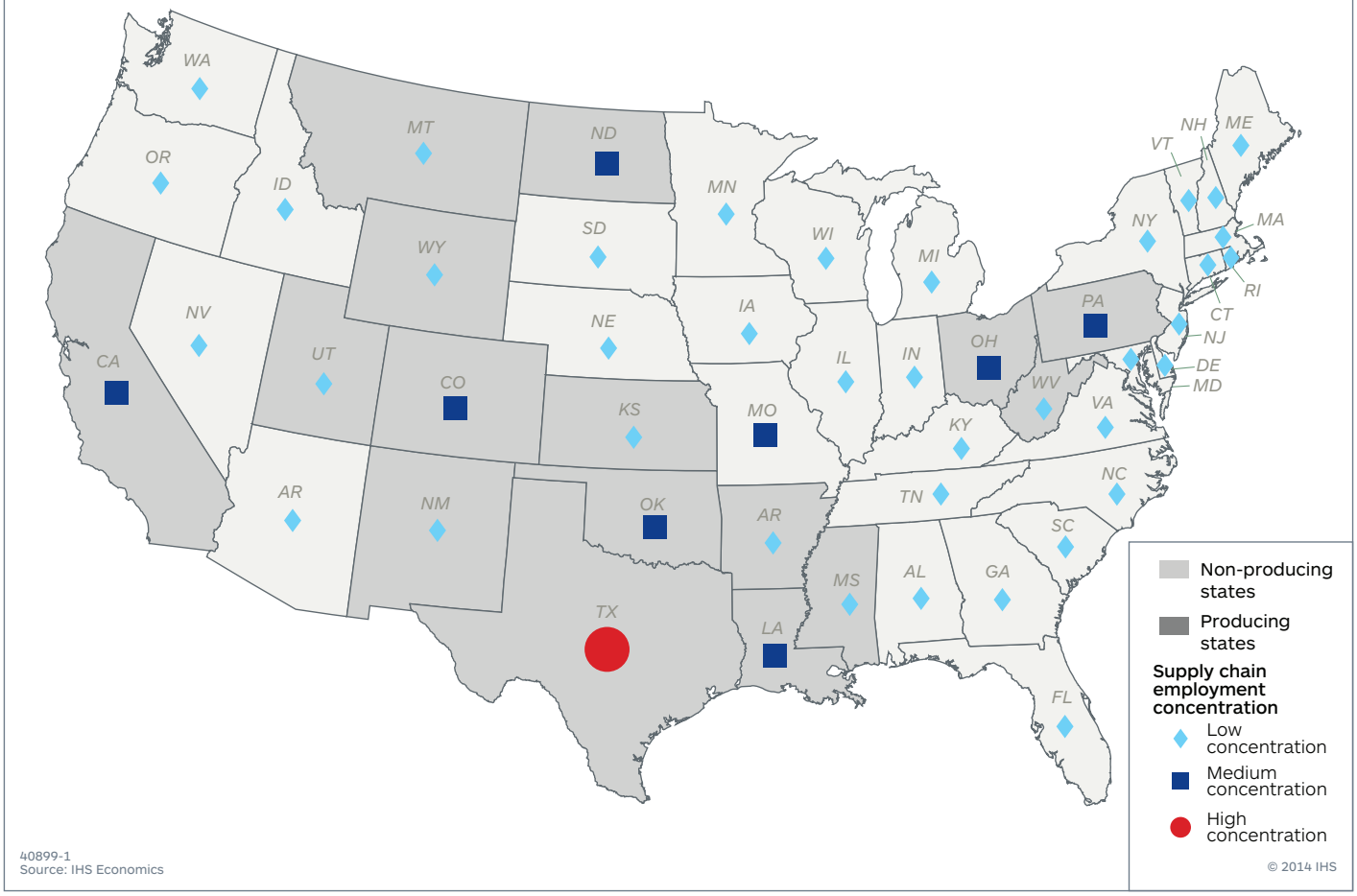
Both sets of states will benefit from the unconventional oil and gas supply chain either directly through new well drilling and completion, unconventional oil and gas production, and spending on capital equipment and commodities or indirectly through the strong support sectors that contribute to the expansive unconventional oil and gas supply chain.

The economic benefits—in terms of employment, labor income, and government revenue—as a result of the unconventional oil and gas supply chain are presented by producing and nonproducing states below.

Employment contributions

Unconventional activity will benefit supply chain sectors across the United States. Our analysis shows that while the supply chain economic contributions tend to be concentrated across the producing states, the rest of the states also benefit. For instance, across the nonproducing states, the largest contributions to the supply chain service sectors, such as engineering and wholesale trade, are estimated to occur primarily across the southern and northeastern states. Furthermore, most of the supply chain contributions across the Midwestern nonproducing states are concentrated in the construction, transportation, and equipment manufacturing sectors. The largest contributions to the supply chain sectors across the producing states are concentrated in the construction sector and support activities for oil and gas operations, followed by professional and rail and truck transportation services.

Unconventional energy supply chain employment: Total, 2014



40899-1
Source: IHS Economics

Producing states' economies have significantly benefitted from investment in production capacity and have supported both in-state and out-of-state suppliers. As a result of the dramatic increase in domestic oil and gas production, concurrent with the worst US recession in 80 years, the unconventional oil and gas supply chain was buoyed by a level of exploration and production investment that partially insulated producing states (such as Texas, Colorado, Oklahoma, Pennsylvania, Utah, and Arkansas) from the economic maelstrom occurring nationally.

Producing states supported 921,000 total jobs as a result of unconventional activity in 2012. Of that total, nearly half (460,000) of these jobs resided in the unconventional oil and natural gas supply chain. The unconventional oil and gas supply chain is expected to expand employment in producing states at a compound annual growth rate of 2.5% to 630,000 jobs in 2025, supporting an average of 536,000 jobs annually over the 2012–25 forecast period.

Employment in nonproducing states will also expand. Growing at a compound annual growth rate of 5.6%, total unconventional energy activity in nonproducing states is expected to expand employment from 179,000 jobs in 2012 to 364,000 jobs in 2025, supporting an average of 284,000 jobs per year between 2012 and 2025. Of those jobs, the unconventional oil and gas supply chain will account for more than a third, increasing from 64,000 jobs in 2012 to over 127,000 in 2025, supporting an average of 99,000 jobs annually from 2012 to 2025.

The economies in the top-10 producing states are expected to expand faster than the national average over the next decade. The following compares employment growth in the top-10 producing and nonproducing states.

- Unconventional supply chain employment in the top-10 producing states is expected to increase at a compound annual growth rate of 2.7% from 2012 through 2025, faster than the overall IHS state employment forecast of 1.3 % for those states.
- Unconventional supply chain employment contributions in Ohio and Oklahoma are expanding at a compound annual growth rate of 9% and 7%, respectively, well above their average state employment growth rate.
- The unconventional supply chain is expected to contribute about 2.5% employment growth, on average, across the top-10 producing states. The compound annual growth rate for unconventional supply chain employment in producing states is expected to grow faster than the overall IHS US employment growth forecast of 1.1% for the 2012–25.

Top-10 employment contributions relative to total employment: Producing states*
(Number of workers)

	2012	2015	2020	2025	CAGR**
Unconventional energy supply chain employment contribution					
California	14,077	22,686	19,962	23,452	4.0%
Texas	211,576	228,091	233,812	262,214	1.7%
Pennsylvania	49,072	47,321	58,839	77,652	3.6%
Ohio	13,123	21,869	29,009	39,704	8.9%
Colorado	26,596	31,255	34,402	42,183	3.6%
Louisiana	41,107	53,906	35,727	43,314	0.4%
Oklahoma	23,475	30,093	41,025	53,755	6.6%
Kansas	4,435	5,085	5,216	6,847	3.4%
Utah	13,005	13,311	9,191	7,092	-4.6%
Arkansas	10,246	13,785	14,896	16,139	3.6%
Top-10 total	**406,712**	**467,400**	**482,078**	**572,352**	**2.7%**
Producing total	**459,826**	**525,495**	**532,802**	**630,178**	**2.5%**
US total	**524,413**	**615,910**	**638,762**	**757,802**	**2.9%**
Total state employment* **					
California	14,706,058	15,798,157	17,020,724	17,505,953	1.3%
Texas	10,874,075	11,830,870	13,106,353	13,800,523	1.9%
Pennsylvania	5,726,875	5,878,290	6,160,927	6,199,863	0.6%
Ohio	5,190,067	5,391,842	5,640,821	5,679,044	0.7%
Colorado	2,312,817	2,512,009	2,771,671	2,882,435	1.7%
Louisiana	1,925,550	1,996,300	2,096,988	2,091,535	0.6%
Oklahoma	1,614,058	1,688,600	1,790,038	1,827,510	1.0%
Kansas	1,357,542	1,416,052	1,496,830	1,523,747	0.9%
Utah	1,250,033	1,358,381	1,527,139	1,646,920	2.1%
Arkansas	1,176,425	1,216,322	1,287,646	1,312,413	0.8%
Top-10 total	**46,133,500**	**49,086,822**	**52,899,138**	**54,469,943**	**1.3%**
Producing total	**49,966,417**	**53,233,034**	**57,029,084**	**58,755,988**	**1.3%**
US total	**132,533,250**	**139,612,169**	**149,238,638**	**152,706,788**	**1.1%**

*Ranking for all years based on employment in 2014.

**Compound annual growth rate from 2012 to 2025.

***Data are from the IHS US Regional Service forecast, May 2014.

Source: IHS Economics

Overall, the top-10 nonproducing states are expected to continue to expand state-level employment at a compound annual growth rate of 1%, following the national average over the next decade, with the exception of Florida, which is projected to have above average growth. Despite an 'at-trend' overall growth rate for employment in nonproducing states, unconventional supply chain activity is halting or reversing decades-long declines in employment in industrial sectors that had suffered from the offshoring of domestic manufacturing and employment.

- Unconventional supply chain employment contribution in the top-10 nonproducing states is expected to increase at a compound annual growth rate of 6% each year from 2012 through 2025, outpacing overall US employment trends.

- Illinois is projected to have average state-level employment growth between 2012 and 2025, but is projected to experience the largest level of job increase among nonproducing states in unconventional supply chain activity employment, with an increase of 14,000 jobs between 2012 and 2025, or an average of more than 1,000 jobs a year.

- Total government revenue generated by producing states is estimated to increase from $11.3 billion in 2012 to $18.7 billion in 2025, with a compound annual growth of 3.9%. Similarly, nonproducing states will increase total tax collections from supply chain industries, with total government revenue increasing from $1.8 billion in 2012 to a little more than $4 billion in 2025, with a compound annual growth rate of 6.3%.

Sand boom in Wisconsin

Demand for sand, a key ingredient in hydraulic fracturing, has increased tremendously since the start of the unconventional oil and natural gas revolution in the United States more than five years ago. In 2013, companies in the oil and gas industry used an estimated 56 billion pounds of sand for their hydraulic fracturing operations. Demand for Wisconsin's white sand industry (the main type of sand used in hydraulic fracturing) has been booming. Since 2010, more than 100 sand mines have been permitted to start operations, up from only 5 sand mines operating in the state in 2010.[10]

Total employment supported by unconventional energy activity in the Construction Sand and Gravel Mining sector in Wisconsin is expected to increase at an annual rate of 4.5%, from 2,000 workers in 2012 to more than 3,600 workers by 2025. Gross output in this sector follows a similar trend, increasing from about $400 million in 2012 to more than $700 million in 2025.

10 Source: The Wall street Journal "In Fracking sand is the New Gold", December 02, 2013: http://online.wsj.com/news/articles/SB10001424052702304868404579194250973656942

Top-10 employment contributions relative to total employment: Nonproducing states*
(Number of workers)

	2012	2015	2020	2025	CAGR**
Unconventional energy supply chain employment contribution					
New York	4,444	6,247	7,549	9,295	5.8%
Florida	2,437	3,537	4,226	4,968	5.6%
Illinois	13,650	18,398	22,640	27,668	5.6%
North Carolina	1,809	2,580	3,050	3,719	5.7%
Georgia	1,806	2,587	3,067	3,496	5.2%
Michigan	4,108	5,864	6,842	8,774	6.0%
New Jersey	2,136	3,006	3,519	3,945	4.8%
Virginia	2,205	3,082	3,795	4,585	5.8%
Massachusetts	1,652	2,285	2,556	2,779	4.1%
Washington	1,309	2,592	2,297	2,733	5.8%
Top-10 total	**35,557**	**50,178**	**59,541**	**71,963**	**5.6%**
Nonproducing total	**64,587**	**90,416**	**105,959**	**127,624**	**5.4%**
US total	**524,413**	**615,910**	**638,762**	**757,802**	**2.9%**
Total state employment* **					
New York	8,797,608	9,111,504	9,381,819	9,405,181	0.5%
Florida	7,396,650	7,974,295	8,717,240	9,076,411	1.6%
Illinois	5,749,917	5,966,162	6,275,336	6,333,064	0.7%
North Carolina	3,985,500	4,198,359	4,546,180	4,690,010	1.3%
Georgia	3,953,850	4,190,388	4,547,933	4,680,282	1.3%
Michigan	4,034,217	4,187,959	4,373,055	4,403,771	0.7%
New Jersey	3,890,542	4,015,804	4,239,313	4,273,835	0.7%
Virginia	3,737,150	3,863,559	4,140,378	4,258,544	1.0%
Massachusetts	3,309,967	3,453,664	3,632,613	3,651,326	0.8%
Washington	2,921,625	3,104,931	3,315,755	3,378,045	1.1%
Top-10 total	**47,777,025**	**50,066,626**	**53,169,621**	**54,150,468**	**1.0%**
Nonproducing total	**82,308,167**	**80,868,325**	**84,872,858**	**83,820,050**	**0.1%**
US total	**132,533,250**	**139,612,169**	**149,238,638**	**152,706,788**	**1.1%**

*Ranking for all years based on employment in 2014.

**Compound annual growth rate from 2012 to 2025.

***Data are from the IHS US Regional Service forecast, May 2014.

Source: IHS Economics

Jobs are sustained and created across every state in unconventional supply chain industries as a result of new and ongoing unconventional oil and gas activity, with Texas, Louisiana, and Pennsylvania being the largest beneficiaries. Among the producing states, unconventional supply chain activities contribute a large share of total state-level employment from 2012 to 2025. Unconventional supply chain activities comprise an average of 6% of total state-level employment

Ratio of producing state supply chain employment contribution to total state employment
(Average percent, 2012-25)

North Dakota	5.76
Louisiana	2.33
Oklahoma	2.42
Texas	2.26
Wyoming	1.68
West Virginia	1.28
Colorado	1.27
Arkansas	1.18
Pennsylvania	1.00
New Mexico	0.82

Source: IHS Economics

in North Dakota during 2012–25, an indication of the growing importance of these support activities to the state economy.

Labor income

The average annual earnings for the US unconventional energy supply chain industries is estimated at around $79,000–significantly more than the $64,000 yearly average paid in the broad manufacturing sectors in the United States.[11]

Attendant to employment growth in producing states is labor income growth, which contributes both directly and indirectly to economic growth. Unconventional supply chain activities contributed close to $36 billion in labor income in producing states in 2012 and that contribution is expected to grow at a compound annual rate of 2.5% through 2025 to $49 billion annually in 2025. Texas will capture the largest benefits from labor income, as it is the largest employer among all unconventional supply chain activities, growing from about $16 billion in 2012 to nearly $20 billion in 2025. Labor income in nonproducing states will grow at a slightly faster rate of 5% annually, from $5.3 billion in 2012 to $10 billion in 2025. Illinois will capture the largest benefits from labor income among nonproducing states, nearly doubling from $1.1 billion in 2012 to $2.2 billion in 2025.

Top-5 labor income contributions: Producing states*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	16,228	17,816	18,477	20,232	1.7%
Louisiana	3,172	4,034	2,807	3,314	0.3%
Pennsylvania	3,879	3,948	4,894	6,283	3.8%
Colorado	2,245	2,612	2,878	3,418	3.3%
North Dakota	1,729	2,527	2,188	2,280	2.2%
Top-5 total	**27,253**	**30,937**	**31,245**	**35,527**	**2.1%**
Producing total	**35,697**	**41,475**	**42,674**	**49,246**	**2.5%**
US total	**41,015**	**48,915**	**51,381**	**59,502**	**2.9%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Top-5 labor income contributions: Nonproducing states*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Illinois	1,116	1,496	1,832	2,174	5.3%
Minnesota	378	590	712	853	6.4%
Wisconsin	381	548	630	760	5.5%
New York	373	523	634	769	5.7%
Michigan	320	456	528	660	5.7%
Top-5 total	**2,569**	**3,613**	**4,337**	**5,216**	**5.6%**
Nonproducing total	**5,318**	**7,440**	**8,707**	**10,257**	**5.2%**
US total	**41,015**	**48,915**	**51,381**	**59,502**	**2.9%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

11 Average annual manufacturing earnings computed for the period 2012- 2025. Source: IHS Economics

Government revenue

State-level economies continue the long climb out of the economic chasm that started in 2008. IHS estimates that by the end of 2014, the majority of US states will have returned to peak employment levels and 25 states will have unemployment rates under 6%. By 2014, most states had returned to or exceeded prerecession tax receipt levels, with personal and corporate income tax collections boosted by activity in the Mining (including energy), Agriculture, and Housing sectors. Not surprisingly, North Dakota and Texas are leaders among states in employment growth in 2014, even after already elevated levels of employment versus other states. Clearly, the continued investment in unconventional oil and gas development has not only helped lift state economies and fiscal budgets from the depths of the Great Recession, the energy value chain has become a staple of economic growth in producing and even nonproducing states.

State tax revenues represent federal and state corporate and personal income tax estimates. In the producing states, the top-5 states generating the most government revenues are expected to add between $8 billion in 2012 and more than $12 billion by 2025 to state and federal government revenues. While the traditional producing states such as Texas and Louisiana will lead the way, the supply chain industries in the nonproducing states will experience even higher rates of growth in government revenue at about 6% annually. Government revenues in producing states are estimated to grow by 4% annually over the forecast period. Total nonproducing states contributed a total of over $1.8 billion in tax revenues in 2012 and are projected to contribute in excess of $4 billion by 2025.

Top-5 government revenue contributions: Producing states*
(Current $M)

	2012	2015	2020	2025	CAGR**
Texas	3,648	4,092	4,594	5,193	2.8%
Louisiana	1,314	1,662	1,315	1,607	1.6%
Pennsylvania	1,628	1,809	2,456	3,269	5.5%
Colorado	925	1,091	1,308	1,600	4.3%
North Dakota	686	1,026	968	1,044	3.3%
Top-5 Total	**8,202**	**9,681**	**10,640**	**12,712**	**3.4%**
Producing total	**11,326**	**13,733**	**15,456**	**18,726**	**3.9%**
US total	**13,127**	**16,303**	**18,748**	**22,728**	**4.3%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Top-5 government revenue contributions: Nonproducing states*
(Current $M)

	2012	2015	2020	2025	CAGR**
Missouri	409	557	742	903	6.3%
Michigan	301	427	555	682	6.5%
Illinois	189	266	352	434	6.6%
Minnesota	103	170	222	276	7.9%
Wisconsin	110	157	187	219	5.5%
Top-5 total	**1,112**	**1,576**	**2,058**	**2,515**	**6.5%**
Nonproducing total	**1,802**	**2,570**	**3,292**	**4,002**	**6.3%**
US total	**13,127**	**16,303**	**18,748**	**22,728**	**4.3%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Regional industry analysis

To understand the discrete economic contributions of unconventional oil and natural gas activity, IHS identified the 56 NAICS sectors that compose the unconventional supply chain. Through a supply chain mapping exercise, IHS analyzed the state-by-state connection to each component of the unconventional value chain, as measured by employment, gross output, and labor income.

The unconventional oil and gas supply chain is composed of a range of different activities and is distributed across most states depending upon the location of upstream and midstream development. Producing states have large employment contributions among sectors that are typically considered upstream activities, such as Support Activities for Oil and Gas Operations (NAICS 213112) and Construction Sand and Gravel Mining (NAICS 212321). The top-15 industrial sectors within the producing states' unconventional supply chain contributed 388,000 jobs in 2012 and are expected to increase employment contributions at a compound annual rate of 2% to 514,000 jobs in 2025.

Top-15 sectors: Unconventional energy supply chain employment in producing states*
(Number of workers)

		2012	2015	2020	2025	CAGR**
23[t]	Construction of Other New Nonresidential Structures	58,806	74,333	82,577	103,299	4.4%
213112	Support Activities for Oil and Gas Operations	54,226	71,662	86,555	107,916	5.4%
23[tt]	Construction of New Nonresidential Manufacturing Structures	73,527	49,220	16,527	13,266	-12.3%
5413	Architectural, Engineering, and Related Services	50,595	57,357	55,317	63,342	1.7%
4841	General Freight Trucking	20,699	27,223	31,959	37,671	4.7%
212321	Construction Sand and Gravel Mining	19,148	23,614	26,968	31,338	3.9%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	17,383	22,287	24,976	29,242	4.1%
213111	Drilling Oil and Gas Wells	12,917	17,526	21,176	26,558	5.7%
4238	Wholesale Machinery and Equipment	12,395	17,221	20,306	23,614	5.1%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	13,157	14,902	13,260	14,935	1.0%
2213	Water, Sewage and Other Systems	12,746	16,210	18,007	21,427	4.1%
3312	Steel Product Manufacturing from Purchased Steel	13,002	13,921	12,755	14,962	1.1%
332410	Power Boiler and Heat Exchanger Manufacturing	13,800	10,592	4,046	3,739	-9.6%
332996	Fabricated Pipe and Pipefitting Manufacturing	8,358	10,200	11,098	12,945	3.4%
4237	Wholesale Hardware, Plumbing, and Heating Equipment	7,044	8,179	8,267	9,615	2.4%
Top-15 total		**387,803**	**434,448**	**433,795**	**513,869**	**2.2%**
Producing total		**459,826**	**525,495**	**532,802**	**630,178**	**2.5%**
US total		**524,413**	**615,910**	**638,762**	**757,802**	**2.9%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of upstream facilities and structures.

tt Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Source: IHS Economics

Nonproducing states have large employment contributions among sectors that are typically considered support industries, including various manufacturing and distribution industries, which are growing at a slightly faster pace than the mix of support functions in producing states. The faster growth in nonproducing states likely indicates the maturing supply chain within producing states, and the adoption of a supply chain mix of activities among nonproducing states. The top-15 industrial sectors within the nonproducing states' unconventional energy supply chain activities contributed close to 55,000 jobs in 2012 and are expected to increase employment contributions at a compound annual growth rate of 5% to 108,000 jobs in 2025. Among nonproducing states, industries such as Cutting Tool and Machine Tool Accessory Manufacturing (NAICS

333515); Construction Sand and Gravel Mining (NAICS 212321); and Architectural, Engineering, and Related Services (NAICS 5413) will double their 2012 employment contributions by 2025.

Top-15 sectors: Unconventional energy supply chain employment in nonproducing states* (Number of workers)

		2012	2015	2020	2025	CAGR**
333515	Cutting Tool and Machine Tool Accessory Manufacturing	10,077	13,938	17,311	21,193	5.9%
212321	Construction Sand and Gravel Mining	9,080	12,821	15,229	18,606	5.7%
5413	Architectural, Engineering, and Related Services	7,176	10,521	12,205	14,261	5.4%
4238	Wholesale Machinery and Equipment	5,054	7,118	8,597	10,128	5.5%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	4,997	6,930	8,557	10,447	5.8%
333912	Air and Gas Compressor Manufacturing	3,720	5,145	6,387	7,816	5.9%
4841	General Freight Trucking	3,440	4,856	5,764	6,874	5.5%
333911	Pump and Pumping Equipment Manufacturing	2,539	3,514	4,351	5,316	5.8%
3312	Steel Product Manufacturing from Purchased Steel	1,660	2,271	2,421	2,852	4.3%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	1,466	2,013	2,366	2,829	5.2%
4931	Warehousing and Storage	1,237	1,748	2,076	2,450	5.4%
336510	Railroad Rolling Stock Manufacturing	1,569	1,447	216	230	-13.7%
5419	Other Professional, Scientific, and Technical Services	896	1,307	1,549	1,812	5.6%
332996	Fabricated Pipe and Pipefitting Manufacturing	861	1,297	1,575	1,927	6.4%
811310	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	862	1,243	1,486	1,761	5.6%
Top-15 total		**54,634**	**76,169**	**90,090**	**108,500**	**5.4%**
Nonproducing total		**64,587**	**90,416**	**105,959**	**127,624**	**5.4%**
US total		**524,413**	**615,910**	**638,762**	**757,802**	**2.9%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Gross output from unconventional oil and gas activities across the supply chain contributed nearly $146 billion in 2012 and is projected to reach almost $206 billion by 2025, growing at a compound annual growth rate of 3% nationwide. Contributing nearly $100 billion in gross output in 2012, the top-15 producing states account for nearly 70% of US supply chain gross output between 2012 and 2025. Among all producing states, gross output reached $126 billion in 2012 and will grow consistently to nearly $170 billion by 2025 at a rate of 2% per year. The largest gross output value among producing states' unconventional supply chain activities occur in the following sectors: Support Activities for Oil and Gas Operations (NAICS 213112); Drilling Oil and Gas Wells (NAICS 213111); and Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures).

Top-15 sectors: Unconventional energy supply chain gross output in producing states*
(2012 $M)

		2012	2015	2020	2025	CAGR**
213112	Support Activities for Oil and Gas Operations	21,072	27,810	33,323	39,612	5.0%
23[t]	Construction of New Nonresidential Manufacturing Structures	13,829	9,559	3,071	2,444	-12.5%
213111	Drilling Oil and Gas Wells	8,646	11,657	13,977	16,641	5.2%
3312	Steel Product Manufacturing from Purchased Steel	8,869	9,284	8,059	8,935	0.1%
23[tt]	Construction of Other New Nonresidential Structures	8,139	10,237	11,324	13,463	3.9%
5413	Architectural, Engineering, and Related Services	7,418	8,184	7,344	8,062	0.6%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	5,958	6,880	6,401	6,960	1.2%
212321	Construction Sand and Gravel Mining	4,301	5,269	5,968	6,589	3.3%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	3,743	4,104	3,918	4,314	1.1%
332410	Power Boiler and Heat Exchanger Manufacturing	3,409	2,647	1,017	905	-9.7%
333912	Air and Gas Compressor Manufacturing	3,118	3,972	4,397	4,888	3.5%
325120	Industrial Gas Manufacturing	2,975	3,876	4,478	5,022	4.1%
4841	General Freight Trucking	2,825	3,602	4,090	4,611	3.8%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	2,834	3,597	3,974	4,409	3.5%
2213	Water, Sewage and Other Systems	2,828	3,574	3,940	4,452	3.6%
Top-15 total		**99,963**	**114,255**	**115,279**	**131,306**	**2.1%**
Producing total		**126,397**	**146,765**	**149,504**	**169,861**	**2.3%**
US total		**145,681**	**173,522**	**180,620**	**205,907**	**2.7%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

The top-15 nonproducing states comprise 84% of total gross output contributions among all nonproducing states, contributing $16 billion of gross output in 2012. Among all nonproducing states, gross output is expected to grow at a compound annual growth rate of 5% per year, from $19 billion in 2012 to $36 billion by 2025. The key sectors for gross output among nonproducing states' unconventional supply chain activities include: Agriculture, Construction, and Mining Machinery Manufacturing (NAICS 3331); Air and Gas Compressor Manufacturing (NAICS 333912); and Construction Sand and Gravel Mining (NAICS 212321). The fastest growth among nonproducing states' supply chain activities will occur in Industrial Gas Manufacturing (NAICS 325120), at a rate of 7% per year, more than doubling output from $493 million in 2012 to $1.1 billion in 2025.

Top-15 sectors: Unconventional energy supply chain gross output in nonproducing states* (2012 $M)

		2012	2015	2020	2025	CAGR**
3331	Agriculture, Construction, and Mining Machinery Manufacturing	2,549	3,522	4,314	5,016	5.3%
333912	Air and Gas Compressor Manufacturing	2,080	2,847	3,504	4,069	5.3%
212321	Construction Sand and Gravel Mining	1,863	2,625	3,091	3,584	5.2%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	1,737	2,379	2,935	3,411	5.3%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	1,605	2,186	2,543	2,940	4.8%
3312	Steel Product Manufacturing from Purchased Steel	1,033	1,454	1,467	1,653	3.7%
333911	Pump and Pumping Equipment Manufacturing	1,011	1,386	1,699	1,971	5.3%
5413	Architectural, Engineering, and Related Services	959	1,393	1,597	1,806	5.0%
4238	Wholesale Machinery and Equipment	799	1,116	1,335	1,529	5.1%
325120	Industrial Gas Manufacturing	493	734	933	1,122	6.5%
4841	General Freight Trucking	448	628	737	851	5.1%
336510	Railroad Rolling Stock Manufacturing	543	505	88	94	-12.6%
213112	Support Activities for Oil and Gas Operations	343	461	529	605	4.5%
5419	Other Professional, Scientific, and Technical Services	322	467	547	619	5.2%
333618	Other Engine Equipment Manufacturing	297	411	483	552	4.9%
Top-15 total		**16,079**	**22,114**	**25,801**	**29,822**	**4.9%**
Nonproducing total		**19,284**	**26,757**	**31,116**	**36,046**	**4.9%**
US total		**145,681**	**173,522**	**180,620**	**205,907**	**2.7%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Economic contribution assessment by state and core group

The unconventional oil and gas supply chain consists of a complex and extensive group of industries that extends through many sectors of the US economy. The unconventional supply chain industries were broadly assigned to the following five core groups:

- Capital goods
- Construction and well services
- Logistics
- Materials
- Professional and other services

Capital goods

Major off-highway equipment and industrial machinery are widely used throughout the unconventional value chain and include construction and mining machinery; pumps and compressors; power generators; and power boilers and heat exchangers. Transportation equipment such railcars and heavy-duty trucks are also critical for moving key raw materials to the well-site and extracted crude oil to refineries.

The unconventional supply chain capital good requirements generate large output values in these industries, similar to materials, across the producing states. Output growth for capital goods in producing states persists at a close to 2% a year on top of what has been strong existing demand from this sector. The largest growth among

capital goods output will be in Air and Gas Compressor Manufacturing (NAICS 333912) across both producing and nonproducing states. This sector is expected to grow at about 4% a year, supporting $8 billion of output to unconventional oil and gas development in all states by 2025. The growth in the equipment sectors is far reaching and the largest change in growth in capital goods output will occur in the nonproducing states from 2012 to 2025.

While nonproducing states do not have significant emerging oil or natural gas plays, their economies, and manufacturing sectors in particular, are increasingly participating in the growth of the unconventional supply chain. The compound annual growth rate of output in capital goods production among nonproducing states is expected to increase at 5% per year from 2012 through 2025. The nonproducing states' capital goods production growth exceeds the producing states' growth rate of 3%. By 2025, nonproducing states will nearly double their share of output in the top-5 capital goods sectors, growing from 48% of output in 2012 to 78% of output in 2025 in Agricultural, Construction and Mining Machinery Manufacturing (NAICS 3331), Air and Gas Compressor Manufacturing (NAICS 333912), Cutting Tool and Machine Tool Accessory Manufacturing (NAICS 333515), Pump and Pumping Equipment Manufacturing (NAICS 333911), and Wholesale Machinery and Equipment (NAICS 4238). The shift in capital goods production for the unconventional supply chain to nonproducing states represents part of a growing focus on the oil and gas sector by traditional capital goods manufacturers. Furthermore, the growth in nonproducing states of capitals goods production also suggests that the manufacturing capacity outside the producing states will be necessary to meet future demand.

Capital goods top-5 sectors: Unconventional energy supply chain gross output in producing states* (2012 $M)

		2012	2015	2020	2025	CAGR**
3331	Agriculture, Construction, and Mining Machinery Manufacturing	5,958	6,880	6,401	6,960	1.2%
332410	Power Boiler and Heat Exchanger Manufacturing	3,409	2,647	1,017	905	-9.7%
333912	Air and Gas Compressor Manufacturing	3,118	3,972	4,397	4,888	3.5%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	2,834	3,597	3,974	4,409	3.5%
4238	Wholesale Machinery and Equipment	2,225	2,859	3,003	3,328	3.1%
Top-5 total		**17,542**	**19,956**	**18,792**	**20,490**	**1.2%**
Producing total		**24,825**	**28,702**	**27,675**	**30,590**	**1.6%**
US total		**34,531**	**41,859**	**43,229**	**48,649**	**2.7%**

*The ranking for all years are based on employment in 2014.

** Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Capital goods top-5 sectors: Unconventional energy supply chain gross output in nonproducing states* (2012 $M)

		2012	2015	2020	2025	CAGR**
3331	Agriculture, Construction, and Mining Machinery Manufacturing	2,549	3,522	4,314	5,016	5.3%
333912	Air and Gas Compressor Manufacturing	2,080	2,847	3,504	4,069	5.3%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	1,737	2,379	2,935	3,411	5.3%
333911	Pump and Pumping Equipment Manufacturing	1,011	1,386	1,699	1,971	5.3%
4238	Wholesale Machinery and Equipment	799	1,116	1,335	1,529	5.1%
Top-5 total		**8,175**	**11,250**	**13,787**	**15,996**	**5.3%**
Nonproducing total		**9,707**	**13,157**	**15,554**	**18,058**	**4.9%**
US total		**34,531**	**41,859**	**43,229**	**48,649**	**2.7%**

*The ranking for all years are based on employment in 2014.

** Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Air and Gas Compressor Manufacturing (NAICS 333912) is the largest growth segment for capital goods spending among unconventional supply chain activities. The top-5 producing states contribute twice as much output of air and gas compressor machinery and components than nonproducing states. Compressor production in nonproducing states is expected to grow at a compound annual growth rate of 5% through 2025, doubling output from $2 billion to near parity with producing states' output of $4 billion in 2025. New York, Oklahoma, and Illinois are projected to generate the largest output growth across all states. Florida, Texas, and Colorado are also expected to experience an appreciable rate of output growth from 2012 through 2025.

Top-5 producing states: Unconventional energy supply chain gross output in the Air and Gas Compressor Manufacturing sector* (2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	1,430	1,813	2,078	2,279	3.6%
Colorado	664	848	899	1,009	3.3%
California	390	486	488	508	2.1%
Oklahoma	215	282	343	394	4.8%
New Mexico	204	222	164	143	-2.7%
Top-5 total	**2,902**	**3,651**	**3,972**	**4,333**	**3.1%**
Producing total	**3,118**	**3,972**	**4,397**	**4,888**	**3.5%**
US total	**5,197**	**6,819**	**7,900**	**8,957**	**4.3%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Top-5 nonproducing states: Unconventional energy supply chain gross output in the Air and Gas Compressor Manufacturing sector*
(2012 $M)

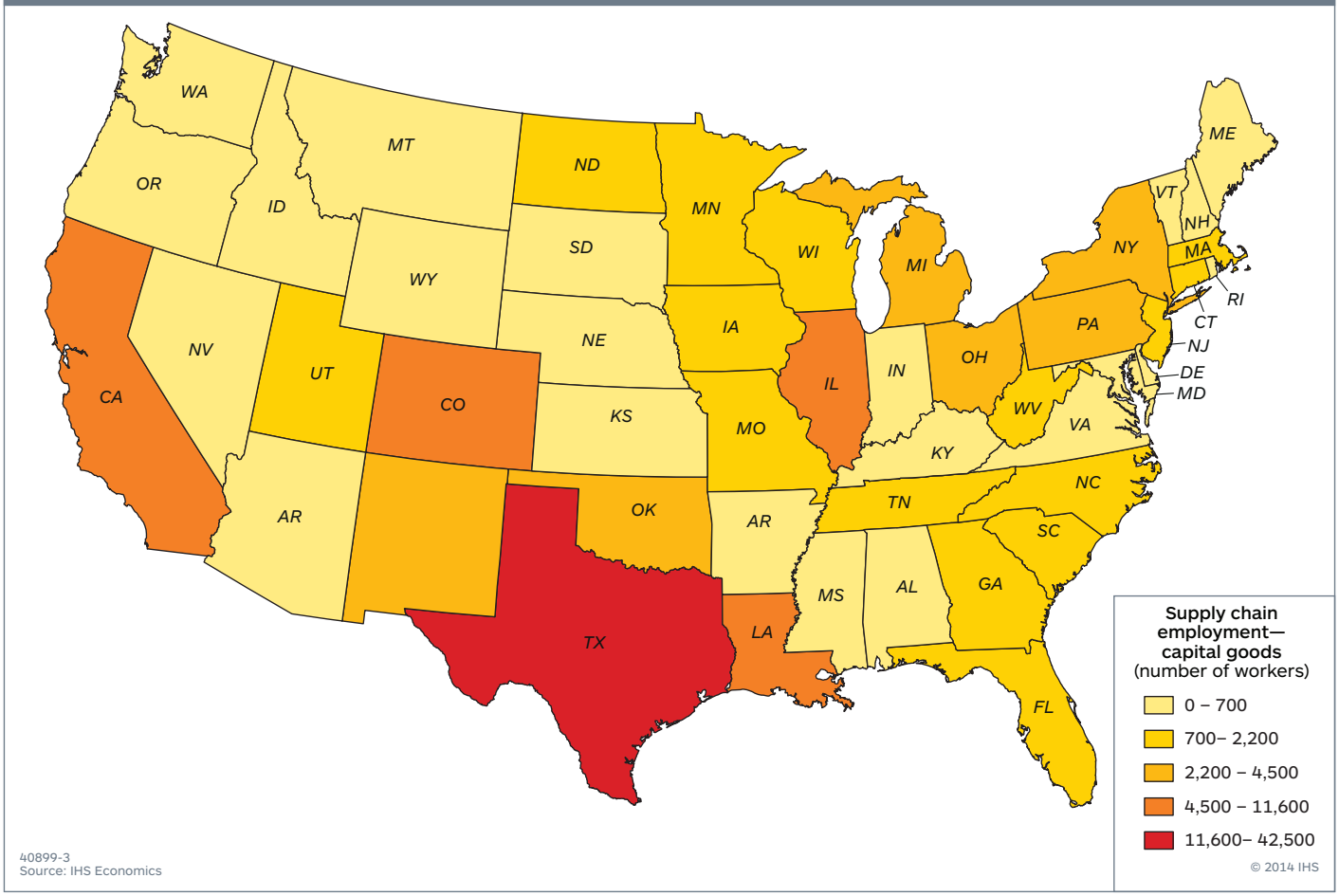
	2012	2015	2020	2025	CAGR**
New York	624	923	1,256	1,642	7.7%
Illinois	208	285	350	407	5.3%
Minnesota	160	187	189	194	1.5%
Missouri	122	156	175	176	2.9%
Florida	110	151	175	184	4.0%
Top-5 total	**1,224**	**1,702**	**2,144**	**2,603**	**6.0%**
Nonproducing total	**2,080**	**2,847**	**3,504**	**4,069**	**5.3%**
US total	**5,197**	**6,819**	**7,900**	**8,957**	**4.3%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Unconventional energy supply chain employment: Capital goods, 2014



40899-3
Source: IHS Economics

Agriculture, Construction, and Mining Machinery Manufacturing (NAICS 3331) is the single largest equipment sector in the unconventional supply chain in terms of gross output. Similar to the Air and Gas Compressor Manufacturing (NAICS 333912) sector, the Agriculture, Construction, and Mining Machinery Manufacturing sector is expected to shift production growth among producing and nonproducing states from 2012 to 2025. Producing states contributed nearly $6 billion of output in 2012, while nonproducing states contributed $2.5 billion. Yet nonproducing states are growing their share of off-highway machinery production destined for unconventional oil and gas at a compound annual rate of 5%, while producing states are expected to grow at just 1% per year through 2025, albeit off a high base of existing business. In this game of catch-up, some producing states, such as Louisiana, are expecting a slight decline in output between 2015 and 2020, so that by 2025, nonproducing states will be contributing up to 40% of output in the industry. Illinois, Minnesota, and Missouri are expected to grow their capital goods output at the fastest rates from 2012 through 2025.

Top-5 producing states: Unconventional energy supply chain gross output in the Agriculture, Construction, and Mining Machinery Manufacturing sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	2,507	2,809	2,804	3,017	1.4%
Colorado	905	1,142	1,203	1,351	3.1%
Louisiana	275	439	128	89	-8.3%
California	483	609	614	639	2.2%
Ohio	418	479	552	699	4.0%
Top-5 total	**4,588**	**5,478**	**5,301**	**5,795**	**1.8%**
Producing total	**5,958**	**6,880**	**6,401**	**6,960**	**1.2%**
US total	**8,506**	**10,402**	**10,715**	**11,976**	**2.7%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Top-5 nonproducing states: Unconventional energy supply chain gross output in the Agriculture, Construction, and Mining Machinery Manufacturing sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Illinois	1,013	1,352	1,678	1,937	5.1%
Iowa	372	537	617	671	4.6%
Wisconsin	202	268	286	338	4.0%
Missouri	126	209	285	341	8.0%
Minnesota	121	170	211	259	6.0%
Top-5 total	**1,835**	**2,536**	**3,076**	**3,546**	**5.2%**
Nonproducing total	**2,549**	**3,522**	**4,314**	**5,016**	**5.3%**
US total	**8,506**	**10,402**	**10,715**	**11,976**	**2.7%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Railroad Rolling Stock Manufacturing (NAICS 336510), dominated by tanker car production and, to a lesser extent, hopper car production, is a capital goods segment driven largely by the operational expenditures for transport of crude oil and materials for hydraulic fracturing. The top-5 states for railcar production contributed over $1.3 billion to US gross output in 2012 before leveling off to around $145 million on average in the latter years of the forecast period (2020 to 2025). Texas and Oregon are projected to show the largest output across all states up to 2016. Starting with 2017, IHS estimates that the manufacturing activity will be driven only by

annual scrapping replacement of around 2.5% of the fleet. Therefore, our estimates post-2017 for all the states are significantly lower compared with the first half of the forecast horizon.

Top-5 states: Unconventional energy supply chain gross output in the Railroad Rolling Stock Manufacturing sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	415	378	48	48	-15.2%
Oregon	357	323	33	33	-16.8%
Ohio	180	166	26	28	-13.4%
Pennsylvania	192	170	19	19	-16.1%
Arkansas	183	166	18	18	-16.5%
Top-5 total	**1,326**	**1,203**	**143**	**146**	**-15.6%**
US total	**1,682**	**1,541**	**220**	**228**	**-14.2%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

New heavy-duty truck production occurs in both producing and nonproducing states and is driven by spending for transport of raw materials such as water, sand, and chemicals which are integral to the hydraulic fracturing process. The top-5 states for heavy-duty truck production contribute $1.1 billion to US output in 2012, doubling to about $2.2 billion by 2015. Truck production across all states is expected to grow at a compound annual growth rate of 5.5% through 2025. Kentucky and Pennsylvania are projected to show the largest output growth across all states. Texas and California are also expected to experience an appreciable rate of output growth from 2012 through 2025.

Top-5 states: Unconventional energy supply chain gross output in the Heavy Duty Truck Manufacturing sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	895	1,143	1,500	1,874	5.9%
Oklahoma	131	111	85	67	-5.1%
Kentucky	49	67	98	134	8.0%
Pennsylvania	41	47	81	123	8.9%
California	19	20	31	41	6.2%
Top-5 total	**1,134**	**1,388**	**1,794**	**2,239**	**5.4%**
US total	**1,163**	**1,425**	**1,853**	**2,323**	**5.5%**

*Ranking for all years based on labor income in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Construction and well services

Construction activity is present through all aspects of the unconventional energy value chain as well as the supplemental construction activity in drilling regions that are not associated with unconventional oil and gas operator capital expenditure and operating expenditure. Suppliers within this group include general contractors, building trades, and other oil and gas field support services performed on a contract basis.

In certain regions within the United States, the substantial increase in unconventional oil and gas exploration and production from 2008 until the present helped blunt the economic distress suppliers would have otherwise experienced as a result of the collapse of the construction and real estate market. Amid a nationwide

rash of residential foreclosures and half-finished commercial developments, construction equipment demand remained strong within western Pennsylvania and the greater Denver area, buoyed by investment in unconventional oil and gas development.[12] Furthermore, when the US unemployment rate peaked at 9.9% in the fourth quarter of 2009, the unemployment rates in the Pittsburgh, Pennsylvania, and Midland, Texas, metropolitan statistical areas were 2 and 3 percentage points lower, respectively.

Construction and well services sectors: Unconventional energy supply chain gross output in producing states*
(2012 $M)

		2012	2015	2020	2025	CAGR**
213112	Support Activities for Oil and Gas Operations	21,072	27,810	33,323	39,612	5.0%
213111	Drilling Oil and Gas Wells	8,646	11,657	13,977	16,641	5.2%
23t	Construction of Other New Nonresidential Structures	8,139	10,237	11,324	13,463	3.9%
23tt	Construction of New Nonresidential Manufacturing Structures	13,829	9,559	3,071	2,444	-12.5%
Producing total		**51,686**	**59,264**	**61,694**	**72,160**	**2.6%**
US total		**52,190**	**59,959**	**62,265**	**72,798**	**2.6%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of upstream facilities and structures.

tt Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Source: IHS Economics

Construction and well services sectors: Unconventional energy supply chain gross output in nonproducing states*
(2012 $M)

		2012	2015	2020	2025	CAGR**
213112	Support Activities for Oil and Gas Operations	343	461	529	605	4.5%
23t	Construction of New Nonresidential Manufacturing Structures	161	235	42	33	-11.5%
23tt	Construction of Other New Nonresidential Structures	-	-	-	-	-
213111	Drilling Oil and Gas Wells	-	-	-	-	-
Nonproducing total		**504**	**695**	**570**	**638**	**1.8%**
US total		**52,190**	**59,959**	**62,265**	**72,798**	**2.6%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Growth in unconventional oil and gas-related construction spending in producing states is limited to the construction activity necessary for upstream oil and gas exploration and production. While certain sectors within the construction industry, such as Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures), are expected to decline from 2012 through 2025 (coming off a peak of near-term development of midstream and downstream infrastructure), most construction activities that create demand within the unconventional supply chain are expected to grow steadily in producing states due to continued upstream investment. Gross output in the Construction of Other New Nonresidential Structures (part of NAICS 23—construction of upstream facilities and structures) sector is forecasted to grow at a compound annual rate of 4% a year between 2012 and 2025 among producing states, expanding its contribution to output from $8.1 billion in 2012 to $13.5 billion in 2025.

12 Total employment in the construction industry in the Denver area recovered much faster from the Great Recession relative to the national average. According to the US Census Bureau, by 2012 total employment in construction increased by around 8% on an annual basis in the Denver metropolitan area while the US average increased by only 2.1%.

Support Activities for Oil and Gas Operations (NAICS 213112), which include exploration services, excavating, and services related to well surveying, preparation, and clean-up, is expected to grow even more rapidly than construction activities. It has the largest output within this supply chain component, contributing between $21 billion and $40 billion of gross output among producing states over the forecast horizon. Both producing and nonproducing states will grow at a strong compound annual rate of 4-5%, with the most rapid gains in the producing states.

The construction activity supported by the unconventional supply chain is broken down by the energy value chain segments: upstream, midstream, and downstream. The upstream construction activity takes place only in the producing states, while the activity related to midstream and downstream construction is spread across most of the states, including nonproducing ones. Midstream and downstream construction is represented by the following segments: pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Unconventional energy supply chain construction and well services: Gross output
(2012 $M)

	2012	2015	2020	2025
Producing states				
Construction services				
Upstream construction	8,139	10,237	11,324	13,463
Construction of pipelines	4,594	2,011	870	741
Construction of rail	470	215	35	27
Construction of marine structures	628	531	122	69
Construction of storage facilities	297	525	141	90
Construction of LNG export facilities*	1,138	2,492	558	402
Construction of manufacturing structures	6,702	3,785	1,345	1,116
Construction services total	**21,968**	**19,796**	**14,395**	**15,906**
Well services				
Support Activities for Oil and Gas Operations	21,072	27,810	33,323	39,612
Drilling Oil and Gas Wells	8,646	11,657	13,977	16,641
Well services total	**29,718**	**39,467**	**47,299**	**56,253**
Producing states total	**51,686**	**59,264**	**61,694**	**72,160**
Nonproducing states				
Construction services				
Upstream construction	0	0	0	0
Construction of pipelines	61	62	20	13
Construction of rail	69	73	13	13
Construction of marine structures	31	0	1	0
Construction of storage facilities	0	101	8	7
Construction of LNG export facilities*	0	0	0	0
Construction of manufacturing structures	0	0	0	0
Construction services total	**161**	**235**	**42**	**33**
Well services				
Support Activities for Oil and Gas Operations	343	461	529	605
Drilling Oil and Gas Wells	0	0	0	0
Well services total	**343**	**461**	**529**	**605**
Nonproducing states total	**504**	**695**	**570**	**638**
US total	**52,190**	**59,959**	**62,265**	**72,798**

*Estimates based on current projects in Texas and Louisiana and do not include proposed projects that are subject to additional approvals.

Source:IHS Economics

The states with the largest economic contributions in the construction sectors within the construction and well services core group supported by the unconventional energy supply chain are also the largest producing states. Texas and Pennsylvania account for more than 50% of gross output of the total unconventional energy supply chain construction activity over the forecast period.

Top-5 states: Unconventional energy supply chain gross output in construction and well services* (2012 $M)

	2012	2015	2020	2025
Construction services				
Texas	9,768	7,963	6,281	6,464
Louisiana	1,923	2,948	1,324	1,580
North Dakota	1,734	2,586	1,266	1,233
Pennsylvania	3,180	1,221	1,336	1,623
Oklahoma	1,182	1,275	1,684	2,128
Top-5 total	**17,787**	**15,994**	**11,891**	**13,028**
Construction services total	**22,129**	**20,031**	**14,437**	**15,940**
Well services				
Texas	8,986	10,798	12,526	13,394
Pennsylvania	6,112	9,687	12,600	16,238
Louisiana	4,855	4,452	4,712	5,842
Colorado	3,273	3,676	4,409	5,081
North Dakota	1,828	2,868	2,989	3,111
Top-5 total	**25,053**	**31,482**	**37,237**	**43,666**
Well services total	**30,061**	**39,928**	**47,828**	**56,858**
US total	**52,190**	**59,959**	**62,265**	**72,798**

*Ranking for all years based on results in 2014.

Source:IHS Economics

The Utica Shale play has transformed the construction industry in eastern Ohio[13]

The diversity of recoverable resources in the Utica Shale (natural gas and oil, as well as natural gas liquids) drives the demand for a diverse supply chain. In order to maintain and grow the production of Utica resources, producers rely on a multitude of industries, which have transformed the construction and manufacturing sectors in Ohio.

For example, the oil and gas exploration of the Utica play has fueled the recent expansion of Bolt Construction. Bolt, an equipment manufacturing supplier to the oil and gas industry based in Youngstown Ohio, specializes in the construction of hydrant systems, compressor stations, and piping components. Over the past three years, the company has been experiencing record sales, driven mainly by unconventional activity in the Utica Shale in the eastern part of Ohio. Over the past several years, the company has doubled the size of its offices and more than tripled the number of its employees, from 30 a few years ago to more than 100 today. In order to accommodate the increased demand from oil and gas companies operating in the area, Bolt is in the process of building a state-of-the-art fabrication shop and is planning to expand its workforce even further.

13 The Business Journal, Youngstown, Ohio, September 24, 2012.

Logistics

The logistics group includes four supply chain sectors: General Freight Trucking (NAICS 4841); Pipeline Transportation (NAICS 486); Rail Transportation (NAICS 4821); and Water Transportation (NAICS 483). While the producing states account for more than 80% of the total economic benefits in the logistics core group in terms of gross output, the nonproducing states are more dynamic, with their output increasing at a larger annual growth rate than the producing states.

In both producing and nonproducing states, the largest output contributions supported by the unconventional energy activity are experienced by General Freight Trucking (NAICS 4841), while output generated by the Pipeline Transportation sector (NAICS 486) is expected to increase the most over the forecast horizon. In producing states, output in the logistics core group is expected to increase from $4.8 billion in 2012 to almost $8 billion in 2025, while in nonproducing states output will increase from just over $800 million to more than $1.5 billion in 2025.

Logistics sectors: Unconventional energy supply chain gross output in producing states* (2012 $M)

		2012	2015	2020	2025	CAGR**
4841	General Freight Trucking	2,825	3,602	4,090	4,611	3.8%
486	Pipeline Transportation	985	1,442	1,639	1,816	4.8%
4821	Rail Transportation	931	1,155	1,227	1,396	3.2%
483	Water Transportation	115	141	151	171	3.1%
Producing total		**4,856**	**6,341**	**7,107**	**7,994**	**3.9%**
US total		**5,672**	**7,493**	**8,462**	**9,558**	**4.1%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Logistics sectors: Unconventional energy supply chain gross output in nonproducing states* (2012 $M)

		2012	2015	2020	2025	CAGR**
4841	General Freight Trucking	448	628	737	851	5.1%
4821	Rail Transportation	216	296	337	380	4.4%
486	Pipeline Transportation	92	143	183	223	7.0%
483	Water Transportation	60	85	98	111	4.8%
Nonproducing total		**816**	**1,152**	**1,355**	**1,564**	**5.1%**
US total		**5,672**	**7,493**	**8,462**	**9,558**	**4.1%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

The General Freight Trucking industry (NAICS 4841) will continue to experience steady growth among both producing and nonproducing states' unconventional supply chain activities. Producing states, predominantly Texas, will continue to drive this sector through 2025. Texas alone contributed $1.5 billion of gross output in General Freight Trucking in 2012 while the total of the top-5 nonproducing states contributed $156 million of gross output in 2012—just one tenth of the total output of Texas. While output contributions from the top-5 nonproducing states are expected to grow to nearly to $292 million by 2025, with a compound annual growth rate of 5% from 2012 through 2025, their projected output contribution will remain miniscule compared with producing states. Nonproducing states' General Freight Trucking output contribution of $851 million in 2025 is just 18% of the producing states' forecasted output of $4.6 billion in 2025.

Top-5 producing states: Unconventional energy supply chain gross output in the General Freight Trucking sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	1,495	1,816	2,087	2,246	3.2%
Louisiana	177	252	216	249	2.7%
Oklahoma	163	241	354	450	8.1%
North Dakota	165	237	232	241	3.0%
Pennsylvania	182	199	254	318	4.4%
Top-5 total	**2,181**	**2,746**	**3,142**	**3,503**	**3.7%**
Producing total	**2,825**	**3,602**	**4,090**	**4,611**	**3.8%**
US total	**3,273**	**4,230**	**4,827**	**5,461**	**4.0%**

*Ranking for all years based on gross output in 2014.
**Compound annual growth rate from 2012 to 2025.
Source: IHS Economics

Top-5 nonproducing states: Unconventional energy supply chain gross output in the General Freight Trucking sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Illinois	40	56	66	77	5.1%
Tennessee	34	45	49	52	3.3%
Georgia	28	42	50	58	5.7%
Indiana	28	40	46	52	4.9%
Michigan	26	37	45	53	5.7%
Top-5 total	**156**	**220**	**256**	**292**	**4.9%**
Nonproducing total	**448**	**628**	**737**	**851**	**5.1%**
US total	**3,273**	**4,230**	**4,827**	**5,461**	**4.0%**

*Ranking for all years based on gross output in 2014.
**Compound annual growth rate from 2012 to 2015.
Source: IHS Economics

Oklahoma, Georgia, and Michigan are expected to experience the highest output contribution growth in the General Freight Trucking sector (NAICS 4841) with annual growth rates ranging from 6–8% from 2012 through 2025. Texas will continue to dominate the industry and will continue to grow at a steady 3% per year, while the average of all other producing states will continue to grow at a steady 4% per year from 2012 through 2025.

Materials

The materials group includes various raw material products such as iron and steel, non-ferrous metals, sand, gravel, cement, industrial gas, chemicals, and fabricated metals.

Materials production output in the unconventional supply chain is expected to grow steadily between 2012 and 2025, with larger growth rates among the nonproducing states, but larger levels of output in the producing states. The largest output growth will be in Construction Sand and Gravel Mining (NAICS 212321) and Industrial Gas Manufacturing (NAICS 325120), an input to the manufacturing of goods in the supply chain. Nonproducing states' growth in the materials component of the unconventional supply chain will outpace the producing states' by 2.8 percentage points through 2025.

Materials top-5 sectors: Unconventional energy supply chain gross output in producing states* (2012 $M)

		2012	2015	2020	2025	CAGR**
3312	Steel Product Manufacturing from Purchased Steel	8,869	9,284	8,059	8,935	0.1%
212321	Construction Sand and Gravel Mining	4,301	5,269	5,968	6,589	3.3%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	3,743	4,104	3,918	4,314	1.1%
325120	Industrial Gas Manufacturing	2,975	3,876	4,478	5,022	4.1%
325180	Other Basic Inorganic Chemical Manufacturing	2,436	3,160	3,645	4,076	4.0%
Top-5 total		**22,324**	**25,694**	**26,069**	**28,936**	**2.0%**
Producing total		**29,614**	**34,204**	**34,827**	**38,800**	**2.1%**
US total		**84,654**	**105,518**	**115,696**	**136,497**	**3.7%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Materials top-5 sectors: Unconventional energy supply chain gross output in nonproducing states* (2012 $M)

		2012	2015	2020	2025	CAGR**
212321	Construction Sand and Gravel Mining	1,863	2,625	3,091	3,584	5.2%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	1,605	2,186	2,543	2,940	4.8%
3312	Steel Product Manufacturing from Purchased Steel	1,033	1,454	1,467	1,653	3.7%
325120	Industrial Gas Manufacturing	493	734	933	1,122	6.5%
4235	Wholesale Metal and Mineral	261	361	385	392	3.2%
Top-5 total		**5,254**	**7,360**	**8,418**	**9,692**	**4.8%**
Nonproducing total		**6,317**	**8,938**	**10,362**	**12,061**	**5.1%**
US total		**84,654**	**105,518**	**115,696**	**136,497**	**3.7%**

*Ranking for all years based on gross output in 2014.

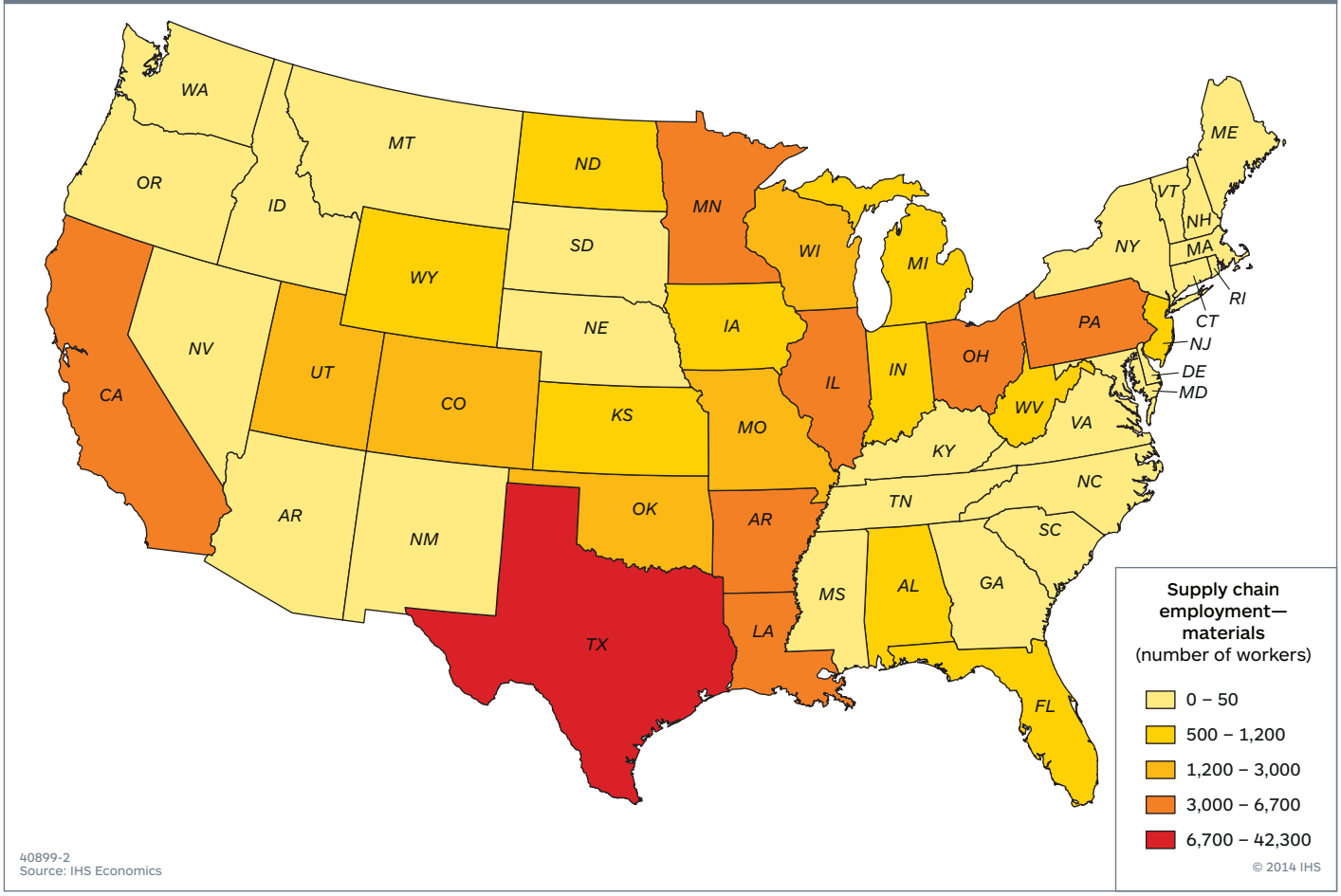
**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

The Construction Sand and Gravel Mining industry (NAICS 212321) is a major material component in the unconventional supply chain, and is included in the top-5 materials components of the supply chain in both producing and nonproducing states. While the top-5 producing states have higher output of Construction Sand and Gravel Mining and are expected to continue to grow at a compound annual growth rate of 3% over the 2012–25 period, the top-5 nonproducing states are projected to expand output by 5% annually, 2 percentage points higher than producing states, through 2025. Ohio, Pennsylvania, and Minnesota are expected to grow at the fastest rates from 2012 through 2025. By 2025, Construction Sand

and Gravel Mining output in the top-4 nonproducing states will exceed output for 3 of the top-5 producing states, indicating a shifting trend towards sourcing from nonproducing states to meet demand for this critical material.

Unconventional energy supply chain employment: Materials, 2014



40899-2
Source: IHS Economics

Top-5 producing states: Unconventional energy supply chain gross output in the Construction Sand and Gravel Mining sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	3,114	3,781	4,255	4,636	3.1%
Arkansas	879	1,077	1,253	1,395	3.6%
Ohio	115	179	251	327	8.4%
California	112	121	88	93	-1.4%
Pennsylvania	21	33	44	50	6.7%
Top-5 total	**4,241**	**5,192**	**5,891**	**6,501**	**3.3%**
Producing total	**4,301**	**5,269**	**5,968**	**6,589**	**3.3%**
US total	**6,164**	**7,895**	**9,058**	**10,174**	**3.9%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2015.

Source: IHS Economics

Top-5 nonproducing states: Unconventional energy supply chain gross output in the Construction Sand and Gravel Mining sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Minnesota	504	841	1,022	1,210	7.0%
Wisconsin	512	641	786	933	4.7%
Illinois	438	617	662	725	4.0%
Missouri	278	354	428	493	4.5%
Iowa	74	93	101	118	3.7%
Top-5 total	**1,805**	**2,546**	**2,998**	**3,479**	**5.2%**
Nonproducing total	**1,863**	**2,625**	**3,091**	**3,584**	**5.2%**
US total	**6,164**	**7,895**	**9,058**	**10,174**	**3.9%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2015.

Source: IHS Economics

Demand for steel plate, the material used in pipe production as well the heavy machinery found in the energy supply chain, continues to grow despite overproduction in other product areas of the steel industry. Steel Product Manufacturing from Purchased Steel industry (NAICS 3312) is an unconventional supply chain sector that also indicates shifting growth trends. While the top-5 producing states contribute nearly 8 times the output of Steel Product Manufacturing from Purchased Steel than nonproducing states (e.g. oil country tubular goods production in Texas, Pennsylvania, and Ohio), output growth is stagnating among producing states. Nonproducing states are expected to grow at 4% per year through 2025, though this growth does not rise to even 20% of producing states' total sector output of $8.9 billion in 2025. While Texas, Ohio, and Pennsylvania are projected to show the largest output, Illinois, Michigan, and Indiana are expected to have the largest percentage output growth from 2012 through 2025.

Top-5 producing states: Unconventional energy supply chain gross output in the Steel Product Manufacturing from Purchased Steel sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	4,395	3,932	3,738	4,042	-0.6%
Louisiana	630	937	541	537	-1.2%
Ohio	884	1,080	941	1,108	1.8%
Pennsylvania	844	914	1,013	1,166	2.5%
Arkansas	559	721	779	873	3.5%
Top-5 total	**7,312**	**7,584**	**7,011**	**7,725**	**0.4%**
Producing total	**8,869**	**9,284**	**8,059**	**8,935**	**0.1%**
US total	**9,901**	**10,739**	**9,526**	**10,588**	**0.5%**

*Ranking for all years based on gross output in 2014.
**Compound annual growth rate from 2012 to 2015.
Source: IHS Economics

Top-5 nonproducing states: Unconventional energy supply chain gross output in the Construction Sand and Gravel Mining sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Minnesota	504	841	1,022	1,210	7.0%
Wisconsin	512	641	786	933	4.7%
Illinois	438	617	662	725	4.0%
Missouri	278	354	428	493	4.5%
Iowa	74	93	101	118	3.7%
Top-5 total	**1,805**	**2,546**	**2,998**	**3,479**	**5.2%**
Nonproducing total	**1,863**	**2,625**	**3,091**	**3,584**	**5.2%**
US total	**6,164**	**7,895**	**9,058**	**10,174**	**3.9%**

*Ranking for all years based on gross output in 2014.
**Compound annual growth rate from 2012 to 2015.
Source: IHS Economics

Professional and other services

Typically associated with operational expenditures, professional and other services represent a wide range of functions, including environmental engineering; occupational health and safety; and financial, insurance, and real estate services.

Professional and other services identified as part of the unconventional oil and natural gas supply chain are expected to expand through 2025, especially in Architectural, Engineering, and Related Services (NAICS 5413), yet another indication of the significance of construction-related activity

within the unconventional supply chain. Producing states compose the bulk of the supply chain in professional and other services output, where the top-5 states generate nearly $14 billion of output in 2012, growing to over $18 billion of output by 2025. At $1.7 billion, the top-5 nonproducing states contributed about 12% of the output that the top-5 producing states generated in 2012. While the top-5 nonproducing states' rate of growth, as measured by the compound annual rate, increases at a more rapid pace than the top-5 producing states, nonproducing states will still lag producing states at a contribution of $3.7 billion of professional and other services sector output versus the producing states' output of $20 billion by 2025.

Professional and other services top-5 sectors: Unconventional energy supply chain gross output in producing states*
(2012 $M)

		2012	2015	2020	2025	CAGR**
5413	Architectural, Engineering, and Related Services	7,418	8,184	7,344	8,062	0.6%
2213	Water, Sewage and Other Systems	2,828	3,574	3,940	4,452	3.6%
5419	Other Professional, Scientific, and Technical Services	1,430	1,776	1,838	2,053	2.8%
5241	Insurance Carriers	1,275	1,646	1,835	2,114	4.0%
532412	Construction, Mining and Forestry Machinery and Equipment Rental and Leasing	1,189	1,574	1,732	1,942	3.8%
Top-5 total		**14,139**	**16,754**	**16,689**	**18,623**	**2.1%**
Producing total		**15,416**	**18,256**	**18,201**	**20,317**	**2.1%**
US total		**17,357**	**21,070**	**21,477**	**24,041**	**2.5%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Professional and other services top-5 sectors: Unconventional energy supply chain gross output in nonproducing states*
(2012 $M)

		2012	2015	2020	2025	CAGR**
5413	Architectural, Engineering, and Related Services	959	1,393	1,597	1,806	5.0%
5419	Other Professional, Scientific, and Technical Services	322	467	547	619	5.2%
532412	Construction, Mining and Forestry Machinery and Equipment Rental and Leasing	212	312	376	436	5.7%
811310	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	130	186	219	251	5.2%
4931	Warehousing and Storage	128	180	212	242	5.0%
Top-5 total		**1,751**	**2,538**	**2,951**	**3,355**	**5.1%**
Nonproducing total		**1,942**	**2,814**	**3,276**	**3,724**	**5.1%**
US total		**17,357**	**21,070**	**21,477**	**24,041**	**2.5%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Architectural, Engineering, and Related Services (NAICS 5413) is the largest sector in the professional and other services core group of the unconventional supply chain. Producing states dominate this sector, with the top-5 producing states contributing $7.4 billion of gross output in 2012 while the top-5 nonproducing states contribute only 13%, or nearly $1 billion, of gross output in 2012. Nonproducing states are expected to nearly double output contributions to $1.8 billion by 2025, at a compound annual growth rate of 5% from 2012 through 2025. But their projected output contribution will remain under a quarter of the contribution of the producing states' Architectural and Engineering, and Related Services output contribution of $8 billion by 2025, which grows at rate of 1% per year.

The nonproducing states of Virginia, Florida, and Michigan are expected to expand output contributions in Architectural, Engineering, and Related Services at the highest growth rates from 2012 through 2025, while the producing states of Texas, Pennsylvania, and Louisiana are projected to have the largest output by millions of dollars in that same time period. Louisiana, North Dakota, and Texas are projected to have slower growth through the forecast period, and in the case of Louisiana and North Dakota, gross output begins declining after 2015, partially as a function of the substantial investment that has already occurred in these states.

Top-5 producing states: Unconventional energy supply chain gross output in the Architectural, Engineering, and Related Services sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Texas	3,261	3,242	3,102	3,237	-0.1%
Louisiana	782	1,083	551	562	-2.5%
North Dakota	602	903	543	534	-0.9%
Pennsylvania	580	501	605	749	2.0%
Ohio	325	384	432	556	4.2%
Top-5 total	**5,551**	**6,113**	**5,234**	**5,639**	**0.1%**
Producing total	**7,418**	**8,184**	**7,344**	**8,062**	**0.6%**
US total	**8,376**	**9,578**	**8,941**	**9,868**	**1.3%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2015.

Source: IHS Economics

Top-5 nonproducing states: Unconventional energy supply chain gross output in the Architectural, Engineering, and Related Services sector*
(2012 $M)

	2012	2015	2020	2025	CAGR**
Virginia	118	179	230	272	6.7%
New York	99	139	150	163	4.0%
Michigan	74	112	131	154	5.8%
Florida	73	110	129	149	5.7%
Massachusetts	59	82	84	87	3.0%
Top-5 total	**421**	**623**	**724**	**826**	**5.3%**
Nonproducing total	**959**	**1,393**	**1,597**	**1,806**	**5.0%**
US total	**8,376**	**9,578**	**8,941**	**9,868**	**1.3%**

*Ranking for all years based on gross output in 2014.

**Compound annual growth rate from 2012 to 2015.

Source: IHS Economics

State snapshots

Unconventional oil and gas production primes the economic engine for a diverse set of industries across the lower 48 states. The producing states of Colorado, Ohio, Oklahoma, Pennsylvania, and Texas, and the nonproducing state of Illinois are among the top states with unconventional supply chain activities directly benefitting from increased unconventional oil and gas production. IHS Economics compiled state snapshots that summarize the top state-level supply chain industries' contributions (by employment and output) as examples of the economic reverberations that go beyond upstream and midstream operators to reach labor, manufacturing, and services in these states. To estimate the total economic contribution of the unconventional supply chain on employment, we developed two measures of impact for the eight states captured in this section (Colorado, Ohio, Oklahoma, Pennsylvania, Texas, Illinois, North Dakota, and

Louisiana): Unconventional supply chain employment as a share of total unconventional energy activity employment as a share of total state employment.

The shares of the unconventional energy supply chain employment in total state employment among the eight states analyzed range from 0.1% in Illinois in 2012 to 7% in 2015 in North Dakota. Each state analyzed is expected to grow its share of supply chain employment relative to overall state employment through 2025, with the exception of Texas. The largest proportional supply chain employment growth will be in Oklahoma, which will grow from 1.4% in 2012 to 2.9% in 2025.

Several of the eight states had active plays in proximity to metropolitan statistical areas (MSA). MSA total employment is contrasted with MSA employment in the natural resources, construction and mining sectors to give a sense of the importance of these industries to the MSA area. State-level supply chain employment in natural resources, construction, and total mining are compared with MSA level employment in those industries, which provides insight into the depth of supply chain impacts on the state and MSA. For example, Texas's combined Midland and Lubbock MSAs have employment in natural resources, construction, and mining that is less significant when compared with the employment in the state's overall unconventional oil and gas supply chain activities. Ohio's state-level employment in natural resources, construction, and mining will grow rapidly, even surpassing employment levels in the same industries in the Youngstown-Warren-Boardman MSA by 2025.

Producing states

Colorado

Investment in development of the Niobrara Shale formation in Colorado's Denver-Julesburg basin is in the early stages, but is expected to increase significantly. The top-5 unconventional supply chain industries are expected to contribute over 25,000 jobs to the state economy and $8.2 billion of gross output by 2025.

Employment snapshot: Colorado

	2012	2025
Denver-Aurora-Broomfield, CO MSA		
Employment: total	1,249,017	1,589,938
Employment: Construction, natural resources, and mining	73,266	118,524
Colorado		
Unconventional supply chain employment: Construction, natural resources, and mining	11,365	17,430

Source: IHS

- The percentage of total employment resulting from unconventional supply chain activity will be approximately 1.5% by 2025.
- Employment contributions from the unconventional energy activity are expected to grow to 3% of Colorado's total state employment by 2025.
- IHS estimates total employment in the Denver MSA will increase to about 1.6 million jobs by 2025. Among that growth, over 118,000 jobs will be in the construction, natural resources, and mining industries.
- By 2025, Colorado unconventional supply chain activities are expected to generate over 17,000 jobs in construction, natural resources, and mining industries.

"Shale energy development has not only allowed Wagner Equipment Co. to grow our business, it has demanded that we do so. We have a large territory and we are committed to serve our customers. Where we have a robust energy sector our more traditional markets are active as well. Residential and commercial construction, road building, aggregate production and land reclamation all have rebounded dramatically. In the areas with energy development we are adding resources, investing in facilities, and hiring local people. This has made us a stronger company and has provided additional strength and security across our three state footprint, even in areas far from the actual activity. Some of the greatest challenges we face today are in meeting the demands of the business opportunities presented by this resurgence in demand. We are working with local community colleges to train more qualified workers to meet our hiring needs, an unthinkable proposition just a few years ago.

While we are pleased and thankful for the current situation, we, like most people in the business community, remain cautious. We have seen how fast things can change. There is great uncertainty in the world today and significant opposition remains toward the energy industry. We understand the concerns and are committed to doing our part to promote responsible energy development in all of the areas we serve. This is where we live with our families and neighbors. This is our home too." Mike Quirk, Wagner Equipment Company, Aurora, Colorado

Colorado

		2012	2015	2020	2025	CAGR**
Top-5 sectors: Unconventional energy supply chain employment* (Number of workers)						
213112	Support Activities for Oil and Gas Operations	6,064	6,756	8,176	9,929	3.9%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	3,590	4,617	4,928	5,832	3.8%
5413	Architectural, Engineering, and Related Services	1,957	2,461	2,724	3,445	4.4%
23[t]	Construction of Other New Nonresidential Structures	2,044	2,393	2,683	3,679	4.6%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	1,720	2,150	2,276	2,690	3.5%
Top-5 employment total		**15,375**	**18,377**	**20,787**	**25,574**	**4.0%**
Supply chain employment total		**26,555**	**31,202**	**34,352**	**42,133**	**3.6%**
Supply chain employment as share of state employment		1.1%	1.2%	1.2%	1.5%	
Total energy activity employment as share of state employment		2.1%	2.4%	2.5%	3.0%	
Top-5 sectors: Unconventional energy supply chain labor income* (2012 $M)						
213112	Support Activities for Oil and Gas Operations	562	624	751	884	3.5%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	246	315	335	384	3.5%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	176	220	232	265	3.2%
5413	Architectural, Engineering, and Related Services	166	203	223	277	4.0%
213111	Drilling Oil and Gas Wells	154	179	215	251	3.8%
Top-5 labor income total		**1,304**	**1,541**	**1,755**	**2,061**	**3.6%**
Supply chain labor income total		**2,242**	**2,609**	**2,874**	**3,415**	**3.3%**
Top-5 sectors: Unconventional energy supply chain gross output* (2012 $M)						
213112	Support Activities for Oil and Gas Operations	2,299	2,545	3,056	3,528	3.3%
213111	Drilling Oil and Gas Wells	975	1,131	1,353	1,553	3.6%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	905	1,142	1,203	1,351	3.1%
333912	Air and Gas Compressor Manufacturing	664	848	899	1,009	3.3%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	545	696	737	828	3.3%
Top-5 gross output total		**5,386**	**6,362**	**7,248**	**8,269**	**3.4%**
Supply chain gross output total		**8,777**	**10,079**	**11,062**	**12,783**	**2.9%**
Unconventional energy supply chain government revenue (Current $M)						
Federal taxes		442	525	630	779	4.4%
State and local taxes		482	567	678	821	4.2%
Supply chain government revenue total		**925**	**1,091**	**1,308**	**1,600**	**4.3%**

*Ranking for all years based on results in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Source: IHS Economics

Ohio

Utica Shale development is still in its early stages but has expanded rapidly. Adequate midstream capacity development is needed before Ohio can fully tap Utica Shale potential, which will require significant investment.

Employment snapshot: Ohio

	2012	2025
Youngstown-Warren-Boardman, OH-PA MSA		
Employment: total	225,025	233,318
Employment: Construction, natural resources, and mining	9,333	11,588
Ohio		
Unconventional supply chain employment: Construction, natural resources, and mining	3,797	17,669

Source: IHS

Unconventional oil and natural gas activities, including infrastructure developement, within the Utica Shale formation in Ohio are expected to contribute more heavily to economic growth later in the 2012–25 forecast period. The top-5 supply chain industries by 2025 are expected to contribute over 18,000 jobs to the Ohio economy and $5 billion of gross output.

- The ratio of employment resulting from unconventional supply chain activity to the total employment in Ohio will be approximately 0.7% by 2025.
- The unconventional oil and gas employment contribution to the Ohio economy is expected to grow to 2% of Ohio's total state employment by 2025.
- The Youngstown MSA is expected to increase total employment to 233,000 by 2025. Among the total, over 11,000 jobs will be in the construction, natural resources, and mining industries.
- Statewide unconventional supply chain employment is expected to generate close to 18,000 jobs in the construction, natural resources, and mining industries by 2025.

Ohio

		2012	2015	2020	2025	CAGR**
Top-5 sectors: Unconventional energy supply chain employment* (Number of workers)						
23[t]	Construction of New Nonresidential Manufacturing Structures	2,691	1,828	632	432	-13.1%
5413	Architectural, Engineering, and Related Services	1,623	2,179	3,021	4,131	7.4%
213112	Support Activities for Oil and Gas Operations	227	2,653	4,663	6,592	29.6%
3312	Steel Product Manufacturing from Purchased Steel	1,261	1,605	1,521	1,900	3.2%
23[tt]	Construction of Other New Nonresidential Structures	208	2,230	3,836	5,686	29.0%
Top-5 employment total		**6,011**	**10,496**	**13,673**	**18,741**	**9.1%**
Supply chain employment total		**13,123**	**21,869**	**29,009**	**39,704**	**8.9%**
Supply chain employment as share of state employment		0.2%	0.4%	0.5%	0.7%	
Total energy activity employment as share of state employment		0.5%	1.0%	1.5%	2.0%	
Top-5 sectors: Unconventional energy supply chain labor income* (2012 $M)						
23[t]	Construction of New Nonresidential Manufacturing Structures	150	96	35	24	-13.1%
5413	Architectural, Engineering, and Related Services	129	177	245	330	7.5%
213112	Support Activities for Oil and Gas Operations	21	245	429	587	29.2%
3312	Steel Product Manufacturing from Purchased Steel	120	151	140	170	2.7%
23[tt]	Construction of Other New Nonresidential Structures	12	128	220	315	28.6%
Top-5 labor income total		**432**	**796**	**1,069**	**1,427**	**9.6%**
Supply chain labor income total		**1,041**	**1,757**	**2,343**	**3,120**	**8.8%**
Top-5 sectors: Unconventional energy supply chain gross output* (2012 $M)						
3312	Steel Product Manufacturing from Purchased Steel	884	1,080	941	1,108	1.8%
23[t]	Construction of New Nonresidential Manufacturing Structures	686	488	160	108	-13.2%
213112	Support Activities for Oil and Gas Operations	90	1,047	1,826	2,453	28.9%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	476	580	523	609	1.9%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	418	479	552	699	4.0%
Top-5 gross output total		**2,554**	**3,673**	**4,002**	**4,977**	**5.3%**
Supply chain gross output total		**4,750**	**7,407**	**8,892**	**11,419**	**7.0%**
Unconventional energy supply chain government revenue (Current $M)						
Federal taxes		174	330	489	681	11.1%
State and local taxes		197	361	532	724	10.5%
Supply chain government revenue total		**371**	**691**	**1,021**	**1,405**	**10.8%**

*Ranking for all years based on results in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Oklahoma

According to the Energy Information Administration (EIA), Oklahoma produced 366,000 barrels of crude oil per day in May 2014 and is currently the fifth-largest shale gas producing. Several emerging unconventional oil plays are attracting significant energy company investment.

In 2015, the top-5 supply chain industries are expected to contribute over 18,000 jobs to the Oklahoma economy and $4.5 billion of gross output.

- The ratio of employment resulting from unconventional supply chain activity to the total state economy's employment will be approximately 2.9% by 2025.
- The employment contribution from unconventional energy activity to the Oklahoma economy is expected to grow to 6.7% of Oklahoma's total state employment.
- Construction employment and gross output are expected to more than double from 2012 through 2025.
- Unconventional supply chain employment stemming from support activities for oil and gas operations is expected to triple and gross output is expected to more than double from 2012 through 2025.

Oklahoma

		2012	2015	2020	2025	CAGR**
Top-5 sectors: Unconventional energy supply chain employment* (Number of workers)						
23t	Construction of Other New Nonresidential Structures	5,484	7,364	10,220	13,930	7.4%
213112	Support Activities for Oil and Gas Operations	3,000	4,642	6,802	9,224	9.0%
5413	Architectural, Engineering, and Related Services	2,226	2,849	4,199	5,562	7.3%
4841	General Freight Trucking	1,243	1,884	2,789	3,718	8.8%
2213	Water, Sewage and Other Systems	1,099	1,649	2,326	3,153	8.4%
Top-5 employment total		**13,052**	**18,387**	**26,336**	**35,587**	**8.0%**
Supply chain employment total		**23,475**	**30,093**	**41,025**	**53,755**	**6.6%**
Supply chain employment as share of state employment		1.4%	1.8%	2.3%	2.9%	
Total energy activity employment as share of state employment		2.8%	3.9%	5.2%	6.7%	
Top-5 sectors: Unconventional energy supply chain labor income* (2012 $M)						
23t	Construction of Other New Nonresidential Structures	317	424	586	773	7.1%
213112	Support Activities for Oil and Gas Operations	278	429	625	821	8.7%
5413	Architectural, Engineering, and Related Services	173	230	340	442	7.5%
2213	Water, Sewage and Other Systems	114	170	239	314	8.1%
213111	Drilling Oil and Gas Wells	80	121	178	235	8.7%
Top-5 labor income total		**961**	**1,374**	**1,968**	**2,585**	**7.9%**
Supply chain labor income total		**1,755**	**2,341**	**3,195**	**4,074**	**6.7%**
Top-5 sectors: Unconventional energy supply chain gross output* (2012 $M)						
213112	Support Activities for Oil and Gas Operations	1,156	1,777	2,584	3,330	8.5%
23t	Construction of Other New Nonresidential Structures	861	1,148	1,581	2,046	6.9%
213111	Drilling Oil and Gas Wells	504	766	1,122	1,451	8.5%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	335	432	522	599	4.6%
5413	Architectural, Engineering, and Related Services	302	393	575	734	7.1%
Top-5 gross output total		**3,158**	**4,515**	**6,384**	**8,160**	**7.6%**
Supply chain gross output total		**6,113**	**8,064**	**10,875**	**13,538**	**6.3%**
Unconventional energy supply chain government revenue (Current $M)						
Federal taxes		322	447	663	887	8.1%
State and local taxes		357	488	723	944	7.8%
Supply chain government revenue total		**679**	**935**	**1,386**	**1,831**	**7.9%**

*Ranking for all years based on results in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of upstream facilities and structures.

Source: IHS Economics

Pennsylvania

As the birthplace of the fossil fuel industry, Pennsylvania is once again experiencing the resurgence of an economy driven by energy exploration and production. Sitting atop the heart of the Marcellus Shale, one of the world's largest deposits of natural gas, Pennsylvania is at the vanguard of the unconventional oil and natural gas revolution. Unconventional energy activity and operations in Pennsylvania have had a sizable positive impact on the state economy, evident even in the grip of the recent Great Recession.

Employment snapshot: Pennsylvania

	2012	2025
Pittsburgh, PA MSA		
Employment: total	1,157,258	1,226,036
Employment: Construction, natural resources, and mining	63,926	84,892
Pennsylvania		
Unconventional supply chain employment: Construction, natural resources, and mining	31,955	52,415

Source: IHS

- The ratio of employment resulting from unconventional supply chain activity to the total state economy's employment will be approximately 1.2% by 2025.
- The unconventional energy employment contribution to the economy is expected to grow to 2.7% of Pennsylvania's total state employment by 2025.
- Employment in the Pittsburgh MSA is expected to increase to over 1.2 million jobs by 2025. Among that growth, nearly 85,000 jobs will be in the construction, natural resources, and mining industries.
- Unconventional supply chain activities are expected to generate over 52,000 jobs in the construction, natural resources, and mining industries by 2025.

Pennsylvania

		2012	2015	2020	2025	CAGR**
Top-5 sectors: Unconventional energy supply chain employment* (Number of workers)						
213112	Support Activities for Oil and Gas Operations	10,694	16,778	21,999	29,823	8.2%
23[t]	Construction of Other New Nonresidential Structures	5,564	7,995	9,804	13,340	7.0%
213111	Drilling Oil and Gas Wells	2,587	4,299	5,631	7,655	8.7%
5413	Architectural, Engineering, and Related Services	3,810	3,749	4,611	5,940	3.5%
23[tt]	Construction of New Nonresidential Manufacturing Structures	12,477	1,099	547	215	-26.8%
Top-5 employment total		**35,132**	**33,919**	**42,591**	**56,973**	**3.8%**
Supply chain employment total		**49,072**	**47,321**	**58,839**	**77,652**	**3.6%**
Supply chain employment as share of state employment		0.8%	0.8%	0.9%	1.2%	
Total energy activity employment as share of state employment		1.5%	1.7%	2.1%	2.7%	
Top-5 sectors: Unconventional energy supply chain labor income* (2012 $M)						
213112	Support Activities for Oil and Gas Operations	991	1,549	2,022	2,655	7.9%
23[t]	Construction of Other New Nonresidential Structures	322	460	562	740	6.6%
213111	Drilling Oil and Gas Wells	273	452	590	776	8.4%
5413	Architectural, Engineering, and Related Services	326	309	377	477	3.0%
23[tt]	Construction of New Nonresidential Manufacturing Structures	817	75	38	15	-26.5%
Top-5 labor income total		**2,729**	**2,846**	**3,589**	**4,663**	**4.2%**
Supply chain labor income total		**3,879**	**3,948**	**4,894**	**6,283**	**3.8%**
Top-5 sectors: Unconventional energy supply chain gross output* (2012 $M)						
213112	Support Activities for Oil and Gas Operations	4,380	6,828	8,884	11,441	7.7%
213111	Drilling Oil and Gas Wells	1,732	2,859	3,716	4,797	8.2%
23[t]	Construction of Other New Nonresidential Structures	704	1,006	1,224	1,581	6.4%
3312	Steel Product Manufacturing from Purchased Steel	844	914	1,013	1,166	2.5%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	663	759	857	956	2.9%
Top-5 gross output total		**8,323**	**12,367**	**15,694**	**19,941**	**7.0%**
Supply chain gross output total		**14,568**	**15,884**	**19,725**	**24,813**	**4.2%**
Unconventional energy supply chain government revenue (Current $M)						
Federal taxes		784	884	1,201	1,616	5.7%
State and local taxes		844	925	1,255	1,653	5.3%
Supply chain government revenue total		**1,628**	**1,809**	**2,456**	**3,269**	**5.5%**

*Ranking for all years based on results in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of upstream facilities and structures.

tt Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Source: IHS Economics

Texas

Texas, the top oil producing US state, has several major unconventional oil and plays, including the Permian Basin, the Barnett Shale, parts of the Haynesville/Bossier Shale and the Granite Wash, and, most notably, the Eagle Ford Shale. Unconventional oil and gas activity and supply chain are key drivers of economic growth in several Texas MSAs.

Employment snapshot: Texas

	2012	2025
Lubbock and Midland, TX MSA		
Employment: total	209,917	247,227
Employment: Construction, natural resources, and mining	27,664	44,557
Texas		
Unconventional supply chain employment: Construction, natural resources, and mining	102,957	110,805

Source: IHS

Overall, Texas represents the largest portion of employment and output in unconventional oil and natural gas activities in the US economy. The top-5 supply chain industries by 2025 are expected to contribute over 123,000 jobs to the Texas state economy and contribute over $24 billion of gross output.

- The ratio of employment resulting from unconventional supply chain activity to total state employment will be approximately 1.8% by 2025.
- The employment contribution from unconventional activity to the state economy is expected to grow to 4.3% of Texas's total state employment by 2025.
- Combined, total employment in the Lubbock and Midlands MSAs is expected to increase to over 247,000 by 2025. Among that growth, over 44,000 jobs will be in the construction, natural resources, and mining industries.

Texas

		2012	2015	2020	2025	CAGR**
Top-5 sectors: Unconventional energy supply chain employment* (Number of workers)						
23t	Construction of Other New Nonresidential Structures	29,183	33,083	36,247	41,219	2.7%
23tt	Construction of New Nonresidential Manufacturing Structures	34,034	20,422	7,876	6,642	-11.8%
5413	Architectural, Engineering, and Related Services	22,681	23,828	23,904	26,013	1.1%
213112	Support Activities for Oil and Gas Operations	17,114	20,867	24,399	27,411	3.7%
212321	Construction Sand and Gravel Mining	14,018	17,130	19,422	22,286	3.6%
Top-5 employment total		**117,030**	**115,329**	**111,848**	**123,571**	**0.4%**
Supply chain employment total		**211,576**	**228,091**	**233,812**	**262,214**	**1.7%**
Supply chain employment as share of state employment		1.9%	1.8%	1.7%	1.8%	
Total energy activity employment as share of state employment		3.9%	4.3%	4.1%	4.3%	
Top-5 sectors: Unconventional energy supply chain labor income* (2012 $M)						
5413	Architectural, Engineering, and Related Services	1,880	1,952	1,950	2,085	0.8%
23t	Construction of Other New Nonresidential Structures	1,687	1,905	2,078	2,286	2.4%
213112	Support Activities for Oil and Gas Operations	1,586	1,927	2,243	2,443	3.4%
23tt	Construction of New Nonresidential Manufacturing Structures	1,862	1,119	439	370	-11.7%
212321	Construction Sand and Gravel Mining	1,272	1,548	1,747	1,941	3.3%
Top-5 labor income total		**8,287**	**8,451**	**8,457**	**9,125**	**0.7%**
Supply chain labor income total		**16,228**	**17,816**	**18,477**	**20,232**	**1.7%**
Top-5 sectors: Unconventional energy supply chain gross output* (2012 $M)						
213112	Support Activities for Oil and Gas Operations	6,212	7,527	8,734	9,335	3.2%
23tt	Construction of New Nonresidential Manufacturing Structures	5,745	3,431	1,354	1,144	-11.7%
23t	Construction of Other New Nonresidential Structures	4,023	4,532	4,927	5,320	2.2%
3312	Steel Product Manufacturing from Purchased Steel	4,395	3,932	3,738	4,042	-0.6%
212321	Construction Sand and Gravel Mining	3,114	3,781	4,255	4,636	3.1%
Top-5 gross output total		**23,490**	**23,204**	**23,008**	**24,477**	**0.3%**
Supply chain gross output total		**54,375**	**58,708**	**60,609**	**65,327**	**1.4%**
Unconventional energy supply chain government revenue (Current $M)						
Federal taxes		2,871	3,215	3,608	4,119	2.8%
State and local taxes		777	877	986	1,074	2.5%
Supply chain government revenue total		**3,648**	**4,092**	**4,594**	**5,193**	**2.8%**

*Ranking for all years based on results in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of upstream facilities and structures.

tt Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Source: IHS Economics

North Dakota

The explosive growth in unconventional oil and associated gas drilling activity in North Dakota's Williston Basin has had a massive impact on the state's economy. Development of the Bakken Shale has lowered the state unemployment rate to 2.8% (July 2014) and stimulated explosive growth in construction of housing and infrastructure.

Unconventional oil and gas activities are expected to continue to contribute significantly to growth in the state economy over the next decade. The top-5 unconventional supply chain industries are expected to contribute over 21,000 jobs to the state economy and more than $4.8 billion of gross output by 2025.

- The percentage of employment resulting from unconventional supply chain activity will be approximately 5.9% of total employment by 2025—the highest share across all states.
- More impressively, employment from the unconventional energy value chain is expected to continue to grow to 14.6% of North Dakota's total state employment by 2025, from about 12% in 2012.
- The supply chain industries with the largest economic contributions are concentrated in the upstream segment of the energy value chain. Support Activities for Oil and Gas Operations (NAICS 213112) is the top supply chain industry, followed by Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures) and Construction of Other New Nonresidential Structures (part of NAICS 23—construction of upstream facilities and structures), and the Architectual, Engineering, and Related Services sector (NAICS 5413).

> *"Shale energy extraction has resulted in exponential business growth at General Equipment & Supplies since 2009. In fact, over the past few years, my company has doubled its revenue, mostly because of energy development. These increased sales and continued strong business climate have come at time when our market share has remained constant. During the same period, we went from 125 employees to over 250 today. In fact, we would hire dozens more workers if we could find enough skilled labor."* Don Shilling, President, General Equipment & Supplies Co., Fargo, North Dakota and 2014 Vice Chairman, Associated Equipment Distributors (AED)

North Dakota

		2012	2015	2020	2025	CAGR**
Top-5 sectors: Unconventional energy supply chain employment* (Number of workers)						
23[t]	Construction of Other New Nonresidential Structures	5,127	8,161	7,978	8,766	4.2%
23[tt]	Construction of New Nonresidential Manufacturing Structures	3,411	4,705	709	452	-14.4%
213112	Support Activities for Oil and Gas Operations	3,301	5,191	5,461	5,974	4.7%
5413	Architectural, Engineering, and Related Services	3,352	4,905	3,915	4,082	1.5%
2213	Water, Sewage and Other Systems	1,544	2,132	2,157	2,368	3.3%
Top-5 employment total		**16,735**	**25,095**	**20,219**	**21,643**	**2.0%**
Supply chain employment total		**22,373**	**33,201**	**28,121**	**30,101**	**2.3%**
Supply chain employment as share of state employment		5.2%	7.0%	5.6%	5.9%	
Total energy activity employment as share of state employment		11.9%	15.6%	14.0%	14.6%	
Top-5 sectors: Unconventional energy supply chain labor income* (2012 $M)						
213112	Support Activities for Oil and Gas Operations	306	479	502	532	4.4%
23[t]	Construction of Other New Nonresidential Structures	296	470	457	486	3.9%
5413	Architectural, Engineering, and Related Services	282	405	320	326	1.1%
23[tt]	Construction of New Nonresidential Manufacturing Structures	229	296	47	30	-14.4%
2213	Water, Sewage and Other Systems	160	220	222	236	3.0%
Top-5 labor income total		**1,273**	**1,871**	**1,548**	**1,611**	**1.8%**
Supply chain labor income total		**1,729**	**2,527**	**2,188**	**2,280**	**2.2%**
Top-5 sectors: Unconventional energy supply chain gross output* (2012 $M)						
213112	Support Activities for Oil and Gas Operations	1,300	2,031	2,120	2,205	4.2%
23[tt]	Construction of New Nonresidential Manufacturing Structures	1,049	1,502	214	135	-14.6%
23[t]	Construction of Other New Nonresidential Structures	686	1,084	1,052	1,097	3.7%
5413	Architectural, Engineering, and Related Services	602	903	543	534	-0.9%
213111	Drilling Oil and Gas Wells	528	838	869	906	4.2%
Top-5 gross output total		**4,164**	**6,358**	**4,799**	**4,878**	**1.2%**
Supply chain gross output total		**5,894**	**8,835**	**6,815**	**6,925**	**1.2%**
Unconventional energy supply chain government revenue (Current $M)						
Federal taxes		326	491	464	506	3.4%
State and local taxes		360	535	504	537	3.1%
Supply chain government revenue total		**686**	**1,026**	**968**	**1,044**	**3.3%**

*Ranking for all years based on results in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of upstream facilities and structures.

tt Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

Source: IHS Economics

Louisiana

Louisiana, long one of the top conventional oil and gas producing states, is home to the established Haynesville Shale, a dry natural gas, oil, and liquids play that is still in the early stages of development, including the Tuscaloosa Marine Shale (TMS) and the Brown Dense. While lower natural gas prices have slowed the addition of new wells drilled in the Haynesville Shale in recent years, activity is likely to grow to feed liquefied natural gas export facilities planned for the US Gulf Coast.

In Louisiana, the largest 5 unconventional supply chain industries are expected to contribute 38,000 jobs and more than $8 billion of gross output by 2015, declining slightly to 28,000 jobs and $6 billion in gross output by 2025.

- The percent of employment resulting from unconventional supply chain activity is expected to be sustained at approximately 2% of total state employment through the 2012–25 forecast period.
- Employment contributions from total unconventional energy activity will account for about 4.7% of Louisiana total state employment in 2015 and 3.9% in 2025.
- The supply chain industries with the largest economic contributions in Louisiana are diverse, operating throughout many different aspects of the unconventional oil and gas value chain. Construction of New Nonresidential Manufacturing Structures (part of NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures) and Support Activities for Oil and Gas Operations (NAICS 213112) are the top contributing industries in terms of gross output, followed by manufacturing (Power Boiler and Heat Exchanger Manufacturing -NAICS 332410) and professional services industries (Architecture, Engineering, and Related Services -NAICS 5413).

Louisiana

		2012	2015	2020	2025	CAGR**
Top-5 sectors: Unconventional energy supply chain employment* (Number of workers)						
23[t]	Construction of New Nonresidential Manufacturing Structures	6,562	12,852	3,617	2,633	-6.8%
5413	Architectural, Engineering, and Related Services	5,612	7,662	4,128	4,405	-1.8%
213112	Support Activities for Oil and Gas Operations	8,932	8,065	8,598	11,186	1.7%
332410	Power Boiler and Heat Exchanger Manufacturing	2,128	4,247	1,295	1,071	-5.1%
23[tt]	Construction of Other New Nonresidential Structures	5,484	4,902	4,925	8,529	3.5%
Top-5 employment total		**28,717**	**37,727**	**22,564**	**27,823**	**-0.2%**
Supply chain employment total		**41,107**	**53,906**	**35,727**	**43,314**	**0.4%**
Supply chain employment as share of state employment		2.1%	2.7%	1.7%	2.1%	
Total energy activity employment as share of state employment		3.6%	4.7%	3.3%	3.9%	
Top-5 sectors: Unconventional energy supply chain labor income* (2012 $M)						
23[t]	Construction of New Nonresidential Manufacturing Structures	363	717	204	148	-6.7%
5413	Architectural, Engineering, and Related Services	439	589	323	343	-1.9%
213112	Support Activities for Oil and Gas Operations	828	745	790	996	1.4%
332410	Power Boiler and Heat Exchanger Manufacturing	168	334	101	79	-5.6%
23[tt]	Construction of Other New Nonresidential Structures	317	282	282	473	3.1%
Top-5 labor income total		**2,114**	**2,667**	**1,700**	**2,039**	**-0.3%**
Supply chain labor income total		**3,172**	**4,034**	**2,807**	**3,314**	**0.3%**
Top-5 sectors: Unconventional energy supply chain gross output* (2012 $M)						
23[t]	Construction of New Nonresidential Manufacturing Structures	1,164	2,274	652	475	-6.7%
213112	Support Activities for Oil and Gas Operations	3,499	3,139	3,322	4,108	1.2%
5413	Architectural, Engineering, and Related Services	782	1,083	551	562	-2.5%
332410	Power Boiler and Heat Exchanger Manufacturing	514	1,015	317	252	-5.3%
3312	Steel Product Manufacturing from Purchased Steel	630	937	541	537	-1.2%
Top-5 gross output total		**6,590**	**8,449**	**5,382**	**5,933**	**-0.8%**
Supply chain gross output total		**11,345**	**14,066**	**10,099**	**11,652**	**0.2%**
Unconventional energy supply chain government revenue (Current $M)						
Federal taxes		631	799	636	787	1.7%
State and local taxes		683	864	678	820	1.4%
Supply chain government revenue total		**1,314**	**1,662**	**1,315**	**1,607**	**1.6%**

*Ranking for all years based on results in 2014.

**Compound annual growth rate from 2012 to 2025.

t Construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures.

tt Construction of upstream facilities and structures.

Source: IHS Economics

Nonproducing states

Illinois

Although classified as a nonproducing state in this analysis, Illinois is experiencing growth from unconventional oil and natural gas activities related to the state's large manufacturing sector. The Illinois economy also has above national average allocations of several industries that use natural gas as feedstock or as an input in manufacturing such as chemicals, plastics and rubber.The top-5 supply chain industries are expected to contribute over 22,000 jobs to the state economy by 2025 and over $5 billion of gross output, reaping economic benefits similar to Ohio.

- The ratio of employment resulting from unconventional supply chain activity to the total state employment will be approximately 0.3% by 2025.
- Employment contributions from unconventional oil and gas activity are expected to grow to 0.5% of Illinois's total state employment by 2025, independent of any potential development of Illinois' own unconventional oil and gas resources.
- Cutting tools and machine tool accessory manufacturing is expected to double employment and nearly double gross output contributions to the unconventional supply chain from 2012 through 2025.
- Iron and steel mills and ferroalloy manufacturing gross output in 2025 is expected to be 2.5 times greater than 2012 gross output, a clear linkage to the demand for construction materials, capital goods, and drilling and line pipe.

Illinois

		2012	2015	2020	2025	CAGR**
Top-5 sectors: Unconventional energy supply chain employment* (Number of workers)						
333515	Cutting Tool and Machine Tool Accessory Manufacturing	5,313	7,160	8,958	10,913	5.7%
212321	Construction Sand and Gravel Mining	2,783	3,510	4,334	5,421	5.3%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	2,017	2,685	3,357	4,049	5.5%
4238	Wholesale Machinery and Equipment	630	907	1,049	1,183	5.0%
5413	Architectural, Engineering, and Related Services	434	626	681	771	4.5%
Top-5 employment total		**11,177**	**14,889**	**18,380**	**22,337**	**5.5%**
Supply chain employment total		**13,772**	**18,531**	**22,655**	**27,682**	**5.5%**
Supply chain employment as share of state employment		0.1%	0.2%	0.2%	0.3%	
Total energy activity employment as share of state employment		0.3%	0.4%	0.4%	0.5%	
Top-5 sectors: Unconventional energy supply chain labor income* (2012 $M)						
333515	Cutting Tool and Machine Tool Accessory Manufacturing	364	489	609	716	5.3%
212321	Construction Sand and Gravel Mining	252	317	390	472	4.9%
3331	Agriculture, Construction, and Mining Machinery Manufacturing	207	275	342	398	5.1%
4238	Wholesale Machinery and Equipment	50	72	83	92	4.7%
333912	Air and Gas Compressor Manufacturing	40	55	67	79	5.4%
Top-5 labor income total		**914**	**1,208**	**1,491**	**1,757**	**5.2%**
Supply chain labor income total		**1,124**	**1,507**	**1,833**	**2,175**	**5.2%**
Top-5 sectors: Unconventional energy supply chain gross output* (2012 $M)						
3331	Agriculture, Construction, and Mining Machinery Manufacturing	1,013	1,352	1,678	1,937	5.1%
333515	Cutting Tool and Machine Tool Accessory Manufacturing	922	1,229	1,525	1,760	5.1%
212321	Construction Sand and Gravel Mining	512	641	786	933	4.7%
333912	Air and Gas Compressor Manufacturing	208	285	350	407	5.3%
331110	Iron and Steel Mills and Ferroalloy Manufacturing	176	255	331	452	7.5%
Top-5 gross output total		**2,830**	**3,762**	**4,670**	**5,489**	**5.2%**
Supply chain gross output total		**3,646**	**4,928**	**6,013**	**7,079**	**5.2%**
Unconventional energy supply chain government revenue (Current $M)						
Federal taxes		87	124	164	206	6.8%
State and local taxes		101	142	187	229	6.5%
Supply chain government revenue total		**189**	**266**	**352**	**434**	**6.6%**

*Ranking for all years based on results in 2014.

**Compound annual growth rate from 2012 to 2025.

Source: IHS Economics

Unconventional oil and natural gas supply chain: Supplemental construction assessment

Summary of key results: Supplemental construction assessment

Substantial construction spending related to unconventional oil and gas development will occur between 2012 and 2025 to support production, distribution, and refining (NAICS 23—construction of pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures and upstream facilities and structures). This operator capital spending is also suplemented by considerable non-operator construction spending related to infrastructure, housing, commercial, and industrial construction activity. Operator and non-operator construction spending ramps up as unconventional oil and gas fields are developed, but tapers off once the structures are largely in place. Accordingly, the rate of construction activity is marked by a series of waves as producing states proceed through their unconventional oil and gas development cycle.

- Non-operator supplemental construction spending related to unconventional oil and gas activity amounted to $4.1 billion in 2013 and is expected to remain near $4 billion in 2014. This additive level of spending translates into nearly 17,000 workers in 2013 and over 15,000 workers in 2014.
- Spending fluctuates over time as various states ramp up or scale down their level of development activity; however, on average, supplemental construction related to unconventional oil and gas will amount to $3.5 billion annually through 2025. The cumulative impact of non-operator supplemental construction related to unconventional oil and gas activity from 2012 through 2025 will amount to $49.3 billion.
- As with spending, the subsequent jobs created by this spending will vary over time. However, we expect job creation related to supplemental construction spending to average 12,300 annually through 2025.
- Spending in residential construction will have the largest impact, amounting to $3.0 billion in 2013 and $2.9 billion in 2014. This will translate into nearly 12,500 jobs in 2013 and just over 11,000 in 2014. Spending peaks in 2021 at $5.3 billion, yielding over 17,000 jobs.
- The second largest impact comes from commercial activity which will generate $804.6 million in 2013 and $873.4 million in 2014, translating into nearly 3,300 jobs in 2013 and nearly 3,400 in 2014. Commercial spending peaks in 2015 at $785.2 million, yielding nearly 3,000 jobs.
- Industrial and infrastructure construction linked to unconventional activity combine to account for $253.2 million of spending in 2013 and $191.5 million in 2014, yielding just over 1,000 and nearly 800 jobs, respectively.

Supplemental construction expenditure and employment impacts by type

	2012	2013	2014	2015	2020	2025
Supplemental construction expenditure (2012 $M)						
Commercial	652	805	873	785	488	479
Industrial	24	30	34	28	13	12
Infrastructure	203	223	158	112	41	36
Residential	2,273	3,042	2,897	1,921	2,249	3,040
US total	**3,152**	**4,099**	**3,962**	**2,847**	**2,790**	**3,567**
Supplemental construction employment (number of workers)						
Commercial	2,739	3,272	3,365	2,932	1,636	1,427
Industrial	100	123	130	106	44	36
Infrastructure	896	967	637	440	147	117
Residential	9,594	12,469	11,197	7,212	7,590	9,149
US total	**13,329**	**16,830**	**15,329**	**10,689**	**9,417**	**10,729**

Source:IHS Economics

The US oil and gas industry—including upstream, midstream and downstream—is a major consumer of construction services. However, the nature of unconventional oil and gas exploration and production is that it creates additional construction demand beyond the direct investment required for extraction, processing, and transportation. In particular, workers in the oil and gas fields need housing, both temporary and permanent. They also stimulate additional business for local restaurants and retailers, leading to demand for new or expanded commercial establishments. The presence of the oil and gas industry also leads to demand for other businesses in the supply chain, which translates into new and expanded industrial structures. Finally, the nature of unconventional oil and gas exploration, production and transportation results in intensive use of rail and roads, requiring repair and upgrades to the installed base, and ultimately new construction investment to improve multi-modal transportation capacity.

To fully capture the economic contributions associated with construction activity that occurs independent of upstream, midstream, and downstream operator expenditures, IHS has estimated the residential, commercial, infrastructure, and industrial construction stimulated by unconventional oil and gas activity. While this added construction is primarily located within oil and gas producing states, it is nonetheless creating demand for construction materials, services and labor in producing and nonproducing states alike.

The expansion of unconventional oil and gas activity could not have come at a better time for the construction industry. The residential construction downturn was one of its proximate causes of the Great Recession, and the contagion of weak demand, poor business confidence, and tight credit ultimately decimated all sub-segments of the construction market. Even infrastructure spending, often a source of countercyclical stimulus, was underfunded in this case, as state and local tax receipts plummeted to a far greater extent than federal intervention could offset. The demand for oil and gas related construction services mitigated the severity of the downturn in many states. In some cases, notably North Dakota and Texas, oil and gas related construction actually expanded construction spending in a hostile environment.

Unconventional oil and gas exploration is both labor and capital intensive. Workers are needed not just to operate equipment on the fields themselves, but throughout the supply chain—transporting materials such as sand and water, repairing equipment that is under almost constant use, and supplying management and logistics. These workers require food and housing. Demand is a function of the size and utilization of the installed base as well as the locally available work force. In the case of North Dakota, the workforce was insufficient to accommodate operator requirements, resulting in a major influx of new workers. Additionally, the existing housing stock was sized to accommodate a stable agricultural environment, not a thriving energy sector. The confluence of new workers and inadequate facilities created a commercial construction boom. In Williston, North Dakota, the heart of the Bakken, commercial construction permits ballooned from $18.5 million in 2009 to $209.3 million in 2012 as first work camps and then hotels and motels were constructed. Demand for lodging space was augmented by the need for restaurants, retail space, and services such as laundry.

However, a key finding of the construction analysis is that the majority of the supplemental economic impact is on residential construction. While the short term needs of new workers can be met with temporary lodging, a proven oil and gas field takes time to develop—and multi-family housing (apartments and condos) is a cheaper long term solution than lodging. Again, Williston data illustrates the point. By mid-2013, commercial construction had actually slowed a bit, but multi-family permits had nearly doubled. Once drilling is completed and the fields are in a stable production, estimates suggest that up to 20% or more of the field development workforce will need to remain to manage and maintain the production, processing, and distribution network. This translates into the need for long term housing that is typically met via single family homes.

From a supplemental construction perspective, infrastructure spending is largely road-related. While there is significant rail investment, it is captured in the foregoing supply chain analysis based on upstream operator spending. Access road construction that takes equipment and materials to the drill sites from existing roads would also typically be captured in the supply chain impact. However, the need to repair, widen, or build public roads would typically not be included in any supply chain approach.

Unconventional oil and gas drilling and production frequently occurs in relatively remote areas. While roads generally exist, they were built to accommodate agricultural or lighter traffic, with a relatively low intensity of use. The traffic associated with unconventional energy production is of significantly greater tonnage and travels at a much higher frequency during the preparation, drilling, and completion stages of well development. Indeed, quiet town centers have become the scenes of traffic jams as large numbers of trucks navigate tight quarters with little or no traffic control devices, moving material and equipment to and from the energy fields. While some new roads have been constructed, the majority of spending has been to maintain and upgrade existing roads to ameliorate the impact of heavy traffic. Local governments, occasionally in partnership with upstream operators, find ways to keep roads functioning since a lack of access can inhibit billions of dollars in unconventional oil and gas investment.

Road construction estimates are more challenging than commercial and residential construction impacts because they depend upon state and local governments prioritizing roads in the face of competing needs. Some states have imposed taxes on energy companies to improve roads, but, in many cases, the money has not yet found its way into physical improvements. An additional issue is that states may allocate money to municipalities for road work, but attach preconditions to the funds that the municipality is unwilling to accept. Even so, the approach used for this analysis is reflective of indicated state priorities. For example, Texas has indicated its intention to invest $1 billion in road construction to support unconventional oil and gas development. The results of our analysis suggest that Texas will spend $1.2 billion over the next ten years on related infrastructure improvements.

Rural or remote communities also tend to lack public water and sewer systems. Construction of such systems takes years of planning and the analysis does not foresee extensive systems installed for most areas in the time frame under investigation. However, the technology does exist for ‘package plants’ to treat sewerage and purify water on a local scale. It is expected that such construction would occur on or near production sites as well as being required by concentrations of commercial and residential structures.

Supplemental construction by type

In 2015, the forecast shows that nearly 70% of all commercial construction expenditures will occur in Texas and Louisiana. North Dakota will have nearly a $100 million in commercial expenditures, less than half of either of those states. Mississippi is poised to grow the most as commercial spending will grow from just over $9,000 in 2015 to $15.7 million in 2025.

Supplemental construction expenditure by type: Commercial
(2012 $)

	2012	2015	2020	2025
Arkansas	834,672	712,079	1,079,654	1,210,235
California	0	22,695,595	3,488,816	3,723,234
Colorado	10,598,207	10,252,862	6,331,461	9,834,207
Kansas	12,169,460	10,726,588	5,721,934	4,726,112
Louisiana	73,810,029	239,020,259	123,402,571	110,831,060
Mississipi	997	9,166	34,551	15,719,193
Montana	2,120,418	4,002,957	1,860,196	2,658,488
New Mexico	293,978	1,602,643	213,498	360,271
North Dakota	60,335,303	99,751,483	26,682,816	20,264,762
Ohio	24,261,466	25,312,717	17,484,293	14,483,162
Oklahoma	21,568,968	13,661,773	21,502,808	20,352,791
Pennsylvania	85,592,984	13,402,704	13,960,933	6,904,891
Texas	274,066,429	299,234,076	218,473,869	215,524,796
Utah	12,438,630	6,198,545	2,636,266	3,702,019
West Virginia	70,834,631	29,580,519	41,395,104	44,072,673
Wyoming	3,401,372	9,058,512	3,235,942	4,619,081
US total	**652,327,543**	**785,222,479**	**487,504,713**	**478,986,974**

Source: IHS Economics

Residential construction expenditures make up the majority of construction expenditures as Texas, with $773.8 million, will have nearly the same amount of spending as commercial construction in the entire United States. Of the four types of construction spending, only residential construction is expected to grow over the forecast horizon. From 2015 to 2025, residential spending is expected to grow 58.2%, infrastructure spending will decline 67.8%, commercial spending is expected to be 39.0% lower, and industrial spending will drop by 58.0%.

Supplemental construction expenditure by type: Residential
(2012 $)

	2012	2015	2020	2025
Arkansas	3,288,080	2,313,799	5,990,452	8,799,020
California	0	82,536,492	21,883,560	30,754,357
Colorado	43,586,543	28,548,913	31,648,737	67,592,035
Kansas	37,757,567	23,884,187	23,479,019	26,594,240
Louisiana	255,612,509	580,808,897	572,627,821	671,686,084
Mississipi	4,740	32,482	218,975	134,310,142
Montana	6,847,710	10,131,995	7,959,803	15,601,610
New Mexico	1,099,138	4,782,413	1,058,862	2,329,869
North Dakota	99,044,436	154,548,514	87,966,973	93,441,057
Ohio	94,584,336	75,659,211	94,989,114	108,303,781
Oklahoma	62,389,414	30,721,839	85,664,881	109,486,672
Pennsylvania	355,932,403	39,342,367	71,270,505	47,355,499
Texas	995,717,908	773,836,368	1,000,207,516	1,354,481,529
Utah	35,951,907	12,169,525	9,979,755	18,748,307
West Virginia	271,043,712	83,980,324	222,693,105	328,139,909
Wyoming	9,908,882	17,771,294	11,275,153	21,898,470
US total	**2,272,769,284**	**1,921,068,618**	**2,248,914,231**	**3,039,522,580**

Source: IHS Economics

In 2015, nearly 70% of all industrial construction expenditures will occur in Texas and Louisiana since much of the oil and gas processing will occur in these states. North Dakota comes in third, with nearly $3.6 million in industrial expenditures, but represents only about a third of the spending from the two top-tier states. States where unconventional energy activity is expected to expand over time, such as Arkansas, Colorado, and Mississippi, offer the greatest growth potential. Mississippi, in particular, is expected to expand from virtually no presence in 2015 to over 3% of the market by 2025.

Supplemental construction expenditure by type: Industrial
(2012 $)

	2012	2015	2020	2025
Arkansas	30,512	25,797	29,014	30,211
California	0	822,207	93,756	92,943
Colorado	387,430	371,437	170,148	245,492
Kansas	444,869	388,599	153,768	117,978
Louisiana	2,698,213	8,659,130	3,316,251	2,766,680
Mississipi	36	332	928	392,399
Montana	77,514	145,018	49,990	66,364
New Mexico	10,747	58,060	5,737	8,993
North Dakota	2,205,629	3,613,757	717,059	505,870
Ohio	886,907	917,019	469,863	361,544
Oklahoma	788,479	494,933	577,854	508,067
Pennsylvania	3,128,953	485,548	375,178	172,367
Texas	10,018,824	10,840,532	5,871,143	5,380,153
Utah	454,709	224,558	70,846	92,414
West Virginia	2,589,444	1,071,631	1,112,429	1,100,188
Wyoming	124,341	328,168	86,961	115,306
US total	**23,846,608**	**28,446,724**	**13,100,925**	**11,956,968**

Source: IHS Economics

Unlike other construction types, infrastructure spending is more evenly distributed as it depends not only on the impact of energy exploration and production, but also on the availability of existing facilities. Given their immature infrastructure relative to demand, West Virginia and North Dakota are expected to lead in spending, accounting for over 40% of all infrastructure construction expenditures in 2015. Louisiana and Texas will account for an additional 30% as large energy investments stretch larger existing infrastructures. Given its long useful life, infrastructure spending generally declines by 2025; however, West Virginia, Oklahoma, Mississippi, and Arkansas will gain shares of the total spending through 2025.

Supplemental construction expenditure by type: Infrastructure
(2012 $)

	2012	2015	2020	2025
Arkansas	603,452	389,224	336,923	370,822
California	0	1,417,943	93,662	81,806
Colorado	3,854,610	1,609,516	403,369	511,822
Kansas	5,398,356	2,887,005	823,676	603,931
Louisiana	14,269,611	22,404,104	6,014,190	4,311,717
Mississipi	582	2,663	4,656	1,734,153
Montana	2,027,548	2,177,727	413,664	464,209
New Mexico	318,413	1,182,350	79,770	123,259
North Dakota	16,254,832	23,123,368	3,813,083	2,650,236
Ohio	7,572,421	4,687,814	1,398,913	886,294
Oklahoma	8,195,960	2,889,139	1,803,319	1,245,837
Pennsylvania	11,787,010	1,143,833	567,854	250,264
Texas	22,319,922	14,167,664	5,249,954	4,472,968
Utah	5,787,686	1,556,617	295,346	317,054
West Virginia	100,350,539	26,416,165	18,204,696	16,417,224
Wyoming	4,285,331	6,414,506	1,286,535	1,726,413
US total	**203,026,271**	**112,469,636**	**40,789,610**	**36,168,007**

Source: IHS Economics

Employment contributions

The employment contribution for the supplemental construction analysis converts dollars invested into jobs using output per worker from the IHS US Industry Service. Output per worker is highly variable across states, reflecting productivity, type of construction, and the relative cost of living, as well as the intensity of construction activity, which tends to drive up wages. States with the highest output per worker have a lower transfer rate of construction spending into jobs than states with lower output per worker.

Supplemental construction expenditures impact on employment by type: US
(Number of workers)

	2012	2015	2020	2025
Commercial	2,739	2,932	1,636	1,427
Industrial	100	106	44	36
Infrastructure	896	440	147	117
Residential	9,594	7,212	7,590	9,149
Total	**13,329**	**10,689**	**9,417**	**10,729**

Source:IHS Economics

Residential construction accounts for the largest number of ancillary construction workers, given the size of the spending impact, but also the lower productivity per worker that is typical of a residential construction site. Residential construction sites tend to be dispersed over a wider area than other building types and offer less potential to substitute capital (construction machinery) for labor. Residential construction also grows over the forecast because of the relatively long lag between employment impacts and permanent, as opposed to transient, housing. Over the forecast, commercial construction drives the second largest demand for employment. Industrial and infrastructure construction are more capital intensive, requiring fewer workers (although often higher skilled ones) and so have lower employment impacts despite impressive construction spending, especially in the infrastructure segment.

Total construction contributions

The total construction impact in terms of employment and gross output are presented in the tables below. These results represent the sum of the supplemental construction contributions and unconventional energy supply chain construction contributions.

The unconventional energy supply chain construction contributions are organized by state and energy value chain segments: upstream, midstream, and downstream. The midstream and downstream segments are represented in our analysis by the following construction categories: pipelines, rail, marine structures, storage facilities, LNG export facilities, and manufacturing structures. The supplemental construction activity was analyzed by state and comprises the following types: residential, commercial, infrastructure, and industrial. Given the different construction categories for each set of analysis, we aggregate the total economic contribution results by state in order to present the total construction activity related to the unconventional activity.

Total construction impact on employment*
(Number of workers)

	2012	2015	2020	2025
Arkansas	768	1,376	1,378	1,307
California	0	3,004	276	568
Colorado	3,521	3,360	3,019	4,170
Kansas	1,752	1,502	1,180	1,490
Louisiana	13,607	21,266	11,180	13,760
Mississipi	0	0	1	904
Montana	554	1,106	811	1,104
New Mexico	1,018	764	624	1,027
North Dakota	9,220	13,801	9,037	9,517
Ohio	3,560	4,542	4,940	6,573
Oklahoma	8,248	8,482	11,327	14,898
Pennsylvania	20,202	9,323	10,679	13,739
Texas	68,081	57,129	47,751	51,915
Utah	3,665	2,983	1,540	990
West Virginia	10,027	3,559	3,825	4,415
Wyoming	1,437	2,047	952	918
Producing states total	**145,662**	**134,243**	**108,521**	**127,294**
Nonproducing states total	**834**	**1,123**	**182**	**148**
US total	**146,496**	**135,366**	**108,703**	**127,442**

*Total construction represents the sum of supplemental and unconventinal energy supply chain construction.

Source: IHS Economics

Total construction impact on gross output*
(2012 $M)

	2012	2015	2020	2025
Arkansas	115	214	215	196
California	0	645	67	104
Colorado	612	519	429	585
Kansas	422	316	199	227
Louisiana	2,269	3,799	2,029	2,369
Mississippi	0	0	0	186
Montana	105	187	131	175
New Mexico	151	117	91	143
North Dakota	1,912	2,867	1,386	1,350
Ohio	843	913	817	996
Oklahoma	1,275	1,323	1,793	2,260
Pennsylvania	3,636	1,276	1,422	1,678
Texas	11,070	9,061	7,511	8,044
Utah	577	421	215	143
West Virginia	1,881	642	732	868
Wyoming	252	342	147	150
Producing states total	**25,120**	**22,644**	**17,185**	**19,473**
Nonproducing states total	**161**	**235**	**42**	**33**
US total	**25,281**	**22,878**	**17,227**	**19,506**

*Total construction represents the sum of supplemental and unconventinal energy supply chain construction.

Source: IHS Economics

Conclusion

As the 'Great Revival' in domestic energy production transforms America's economy, the remarkable impact of unconventional oil and natural gas on the US economy is reverberating throughout the vast nationwide supply chain that supports today's oil and gas production, processing, and transportation activities. Upstream, midstream, and downstream operators are responsible for the significant capital investment required for exploration, production, transport, and refinement of unconventional oil and natural gas. In recognition of this investment, the oil and gas industry is often depicted as the face of the 'unconventional revolution'. However, it is the extensive oil and gas supply chain—labor, equipment, materials, services, and logistics—which represents the backbone that makes it possible to transform geological prospects into resource abundance throughout the energy value chain and the US economy.

The report's key findings indicate that within the unconventional supply chain, across the 56 NAICS sectors analyzed,

- Total employment will grow from 524,000 jobs in 2012 to 757,000 jobs in 2025.
- The average annual wage of these jobs in the 2012–25 period is $79,000 in real 2012 dollars.
- The total supply chain-related gross output contributions will increase from nearly $146 billion in 2012 to almost $206 billion in 2025, representing roughly 0.5% of total US gross output in any given year of the forecast period.
- Total government revenues generated by the unconventional supply chain will increase from more than $13 billion in 2012 to more than $16 billion in 2015 and to about $23 billion in 2025.
- Lastly, study results show that supplemental construction, coupled with unconventional energy supply chain related construction activity, will add on average 127,000 jobs each year over the forecast period, corresponding to about $20 billion of annual gross output on average.