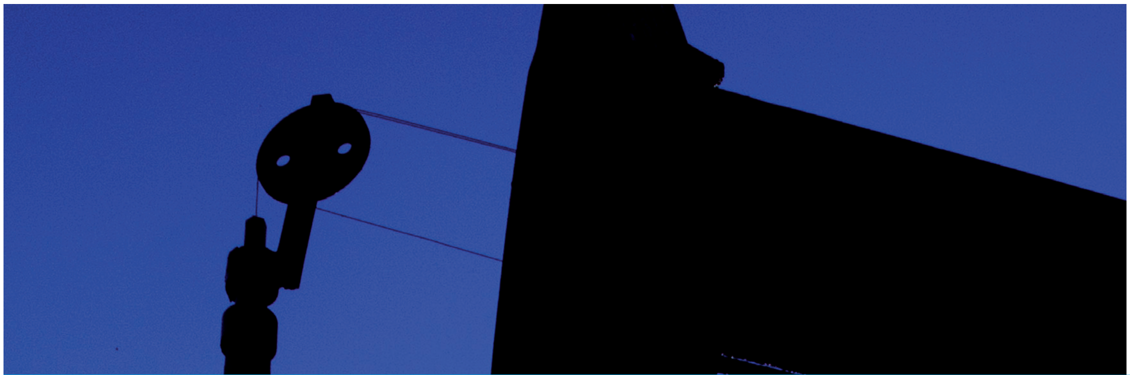

An IHS Report

October 2012

America’s New Energy Future:

The Unconventional Oil and Gas Revolution and the US Economy

Volume 1: National Economic Contributions

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IHS Inc. (NYSE: IHS) is a leading source of information and insight in critical areas that shape today's business landscape, including energy and power; design and supply chain; defense, risk and security; environmental, health and safety, and sustainability; country and industry forecasting; and commodities, pricing and cost. IHS has been in business since 1959 and became a publicly traded company on the New York Stock Exchange in 2005. Headquartered in Englewood, Colorado, USA, IHS employs more than 5,100 people in more than 30 countries around the world.

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This report offers an independent assessment of the contribution of the unconventional gas to the US economy. This research was supported by American Petroleum Institute, Institute for 21st Century Energy, the American Chemistry Council, and Natural Gas Supply Association. 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 national dialogue on the role of the unconventional oil and gas production, employment, economic growth, and energy security.

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Foreword

Just half a decade ago, the outlook for meeting America's demand for oil and natural gas was increasingly focused on non-domestic sources of supply. The standard view held that domestic production would inevitably decline and imports would consequently rise. Indeed, US oil production had been falling for nearly four decades. The country was on a path to spending several hundreds of billions of dollars more a year on imports to meet oil and natural gas demand.

Unconventional oil and natural gas activity is now unlocking new domestic sources of supply. Net petroleum imports have fallen from 60% of total consumption in 2005 to 42% today. The decline is due, in part, to moderating energy demand during the slow recovery in the wake of the Great Recession, but greater fuel efficiency in autos and a slowing of the growth in total vehicle miles will continue to constrain the growth of demand. However, the decline in imports has also been achieved through significant supply side changes resulting from increased domestic oil production. US oil production, which has risen 25% since 2008, is expected to reach 8.5 million barrels per day in 2012.[1] The largest element of this increase comes from what has become the major new advance in energy development: tight oil.

Similarly remarkable is the transformation in the natural gas market emanating from the rapid expansion of unconventional natural gas production. A dozen years ago, shale gas production was only 2% of total US natural gas production. Today, it represents 37%. This burgeoning supply, and its impact on market prices, is a significant factor supporting a manufacturing renaissance. It is also prompting a national discourse about wider markets for natural gas. This includes a dialogue both about natural gas as a vehicle fuel and about liquefied natural gas—not how much the United States imports but rather how much it should export.

Fueling these advances in domestic production are lengthy, complex supply chains for which increased activity means increased employment. As a result, unconventional energy development has become an engine of job creation and economic growth. In 2012, employment in the entire unconventional upstream sector will account for more than 1.7 million jobs and by the end of the decade almost 3 million jobs.

All of these are significant changes. This report addresses the implications of unconventional oil and natural gas for the broader US economy, including increases in capital expenditures, jobs, economic value added, and government revenues.

IHS Advisory Board

[1] Energy Information Administration (EIA), Monthly Energy Review, September 2012. "Oil", as used in this report, includes crude oil, lease condensate, and natural gas liquids (NGLs). Condensate" as we use the word in this report is the same as "lease condensate" used by the EIA.

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Daniel Yergin is Vice Chairman of IHS and Founder of IHS Cambridge Energy Research Associates (IHS CERA). He is author of the Pulitzer-Prize winning book *The Prize* and, recently, *The Quest*, both of which have been national best sellers. Dr. Yergin serves on the US Secretary of Energy Advisory Board and was a member of the Board’s subcommittee that issued its report on shale gas at the request of President Obama. He chaired the US Department of Energy’s Task Force on Strategic Energy Research and Development. Dr. Yergin holds a B.A. from Yale University and a Ph.D. from Cambridge University, where he was a Marshall Scholar.

Nariman Behravesh is Chief Economist of IHS and author of *Spin-Free Economics: A No-Nonsense, Nonpartisan Guide to Today’s Global Economic Debates*. Directing the entire economic forecasting process at IHS, he is responsible for developing the economic outlook and risk analyses for the United States, Europe, and Japan, China and emerging markets. Dr. Behravesh and his team have ranked among the top economic forecasters over the years in surveys by Reuters, *USA Today*, *MarketWatch* and *The Wall Street Journal*. He holds Ph.D. and M.A. degrees in economics from the University of Pennsylvania, and a B.Sc. from the Massachusetts Institute of Technology.

David Hobbs, IHS Chief Energy Strategist, is an expert on energy industry structure and strategies. He has led several influential studies of shale gas and oil and their technical, policy and economic impacts. He previously managed IHS CERA’s energy research activities. Mr. Hobbs is IHS CERA’s representative on the management board of the Global Energy Executive MBA program run jointly between the Haskayne School of Business at the University of Calgary and IHS CERA. He is also a member of the Scientific Advisory Board of the FondazioneEni Enrico Mattei.

James Rosenfield is Senior Vice President of IHS. Cofounder of IHS CERA, Mr. Rosenfield led its growth over three decades and was responsible for its development and strategy. He created and co-chairs IHS CERAWeek, the premiere international energy gathering, and he has spearheaded numerous influential IHS CERA studies. He was a Senior Fellow at Harvard’s Kennedy School of Government, attended Harvard College, and holds an M.B.A. from Boston University.

Key Findings

Unconventional oil and natural gas activity is already revolutionizing America's energy future and bringing enormous benefits to its economy. Unlocking unconventional energy will generate millions of jobs and billions in government receipts. It will make significant contributions to the US economy through direct employment, its many and diverse connections with supplier industries, the amount of spending this direct and indirect activity supports throughout the economy, and the revenues that flow to federal and state and local governments. As the production of unconventional oil and natural gas expands over the next 25 years, the economic contribution of the industry will also expand. IHS Global Insight expects substantial growth in capital expenditures and employment to occur in support of the expansion of production within the unconventional sector:

- More than $5.1 trillion in capital expenditures will take place between 2012 and 2035 across unconventional oil and natural gas activity, of which:
  - Over $2.1 trillion in capital expenditures will take place between 2012 and 2035 in unconventional oil activity.
  - Close to $3.0 trillion in capital expenditures will take place between 2012 and 2035 in unconventional natural gas activity.
- Employment attributed to upstream unconventional oil and natural gas activity will support more than 1.7 million jobs in 2012, growing to some 2.5 million jobs in 2015, 3 million jobs in 2020, and 3.5 million jobs in 2035.
- On average, direct employment will represent about 20% of all jobs resulting from unconventional oil and natural gas activity with the balance contributed by indirect and induced employment.
- In 2012, unconventional oil and natural gas activity will contribute nearly $62 billion in federal, state and local tax receipts. By 2020, total government revenues will grow to just over $111 billion. On a cumulative basis, unconventional oil and natural gas activity will generate more than $2.5 trillion in tax revenues between 2012 and 2035.

What Does Unconventional Mean?

"Unconventional" oil and natural gas is exactly the same commodity as "conventional" oil and natural gas. The word "unconventional" is typically applied to major new advances in extraction technology, in the oil and natural gas industry, that allow access to resources not technically or economically recoverable. In recent years, "unconventionals" have included oil sands, extra-heavy oil extraction technologies and deepwater drilling technologies. In this report we focus on one category of unconventionals—oil and natural gas that is produced using a combination of horizontal drilling, which exposes more of the subsurface to the well, and hydraulic fracturing, which creates pathways that allow the oil and natural gas to flow through the dense rock into that wellbore. What adds to the unconventionality is the rock itself.

Executive Summary

An unconventional oil and natural gas revolution is transforming America's energy economy, with far-reaching impacts on the US economy. It has already created over 1.7 million jobs and, by the end of the decade, will have contributed a total of nearly 3 million jobs. Against a backdrop of a historically slow economic recovery and persistently high unemployment following the Great Recession, the surge in spending associated with unconventional oil and natural gas activity is proving to be an important engine for jobs creation.

America has the opportunity to benefit from a new energy future quite different—and much more positive—than that envisioned just half a decade ago. The opportunity is fueled by a growing domestic supply of oil and natural gas unlocked by a series of technological innovations, primarily the combination of horizontal drilling with hydraulic fracturing, but also by advances in seismic imaging and other technologies.

How important is unconventional oil and natural gas to the United States? In just five years, unconventional oil and natural gas activity has thrust the nation into an unexpected position. It is now the global growth leader in crude oil production capacity growth, adding nearly 1.2 million barrels per day (mbd) of capacity.[2] And the United States is now the largest natural gas producer, at 65 billion cubic feet (Bcf) per day.[3] Additionally, unconventional activity is spurring the growth of natural gas liquids (NGLs) production, adding over 500,000 barrels of oil equivalent (boe) per day since 2008.[4] This has brought the total increase in oil production capacity to some 1.7 mbd since 2008.

Unconventional Gas

Over the past five years, US natural gas production has risen from 52 billion cubic feet (Bcf) per day to 65 Bcf per day—a 25% increase. This rapid rise was driven primarily by shale gas production. Today shale gas accounts for 37% of total natural gas production. In 2000, shale gas accounted for just 2% of total natural gas production.

Today, unconventional natural gas—which includes shale gas, as well as natural gas from tight sands formations and coal bed methane—accounts for nearly 65% of US natural gas production. Natural gas production is currently growing faster than demand, creating a temporary surplus. By the end of the decade, natural gas production will likely reach nearly 80 Bcf per day—almost 75% of which will originate from unconventional activity.

This rapid rise in unconventional production has also enhanced US energy security. Five years ago, because of constrained production, the United States seemed locked into importing increasing amounts of liquefied natural gas (LNG), heading toward eventually spending as much as $100 billion dollars for those imports. Now, these newly unlocked resources ensure that the United States will need, at most, minimal LNG imports to balance supply with demand. Instead of debates over US imports, there is a discussion today about exporting some of the domestic surplus, as well as the potential for using natural gas in some classes of vehicles.

Defining Oil

"Crude oil", as used in this report, includes crude oil and condensate. "Oil", as used in this report, incudes crude oil, condensate, and natural gas liquids

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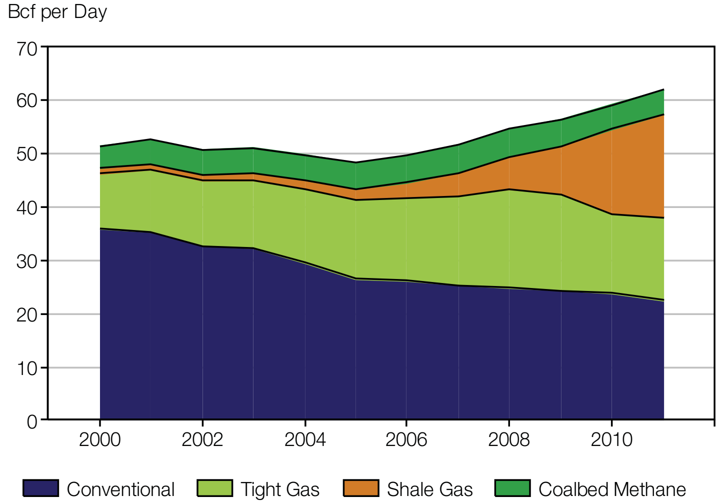
2 EIA—Monthly Energy Review http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_3.pdf

3 BP Statistical Review of World Energy 2012.

4 EIA—Monthly Energy Review http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_3.pdf

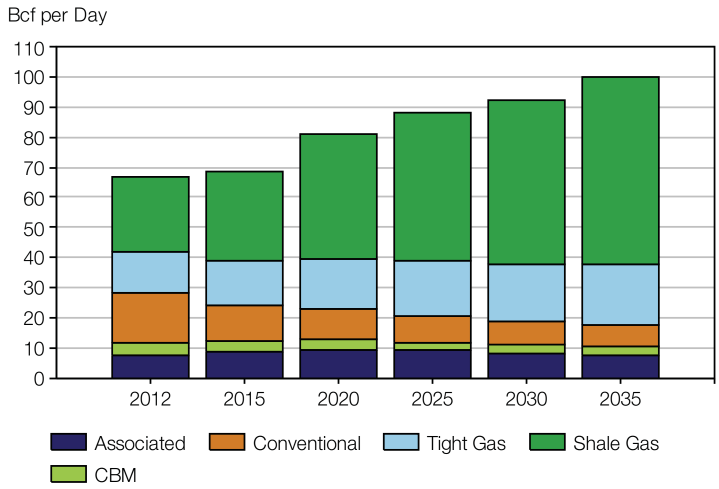
Capital investments and permits are being evaluated for export terminal facilities along the Gulf Coast and Middle Atlantic region for the purpose of LNG export activity. New "greenfield" export terminal projects have also been proposed in the Gulf and Pacific coast regions. Projects for exports to countries with which the United States has free trade agreements receive automatic approval, but this is not the case for projects that would export to non-FTA countries, which comprise most of the nations of the world. One project has thus far received authorization for exports to non-FTA countries. The very fact that an LNG export dialogue has begun underscores the energy and economic revolution in our midst.

US Lower 48 Natural Gas Production by Type: 2000 to 2011



Source: Energy Information Administration, IHS CERA

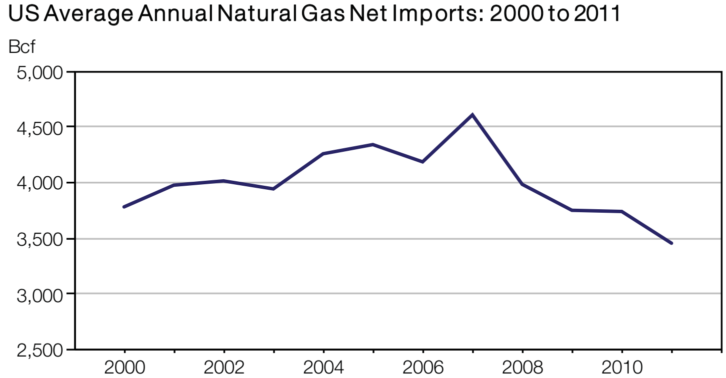
US Lower 48 Natural Gas Productive Capacity* Outlook by Type: 2012 to 2035



NOTE: *Productive capacity is the amount of gas that can be produced if unconstrained by infrastructure bottlenecks.

Source: IHS CERA

US Average Annual Natural Gas Net Imports: 2000 to 2011



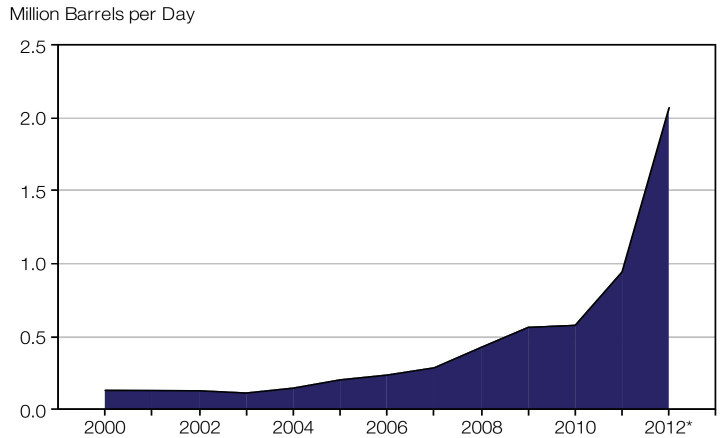
NOTE: Net natural gas imports represents total natural gas imports minus total natural gas exports.

Source: EIA

Unconventional Oil

Prior to the unconventional revolution, US oil production had experienced a long period of decline. From 1970 to 2008, crude oil production fell from 9.6 mbd to 5mbd.[5] However, the application of technological innovations—first developed for natural gas recovery from unconventional resources (shale and tight sand)—to unconventional oil has played a significant role in reversing this production decline. Production of what has become known as "tight oil" or "unconventional"—crude oil and condensate production from sources such as shale and other low permeability rocks—has increased from 100,000 barrels per day in 2003 and is expected to average over 2 million barrels per day in 2012. Growth in unconventional oil production has more than offset declining production elsewhere in the country and has resulted in a gain of 1.2 million barrels per day between 2008 and 2012.

Average Daily US Tight Oil Production: 2000 to 2012

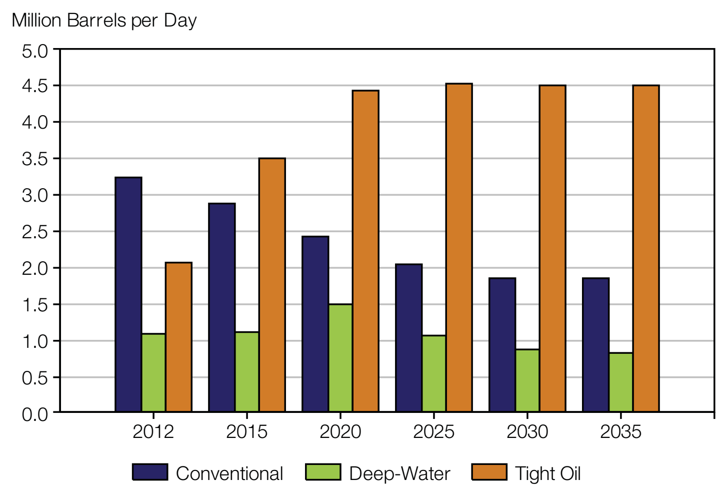


NOTE: *Projected.

Source: IHS CERA

Strong growth in tight oil production is anticipated to continue. By the end of the decade, tight oil production of nearly 4.5 mbd is expected, representing nearly two-thirds of domestic crude oil and condensate production.

US Tight Oil Production Outlook: 2012 to 2035



Source: IHS CERA

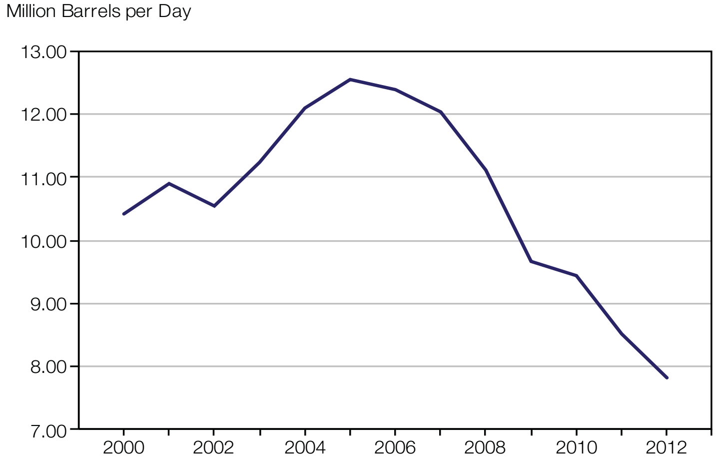
The first growth in US oil production since 1970 began in 2005—strikingly, the same year US oil consumption peaked. The economic climate of the past several years partially explains the decline in demand, but greater fuel efficiency in autos and a slowing, or even reversal, of the growth in total vehicle miles will continue to constrain the growth of demand. On the supply side, however, increasing domestic oil production driven by unconventional oil—when combined with fuel efficiency and demographic factors—will continue to reduce US oil imports in the years ahead. The economic impact is already clear in terms of international trade. At the current pace, 2012 net oil imports are projected to reach $319 billion, equivalent to approximately 45% of our estimated 2012 trade deficit of $695 billion. Oil imports would have cost the United States $70 billion more—and therefore the trade deficit would have risen by about 10%—had the 1.7 mbd increase in production capacity brought about by tight oil since 2008 not been realized.

[5] "Crude oil" includes both crude oil and condensate.

Continuing increases in domestic oil production will also result in a significantly lower trade deficit than would otherwise be the case.

At the current pace of development, the net US oil import requirement could be about 4.5 mbd less by 2020 than it was as recently as 2005. Using the average oil price for the first nine months of 2012 of $112 per barrel, this represents an annual reduction in the oil import bill of nearly $185 billion.[6]

US Average Net Oil Imports*: 2000 to 2012



NOTE: Net oil imports equals oil and oil products imports minus oil and oil products

Source: EIA

Natural Gas Liquids

Finally, this unconventional activity has also contributed to the rise in natural gas liquids—ethane, propane, butanes and natural gasoline or light naphtha. The growth in NGLs production has significant implications for the downstream energy sector. Many of the unconventional oil deposits also contain rich gas, that is, natural gas accompanied by natural gas liquids as well as crude oil. In addition, many of the unconventional gas plays—the so-called "wet gas" plays—contain significant proportions of NGLs. These NGLs are feedstocks for the petrochemical industry and the building blocks for countless industrial and consumer goods. After decades of relatively flat production, unconventional activity unleashed the first rapid growth in domestic production of these liquids. From 2008 to 2012, overall NGL production in the United States grew by over 500,000 barrels per day—a 29% increase that was largely attributable to unconventional activity. Further, production of NGLs from unconventional activity is anticipated to more than double, from 1.8 mbd in 2012 to 3.8 mbd by 2020.[7] The greater availability of natural gas liquids can be expected to support the expansion of US petrochemical manufacturing which uses NGLs as feedstock and will be explored in our future analysis.

Economic Contributions to the United States

This growth in oil and natural gas production is fueled by the exploration and production industry, which is driving the unconventional revolution with over $87 billion in capital expenditures in 2012. Since the majority of the technology, tools, and knowhow are home grown, an overwhelming majority of every dollar spent throughout this supply chain remains in the United States and supports domestic jobs. Extensive supply chains—across many states, including states that do not directly produce unconventional oil and natural gas—reach into multiple facets of the American economy. Below, we present the contribution from the unconventional revolution in terms of capital expenditures, jobs, economic value added, and government revenues.

[6] EIA Average Brent Spot Price FOB (Dollars per Barrel) Jan-Sept 2012

[7] Natural gas liquids (contained) represents unprocessed liquids potentially recoverable from the production of gas and oil

$172 Billion Annual Capital Expenditures By 2020

US Lower 48 Capital Expenditures: Total Unconventional Activity* (Current $M)	**2012**	**2020**	**2035**	**2012-2035****
Drilling Capital Expenditure	28,027	57,680	122,430	1,761,012
Completion Capital Expenditure	46,873	92,322	188,284	2,737,444
Facilities Capital Expenditure	6,701	12,620	24,479	370,727
Gathering System Capital Expenditure	5,701	9,919	17,883	279,326
TOTAL UPSTREAM CAPITAL EXPENDITURE	**87,301**	**172,542**	**353,076**	**5,148,509**

NOTES: *Total unconventional activity represents the sum of unconventional oil and unconventional gas activity.

**2012-2035 represents the total for all years including those years not reported.

Source: IHS Global Insight

As the production of unconventional oil and natural gas expands over the next 25 years, the industry's economic contribution will also expand. While today's capital expenditures are over $87 billion, annual capital expenditures in support of unconventional energy activity will grow to $172.5 billion by the end of the decade, widely impacting the US economy. Cumulative capital expenditures on unconventional oil and natural gas development are expected to exceed $5.1 trillion by 2035 (an average of some $200 billion annually over the entire period). This spending takes place in upstream unconventional oil and natural gas activity and includes drilling, completion, facilities and gathering systems. Spending will feed into the broader supply chain through capital-intensive purchases of heavy equipment, iron and steel, and rig parts, as well as technical skills and services and information technology among others.

3 Million American Jobs By 2020

US Lower 48 Employment Contribution (Number of workers)	**2012**	**2020**	**2035**
Unconventional Oil Activity*	845,929	1,345,987	1,390,197
Unconventional Gas Activity**	902,675	1,639,181	2,108,481
Total Unconventional Activity	**1,748,604**	**2,985,168**	**3,498,678**

NOTES: Numbers may not sum due to rounding.

*Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

**Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

Source: IHS Global Insight

The economic contribution of unconventional energy activity to employment is measured by the sum of (1) the direct contribution, (2) the indirect contribution from supplying industries, and (3) the induced economic contribution that results from workers spending their incomes throughout the entire economy.

These employment opportunities have particular resonance at a time that reigniting the economy, and job growth in particular, is one of the dominant issues on the national agenda. The numbers are striking:

- In 2012, unconventional energy activity supported over 360,000 direct jobs, over 537,000 indirect jobs in supplying industries, and over 850,000 induced jobs—a total of more than 1.7 million jobs in the lower 48 US states.

- The greatest future job growth will occur between 2012 and 2020, during which we forecast unconventional oil and natural gas activity will stimulate the addition of nearly 1.3 million jobs, bringing the total to 3 million workers. These jobs will comprise over 600,000 direct, over 900,000 indirect, and nearly 1.5 million induced jobs.
- Beyond this, by 2035, the industry will add nearly 500,000 jobs, bringing the total contribution to just less than 3.5 million. IHS Global Insight expects that total employment contribution for upstream unconventional activity will account for 1.5% of the overall US workforce on average over the near-term (2012-2015), 1.9% during the intermediate term (2016-2020) and 2% in the long-term (2020-2035).

$416 Billion in Value Added to the US Economy By 2020

US Lower 48 Value Added Contribution

(2012 $M)

	2012	2020	2035
Unconventional Oil Activity*	116,014	191,081	187,858
Unconventional Gas Activity**	121,670	225,470	287,127
Total Unconventional Activity	**237,684**	**416,551**	**474,985**

NOTES: Numbers may not sum due to rounding.

*Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

**Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

Source: IHS Global Insight

In terms of the value-added contribution to gross domestic product (GDP), upstream unconventional energy activity will contribute more than $237 billion in 2012 alone. As industrial activity and capital expenditures expand, the industry's contribution to the overall economy will also grow. The value added contributions will increase to more than $416 billion in 2020 and $475 billion by the end of the forecast.[8]

$111 Billion in Annual Tax Revenues to Federal and State Treasuries By 2020

US Lower 48 Estimated Government Revenue: Total Unconventional Activity*

(2012 $M)

	2012	2020	2035	2012-2035**
Federal Taxes	28,936	50,229	57,846	1,137,602
State and Local Taxes	30,931	57,731	64,967	1,317,506
Federal Royalty Payments	1,964	3,204	1,593	62,141
Total Government Revenue	**61,832**	**111,164**	**124,406**	**2,517,248**
Lease Payments to Private Landowners	504	913	1,232	23,599

NOTES: *Total unconventional activity represents the sum of unconventional oil and unconventional gas activity.

**2012-2035 represents the total for all years including those years not reported.

Source: IHS Global Insight

At a time when government budgets are of great concern, the unconventional revolution has had a considerable fiscal impact: industrial activity and employment associated with unconventional oil, natural gas and NGLs development will contribute nearly $62 billion in federal, state and local tax receipts for 2012 alone.

[8] All dollars are in 2012 constant amounts.

These revenues include personal and corporate taxes from the supply chain of industries, as well as tax revenues from income earned by direct, indirect, and induced employees. Tax revenue includes: (1) federal—corporate and personal income taxes; (2) state and local—corporate and personal income taxes, state severance taxes, and state *ad valorem* levies; and (3) federal royalties—payment for exploration on federal lands. In addition to government taxes and revenues, lease payments to private landowners are also reported.

Federal tax revenues and royalties currently account for nearly $31 billion, while state and local taxes account for another $31 billion. By 2020, total government revenues from unconventional oil and natural gas will grow to just over $111 billion. On a cumulative basis, unconventional activity will generate more than $2.5 trillion in tax revenues between 2012 and 2035. Over the entire 2012 to 2035 forecast interval, state and local tax revenues are roughly as large as federal revenues. While federal personal tax receipts are significantly greater than state personal tax receipts, the addition of corporate taxes at the state level as well as ad valorem and severance tax collections will equalize state and local revenues with federal tax revenues.

Conclusion

Unconventional oil and natural gas activity is reshaping America's energy future and bringing very significant benefits to the economy—in terms of jobs, government revenues, and GDP. This study provides the foundation for a dialogue focused on the evolving and transformative economic effects of this unconventional revolution. It assesses the contribution in terms of the economic impacts to the US and the security of its energy supply. This research explores how the development of new sources of unconventional oil and natural gas is fundamentally changing the US energy outlook and the nation's economic future.

IHS expects cumulative capital expenditures on unconventional oil and natural gas development to reach $5.1 trillion by 2035, or an average of over $200 billion annually. This spending will make contributions to the US economy both through direct employment within the oil and natural gas industry and indirect employment across the diverse suppliers that support the industry. When direct and indirect employees spend their incomes—on food, housing, and other sundries of daily living—they support induced employment throughout the entire economy. Supporting this build-out of upstream unconventional activity are more than 1.7 million jobs today. But, by the end of the decade, the industry will support 3 million jobs and is on a path to supporting 3.5 million jobs in 2035.

Introduction and Research Objectives

Across America's widening energy landscape, the economic impacts of unconventional oil and natural gas are increasingly discernible. These effects are visible within the energy value chain and are extending into the broader reaches of the US economy.

Previous IHS research has demonstrated the appreciable economic impacts derived from unconventional natural gas development, and the very same technologies driving this growth—including hydraulic fracturing and horizontal drilling—have also led to a take-off in production of domestic unconventional tight oil. The confluence of technology, newly identified resources, and slow economic growth is stimulating a fresh dialogue about the emergence of "America's New Energy Future."

In little more than five years, many of the old expectations for the energy and economic future have been upended by the resurgence of US oil and natural gas production. This rebound in crude oil and condensate production has propelled the United States into the lead as the fastest growing producer of oil worldwide.[9]

In the crosscurrents of the slow economic recovery from the deepest economic downturn since the Great Depression, unconventional hydrocarbons are supporting domestic job growth within the energy sector and in the lengthy supply chain that supports energy production. Beyond direct exploration, development, and production activity around the wellhead and well pad, unconventional energy is fueling orders in an array of supply sectors. These include off-highway equipment, steel pipe manufacturing, and information technology services, such as those associated with seismic data visualization and management.

The focus of this report is to assess the evolving national economic contributions of unconventional upstream oil and natural gas development activity. Unique to this analysis are the discrete economic contributions generated by unconventional oil—including crude oil and condensate—and unconventional natural gas—defined as shale gas and tight gas, and the corresponding NGL production from both unconventional oil and natural gas activities. This analysis demonstrates the economic contributions—to employment, national income, and tax revenues—associated with this unconventional oil and natural gas activity, and examines the contribution to direct, indirect and induced employment. This study seeks to quantify how unconventional upstream activity creates economic value in the broader economy through an examination of the exploration and production activity that specifically isolates the various hydrocarbon resources on a major play-by-play basis.

The economic and fiscal contributions of upstream unconventional oil and natural gas activities are presented at the national level. Further research will examine state-by-state contributions. Upstream activity has demonstrated clear economic benefits of oil and natural gas producing plays in various states, such as the Marcellus formation in Pennsylvania, Niobrara in Colorado, Eagle Ford in Texas, as well as formations in other oil and natural gas producing states. However, IHS' analysis demonstrates that non-producing states also realize economic benefits, as do a long list of industries in the energy value chain. For example, Illinois, with its significant industrial manufacturing base, supports upstream activity by producing the capital goods used on drilling sites. These types of linkages will be investigated more thoroughly during our research to assess how widespread the economic effect of the unconventional revolution can be on a sub-regional and sub-sectoral level. Correspondingly, IHS will also assess the evolving fiscal impacts at the state level, at a time when state budgets are under great pressure.

Finally, building from the national and state level assessments, we will ultimately assess the potential for US manufacturing. Our research will explore the employment and competitiveness trends within the manufacturing sector related to upstream unconventional oil and natural gas activity. In particular, we

[9] IHS CERA, US Energy Information Administration, International Energy Agency. NOTE: Crude oil, condensate, and natural gas liquids.

will examine the effects of an ample, affordable domestic supply of oil, natural gas, and NGLs on our manufacturing base—including the petrochemical, steel and other energy-intensive industries as well as the economic activity associated with the supply chains that sustain this expansion. At the conclusion of the full research program, we will have generated three Special Reports:

- The national economic contributions of unconventional upstream oil and natural gas activity in the lower 48 US states (this study);
- The state-level economic contributions of unconventional upstream oil and natural gas activity in the lower 48 US states;
- The economic contributions and prospects for a domestic manufacturing renaissance resulting from unconventional upstream oil and natural gas activity in the lower 48 US states.

Report Structure

This report, the first in the series, is divided into five sections.

- Executive Summary offers an overview of the results.
- An Introduction to Unconventional Oil and Natural Gas offers an overview of the unconventional oil and natural gas industry and explains the differences between unconventional or tight oil, shale gas, tight gas and natural gas liquids.
- An Unconventional Oil and Gas Revolution presents the critical inputs to the economic analysis, namely the production profile and capital expenditure outlook for unconventional oil and natural gas. Since any discussion of production profiles must be bound by market principles, we preface this section with an overview of the US market supply and demand outlook through 2035.
- Economic Contributions details the results of IHS' economic contribution analysis for the unconventional oil and natural gas resources.
- Conclusion provides the key conclusions of the national report.

We also provide several appendices to provide the readers with a deeper understanding of the methodologies, research and data utilized for our analysis. The appendices—available at http://www.ihs.com/info/ecc/a/americas-new-energy-future.aspx—present more detailed results from our study.

- Appendix A contains the underlying methodology and detailed data related to the assumed future production profile and capital expenditure outlook for unconventional oil and natural gas and natural gas liquids.
- Appendix B provides more detailed results of the economic contribution assessment.
- Appendix C presents the economic contribution results at a three digit NAICS industry level.
- Appendix D presents the data and modeling approach underlying the economic contribution analysis.

An Introduction to Unconventional Oil and Natural Gas

What is Unconventional Oil and Gas?

In a conventional hydrocarbon reservoir, oil and natural gas migrate over geologic time from a deeper source rock in which they were originally formed and through other permeable rocks or conduits until the oil or natural gas encounters an impermeable layer of rock or barrier that traps the hydrocarbon in an underlying reservoir. A well is drilled into the reservoir to allow the oil and/or natural gas to flow into the wellbore and then to the surface. Depending on geological conditions, conventional well completion techniques have traditionally included vertical drilling and, in many cases, hydraulic fracturing and other stimulation technologies to facilitate hydrocarbon flow.

Unconventional or "tight oil" is produced from a variety of geological formations using techniques that were pioneered to produce unconventional natural gas. There are significant differences in terms of geology, recovery technology, and productivity of hydrocarbons when comparing conventional and unconventional oil and natural gas reservoirs; the techniques for producing oil from unconventional formations, on the other hand, are essentially the same as those used to produce unconventional natural gas.

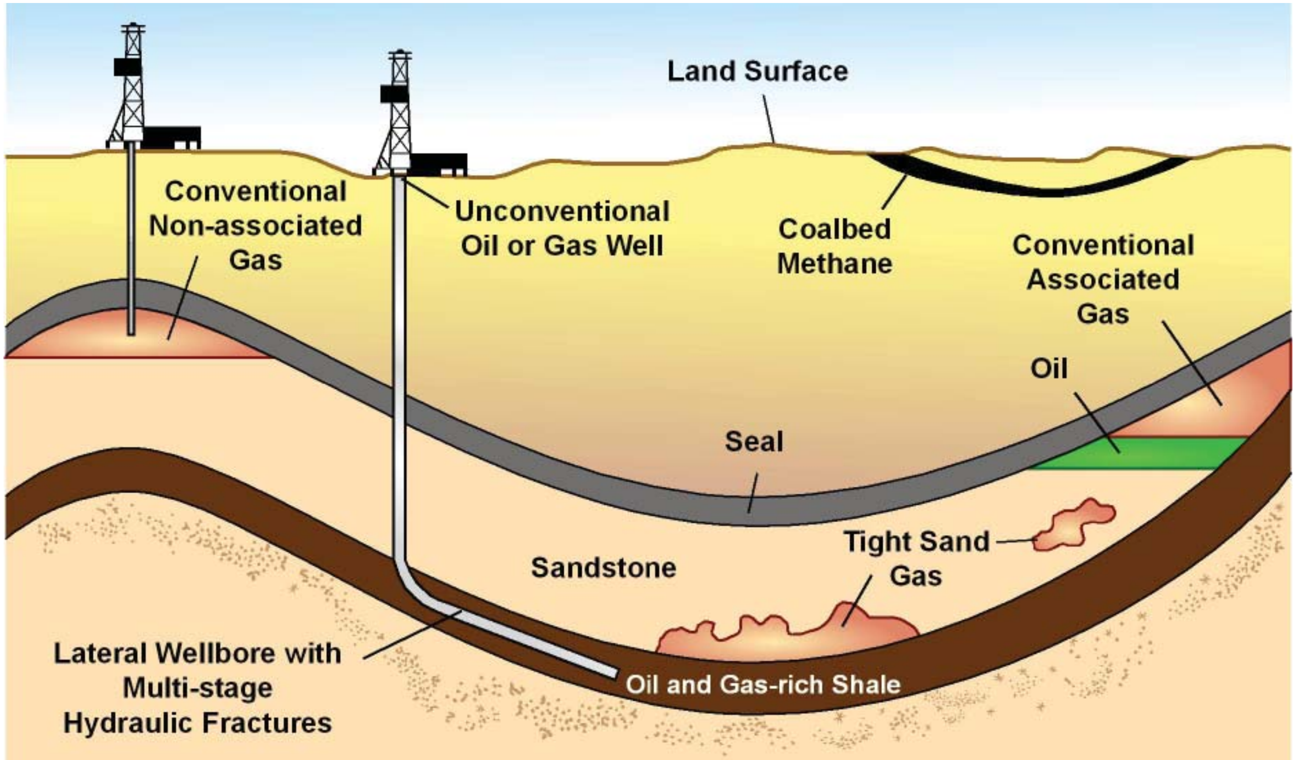
The major characteristic common to both unconventional oil and natural gas is that hydrocarbons are produced from geological formations that previously prevented the hydrocarbons from flowing at commercial rates; hence, production from these formations had generally not been economic until recently. Shale gas is contained in low-permeability shale rock; tight sands gas is contained in low-permeability sandstones and carbonates; and tight oil is contained in shales and low-permeability carbonates, and sandstones. Because all of these rocks have low permeability, they are informally referred to as being "tight." Permeability—a measure of how easily gases and liquids can flow through rock—is one of the factors driving the choice of techniques for the extraction of natural gas or oil from the rock formation.

It has long been known that low-permeability reservoirs, including the source rocks that fed conventional reservoirs, existed and that they contained significant amounts of natural gas and oil. However, traditional completion techniques did not yield sufficient production for economic development. Through years of applied research and testing in formations such as the East Texas Barnett shale, production techniques have been developed to extract oil and natural gas from these low permeability rocks.

In particular, the combination of horizontal drilling and hydraulic fracturing has proved critical to unconventional oil and natural gas development. Both have a long history of use. Horizontal drilling involves drilling a vertical well to the desired depth and then drilling laterally, or horizontally, to access a larger portion of the intended reservoir. Hydraulic fracturing involves the injection of fluid (usually a mixture of water, sand, and small amounts of chemicals) through the wellbore under high pressure into low-permeability reservoirs to create artificial fractures that create conduits through which hydrocarbons can flow. The sand or "proppant" is left behind in those cracks or "fractures" to prevent them from closing after the pressurized fluids are removed. These propped fractures offer pathways (permeability) for oil and natural gas to flow more easily through the wellbore and then to the surface.

Horizontal drilling and hydraulic fracturing techniques have been refined and improved in recent years, increasing productivity from unconventional reservoirs. Much of this refinement is play specific, since each formation behaves slightly differently. The use of these two techniques in combination allows a larger surface area of the reservoir to be exposed to a single well and thus a larger area across which reservoir fluids can flow into the wellbore. As a result, these techniques allow commercial production of significant amounts of hydrocarbons that have been unable to escape over millions of years from ultra-tight, low-permeability formations.

The Geology of Conventional and Unconventional Oil and Gas



Source: EIA

Unconventional natural gas is typically classified according to the type of formation from which it is extracted: shale, tight sandstone, and coal seams.[10] In practice, many natural gas plays contain combinations of these, and the designation of a particular play as a shale gas play or a tight gas play is typically the result of geologists' consensus based on the predominant rock characteristics. Portions of a play can vary from shale-dominant to tight sands-dominant by depth or geographical location. Similarly, the hydrocarbon content across the play may transition from dry gas to wet gas and condensate, to crude oil, all generally designated as "tight" gas or oil depending on the source rock.

The Production of Unconventional Oil and Natural Gas

Oil and natural gas produced from conventional and unconventional sources are virtually identical in the fundamental aspects of their exploration, development, production, transportation, processing, and marketing. They differ primarily in terms of well construction. Wells for unconventional hydrocarbons tend to be more expensive than those for conventional production from a similar depth reservoir due to the long horizontal wellbores required and the far greater complexity of well completion. The latter requires creating fractures through a multi-stage hydraulic fracture completion, performed in the production start-up stage. The major components of oil and natural gas production are briefly described below.

Prospecting and Exploration

Numerous geological evaluations, seismic surveys, pilot drilling and testing are required to determine whether an oil or natural gas field has the potential for commercial development—typically after significant investment has been made in securing leases. Development plans are formulated with an eye toward minimizing environmental and other local disturbances and ensuring that all necessary permits are

[10] This study examined only shale gas and tight sands.

secured for well locations that would access the most economically recoverable quantities of oil and natural gas.

Well Construction

Well construction starts with detailed planning of a well's location, both at the surface and for the trajectory and target below ground. Once a well location has been surveyed and staked out, and a drilling permit has been granted by state and/or local regulatory authorities (or by federal authorities on federal land), the site is prepared for drilling.

Drilling

A drilling rig penetrates the ground by means of a rotating drill bit attached to the bottom of a steel pipe assembly known as the drill string. Specialized "mud" is continuously pumped down the drill string and up the wellbore in order to keep the drill bit cool and lift rock cuttings away from the bit and up to the surface. As drilling progresses, steel sleeves, or casing, are lowered and cemented in place, starting at the surface and moving downward. The steel casing and cement surrounding it isolates the contents of the wellbore from the adjacent rock formations and from underground sources of potable water. After drilling the vertical segment, the drill bit is directed to "kick off" in an arc until it achieves a target horizontal trajectory, where it continues with a lateral segment to a designated length, typically between 5,000 and 15,000 feet.

Completion

Well completion is the process of preparing a well, after drilling, to begin production. Completion steps include installation of the remainder of the casing, followed by perforation. The perforation step creates holes through the casing wall and enclosing cement layer to connect the wellbore to the hydrocarbon-bearing reservoir. Those holes are created in the target zone only, and apart from allowing inflow of oil and natural gas, they also facilitate the outflow of water at high pressure in order to create hydraulic fractures in the rock. Perforation is accomplished by means of controlled explosive charges set off in the wellbore and mounted in specially designed perforating "guns" that are electrically triggered from the surface. Once the casing is perforated, the target zone area accessed by the well is ready to be hydraulically fractured. Pumps inject large volumes of completion fluid—mostly water and sand with small quantities of additives—down the wellbore under very high pressure. The pressure from the pumps is propagated by the fluid coursing down the wellbore and against the reservoir rock, creating fractures in the rock. After fracturing is complete for all portions of the horizontal wellbore, valves on surface are opened up, allowing water to flow back from the rock face, leaving sand behind to keep the fractures propped open. As the completion fluid is removed from the wellbore, oil and/or natural gas can migrate into the fractures, travel along the fractures to the wellbore, up to the surface wellhead, and on to gathering facilities leading to processing plants and then to sales and marketing pipelines.

Production

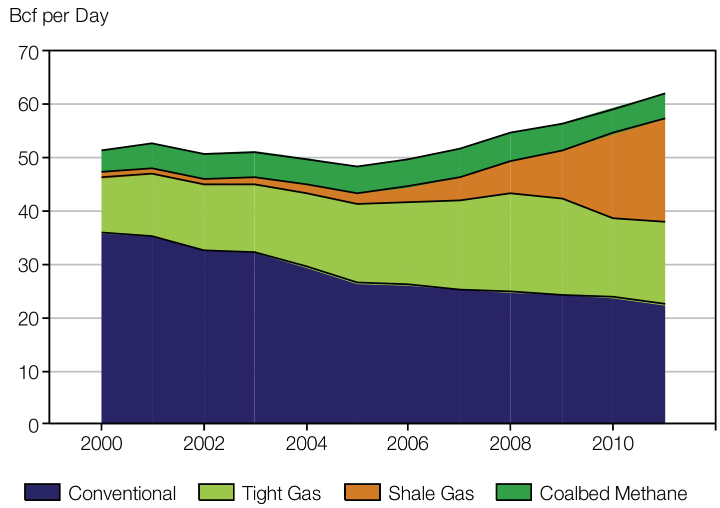
After completion, production goes into full swing, assuming that there is sufficient transport and processing capability. Local production tie-in lines lead to compression stations located in the production area. Formation water mingled with oil and natural gas — a byproduct of production—is stripped out by means of separators and dehydrators, and the cleaner hydrocarbon is transported through a network of gathering pipelines that continually collect oil and natural gas from various operators' leases, feeding natural gas to processing plants and oil to a pipelines for eventual refining. Gas processing plants extract natural gas liquids such as ethane, propane, butane, isobutene, and pentane for sale in their respective markets. Dry gas then enters a pipeline for delivery to end markets, such as power generation or manufacturing plants or urban distribution networks.

An Unconventional Oil and Gas Revolution: Supply and Demand

The Shale Gale—Abundant Natural Gas

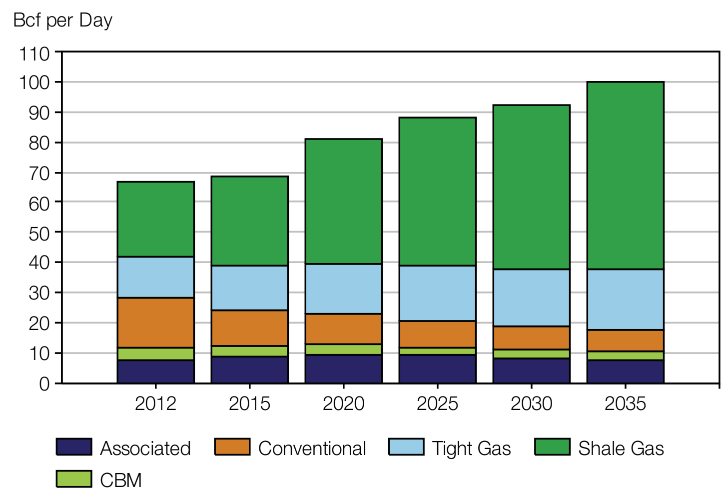
The prospect of an abundant long-term natural gas supply has revolutionized the US natural gas market. As recently as 2007 it was commonly believed that the US natural gas resource base had matured or was economically inaccessible and that increasing imports of liquefied natural gas ("LNG") would be required to meet demand. But then shale gas production began to grow. The key efforts to capture natural gas from shale rock began in the early 1980s in the Barnett Shale in Texas. But it was not until the late 1990s and the first years of this century that the technologies came together.[11] Natural gas production in the US Lower 48 grew from nearly 50 Bcf per day in January 2007 to roughly 56 Bcf per day in July 2008—an increase of nearly 13% in just 18 months. Total natural gas production has now grown to 65 Bcf per day, of which 50% is shale and tight gas. Natural gas supply is no longer in doubt. In fact, the US natural gas market, which was once considered supply-constrained, is now demand-constrained. This means the outlook for shale gas production depends in considerable part on the outlook for natural gas demand.

US Lower 48 Natural Gas Production by Type: 2000 to 2011



Source: Energy Information Administration, IHS CERA

US Lower 48 Natural Gas Productive Capacity* Outlook by Type: 2012 to 2035



NOTE: *Productive capacity is the amount of gas that can be produced if unconstrained by infrastructure bottlenecks.

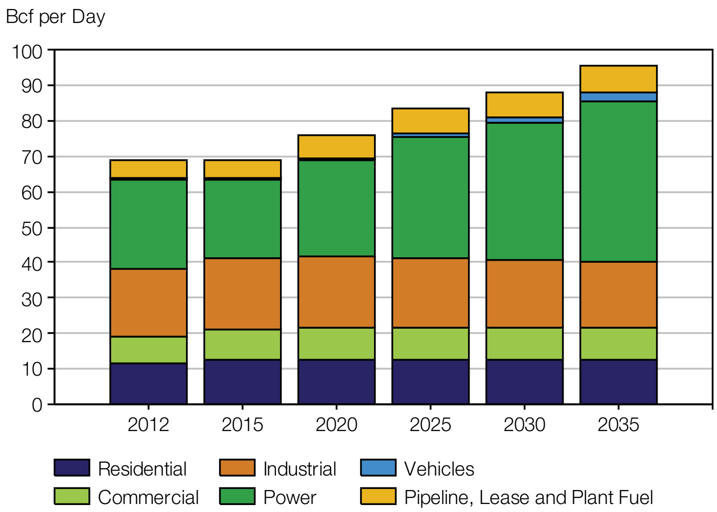
Source: IHS CERA

IHS CERA expects total domestic natural gas production to continue to grow over the long term, in line with expanding natural gas consumption. Almost all of the future growth of US natural gas production is expected to come from shale gas and tight gas plays. By 2035, total natural gas production is expected to approach 100 Bcf per day of which nearly 80% will come from shale gas and tight gas alone.

Since the nation's endowment of recoverable natural gas has expanded so rapidly as a result of unconventional technologies, the United States is expected to be able to meet future demand growth almost entirely from North American sources. Little or no LNG imports will be required, and any imports will only be for seasonal balancing purposes. IHS CERA's long-term outlook for natural gas demand envisions lower US 48 demand increasing from almost 70 Bcf per day in 2012 to 96 Bcf per day

[11] Daniel Yergin, "The Natural Gas Revolution," chapter 16, *The Quest: Energy Security and the Remaking of the Modern World* (New York: Penguin, 2012).

US Lower 48 Natural Gas Demand by Type: 2012 to 2035



Source: IHS CERA

by 2035. Much of this increase occurs in the power sector, where demand will more than double over this period, with additional demand coming from petrochemicals and other natural gas-intensive industries, as well as some development of natural gas-fueled vehicles. Relatively little growth is expected for the residential and commercial sectors.

Environmental emissions regulations, renewable energy mandates, investment economics, and more flexible time frames—all will work to promote increased natural gas use for power generation. US Environmental Protection Agency regulations aimed at restricting emissions of sulfur, mercury, particulate matter, and potentially carbon dioxide are increasing the costs of operating coal generation units and sometimes are hastening their retirement. Since natural gas is a cleaner-burning fuel than coal, with only half the carbon content, and is available at relatively lower prices, natural gas is increasingly being favored over coal for power generation.

Economics also favor natural gas. Gas-generation plants have lower capital costs than most other types of generation units, and they can often be built more quickly than coal or nuclear units. Moreover, the low price of natural gas makes it a stronger competitor against coal in electric dispatch. Recently, utilization of existing gas-fired capacity has increased with the fuel share for gas rising from 20% in 2008 to 29% in 2012.

Finally, the increasing share of renewables in power generation capacity, driven in part by state Renewable Portfolio Standards, favors natural gas for backup generation when wind and solar power are unavailable. IHS CERA expects total additions to generation capacity to be nearly 500 gigawatts (GW) between 2012 and 2035. Retirements of coal plants will reach 93 GW over this period. Gas-fired capacity will account for 53% of this additional capacity, with 40% furnished by wind and other renewables, 5% from nuclear, and 2% from advanced coal technologies. This translates into an increase in power sector demand for natural gas from 21 Bcf per day in 2011 to 45 Bcf per day by 2035.

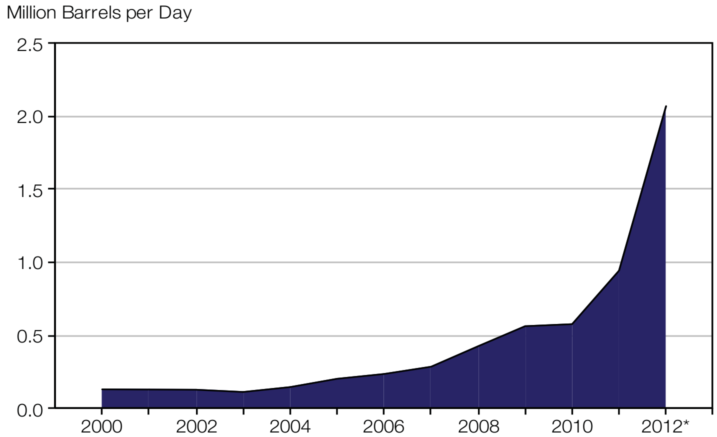
Industrial demand also has growth potential. The development of shale gas and associated natural gas from tight oil plays is dramatically increasing the availability and potential supply of attractively priced natural gas liquids (NGLs), which are commonly used as a petrochemical feedstock. Production from these plays includes varying amounts of hydrocarbons other than methane. These include ethane, propane, normal butane, isobutane, and natural gasoline (sometimes referred to as "pentanes plus"). The petrochemical feedstock represents the single most important end-use sector for NGLs in North America, accounting for more than half of the total demand for NGLs. The production of NGLs from shale gas and tight gas plays and from associated natural gas in tight oil plays will grow from 1.8 million barrels of oil equivalent (mboe) per day in 2012 to 4.8 mboe per day by 2035.[12]

[12] Natural gas liquids (contained) represents unprocessed liquids potentially recoverable from the production of gas and oil.

The Great Revival—New Oil

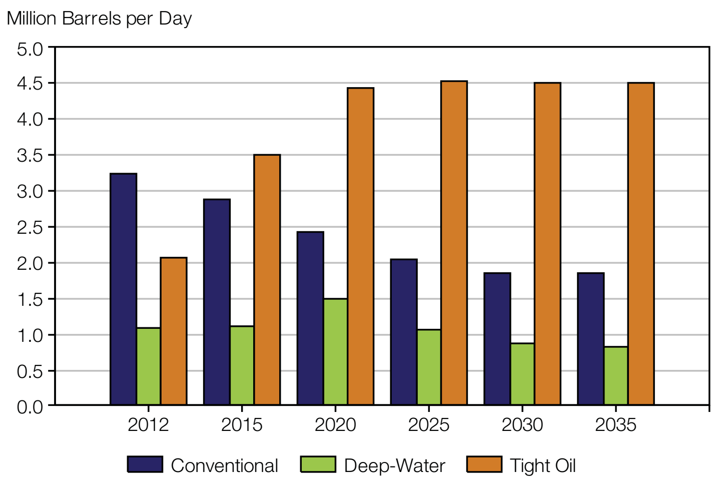
As the natural gas Shale Gale was taking off, operators in North Dakota and Montana were already drilling horizontal wells and working to determine if the same drilling techniques involving hydraulic fracturing could be successful in unconventional oil formations. These techniques did indeed prove themselves and, as with shale gas, led to a rapid increase in US oil production over the past few years. The Bakken play in North Dakota and the Eagle Ford play in Texas are prime examples of this growth. From less than 100,000 barrels per day (bd) in 2005, North Dakota's production is now near 700,000 barrels per day as a result of growth in the Bakken play. The Eagle Ford in Texas, another significant play, has risen from virtually nothing in 2005 and is expected to average 515,000 barrels per day in 2012. Operators quickly used these techniques to develop other formations such as in the Niobrara play in Colorado, and to begin to explore new plays such as the Utica in Ohio. They are also now using these techniques to rejuvenate major mature regions—most notably the Permian Basin in West Texas—by going back to poor-quality reservoirs within conventional plays.

Average Daily US Tight Oil Production: 2000 to 2012



NOTE: *Projected.
Source: IHS CERA

US Tight Oil Production Outlook: 2012 to 2035



Source: IHS CERA

The production of tight oil (crude oil and condensate from unconventional sources) is expected to increase from 2 mbd in 2012 to 4.5 mbd by 2035, accounting for about 63% of total US crude oil and condensate production.

At this point, recoverable crude oil from unconventional plays is estimated to be approximately 38 billion barrels, with about one-third of this in mature poor-quality conventional plays. The experience of the shale gas revolution shows that productivity rates can increase dramatically as the industry gains knowledge and experience using its new production technologies. However, since tight oil is a new resource and production is in the early stages of development, there is more uncertainty about its ultimate potential.

Production Profiles for Unconventional Oil and Gas Plays

The outlooks for both production and the corresponding capital expenditures for the unconventional oil and natural gas industry are required to accurately assess economic contribution. Within our framework, the capital requirement is a function of underlying production. That is, IHS CERA projects production and then derives the corresponding capital expenditures necessary to support that level of production.

In developing our production profiles and capital expenditure outlooks from 2012 through 2035, IHS CERA’s outlook considered production from 20 major plays—seven tight oil plays, nine shale gas plays and four tight gas plays. IHS’ outlook for unconventional oil and natural gas production in the lower US 48 states includes production from the following plays considered in this study:

Tight Oil Plays	Shale Gas Plays	Tight Sands Gas Plays
Bakken	Eagle Ford Shale Wet Gas	Uinta-Piceance
Eagle Ford Oil and Volatile Oil	Eagle Ford Shale Dry Gas	Jonah-Pinedale
Delaware Basin—Bone Spring	Marcellus Shale	Cotton Valley
Midland Basin—Spraberry-Wolfcamp	Utica Shale (Gas)	Granite Wash—Colony Wash
Mississippian	Woodford Shale	
Cleveland-Tonkawa	Haynesville Shale	
Utica (Oil)	Fayetteville shale	
	Barnett Shale	
	Niobrara	

The variables used to derive production profiles for each of these 20 plays were obtained from IHS databases and internal research. These variables include:

- Rig count (including assumptions about ramp up, maximum rigs, time at plateau, ramp down);
- Number of days to drill and complete a well;
- Type curves showing production profiles over time for a typical well;
- Acreage (total area to be developed);
- Well spacing;
- Probability of geologic success.

The number of possible locations to be developed was derived from the last three items. Type curves were derived for each play using IHS databases and software tools (Enerdeq and PowerTools) based on actual well production data.

The number of days to drill a well (including mobilization and demobilization of the rigs) was also obtained from well data in IHS databases. Rig forecasts were developed for each play based on historic rig counts and on estimated active rig counts operating in 2012, along with the per-well economics of each individual play.

US Lower 48 Annual Unconventional Oil and Gas Production and Well Completions

	2012	2015	2020	2035
PRODUCTION				
Unconventional Oil* (mbd)	**2.07**	**3.50**	**4.43**	**4.50**
Tight Oil	1.49	2.65	3.28	3.26
Shale Gas Condensate	0.30	0.49	0.71	0.83
Tight Gas Condensate	0.28	0.36	0.44	0.41
Unconventional Gas (Bcf per day)**	**36.12**	**44.27**	**59.53**	**80.05**
Associated Gas***	2.59	4.90	6.62	7.09
Shale Gas	23.83	27.82	37.67	54.17
Tight Gas	9.70	11.54	15.25	18.79
Natural Gas Liquids (Contained)** (mbdoe per day)**	**1.81**	**2.67**	**3.82**	**4.84**
Associated Gas	0.44	0.84	1.10	1.19
Shale Gas	0.85	1.13	1.67	2.44
Tight Gas	0.52	0.70	1.06	1.21
WELL COMPLETIONS				
Unconventional Oil[t]	**7,179**	**8,472**	**8,636**	**8,934**
Unconventional Gas[tt]	**7,766**	**9,004**	**10,210**	**11,203**
Shale Gas	5,086	5,545	6,688	7,503
Tight Gas	2,681	3,459	3,521	3,700
PRICE INDICES				
WTI Price (2012 $US per bbl)	$95.04	$77.34	$89.54	$86.81
Henry Hub Price (2012 $US per Mcf)	$2.57	$4.37	$4.16	$5.07

NOTES: *Unconventional oil production represents oil and condensate recovered from tight oil, shale gas and tight gas plays.

**Unconventional gas production represents natural gas recovered from unconventional shale gas and tight gas plays and associated gas recovered from tight oil plays.

***Associated gas represents gas recovered from the production of oil in tight oil plays.

****Natural gas liquids (contained) represents unprocessed liquids potentially recoverable from the production of associated gas in tight oil plays and liquids rich gas in shale gas and tights gas plays.

t Well completions in plays designated as tight oil.

tt Well completions in plays designated as shale gas and tight gas.

Source: IHS CERA

Drilling Costs and Capital Expenditures

An unconventional oil or gas well in a shale or tight sand target can cost anywhere between $3 million and $12 million to drill and prepare for production. Well costs vary depending on several physical factors, including the vertical depth of the oil or gas reservoir, the length of the lateral pipe, the reservoir pressure, rock characteristics, and number of fracture stages, as well as commercial factors such as ease of access to materials and services, and the price and supply of water, fluid, sand, drilling, and completion services. There are four categories of upstream capital expenditures in this study: drilling, completion, facilities, and gathering. Compression is included in both facilities and gathering. Capital costs for processing are included but are treated separately. Lease acquisition costs are not included, as most of the known active plays are heavily leased, and these costs should be treated as sunk costs. While we anticipate some additional leasing, most of the activity will be through acquisitions and divestitures, which are highly variable and difficult to predict.

Well productivity and costs are roughly similar for shale or tight sand gas wells. Differences in production costs are driven by the characteristics and complexities of individual plays or well requirements rather than by the play's designation as shale or tight gas. In comparison to conventional natural gas, production per well for all types of unconventional natural gas is usually much higher, which drives down unit costs of production. The same is true in comparing tight oil plays and in comparing tight oil with onshore conventional oil.

Well costs are divided into three main categories. (They are further subdivided into the level of consumable goods and services in Appendix A). The three main cost categories are:

Well Capital Expenditures

Expenditure Category	Percentage
Drilling	35%
Completion	55%
Facilities	10%

All capital costs were escalated using a normalized version of the Upstream Capital Cost Index for Land developed for IHS CERA's Upstream Capital Cost Forum to reflect projected cost increases in excess of projected inflation for the inputs to oil and natural gas development.

IHS CERA estimated the costs associated with the production outlook for unconventional oil and natural gas based on data and analysis from IHS databases and proprietary models (these are also detailed in Appendix A). IHS CERA expects over $5.1 trillion in capital expenditures for unconventional oil and natural gas development to take place between 2012 and 2035. Over this period, unconventional tight oil development will account for $2.2 trillion of this total. It should be noted that while tight oil production is essentially unchanged from 2020 through 2035, the level of capital expenditures (in nominal terms) rises rapidly. This reflects the amount of capital required to maintain the steady state level of production in the face of declines in tight oil production from known plays today.

Shale gas and tight gas together will account for almost $3 trillion ($1.9 trillion for shale gas and nearly $1 trillion for tight gas). These expenditures will drive economic contribution, in terms of jobs, value added, labor income, and tax revenues. These economic contributions are discussed in the following section.

US Lower 48 Annual Capital Expenditure by Type
(Current $M)

	2012	2015	2020	2035	2012-2035*
Unconventional Oil Activity**					
Drilling Capital Expenditure	13,502	19,889	24,448	50,345	755,774
Completion Capital Expenditure	20,889	30,475	36,665	68,015	1,074,492
Facilities Capital Expenditure	3,608	5,109	6,300	11,621	189,170
Gathering System Capital Expenditure	2,707	4,006	4,930	10,373	152,871
TOTAL UPSTREAM CAPITAL EXPENDITURE	**40,706**	**59,480**	**72,343**	**140,353**	**2,172,307**
Unconventional Gas Activity***					
Drilling Capital Expenditure	14,525	21,573	33,232	72,086	1,005,238
Completion Capital Expenditure	25,984	36,719	55,657	120,269	1,662,952
Facilities Capital Expenditure	3,092	4,459	6,319	12,858	181,557
Gathering System Capital Expenditure	2,994	4,057	4,989	7,510	126,454
TOTAL UPSTREAM CAPITAL EXPENDITURE	**46,595**	**66,808**	**100,198**	**212,723**	**2,976,202**
Total Unconventional Activity					
Drilling Capital Expenditure	28,027	41,463	57,680	122,430	1,761,012
Completion Capital Expenditure	46,873	67,194	92,322	188,284	2,737,444
Facilities Capital Expenditure	6,701	9,568	12,620	24,479	370,727
Gathering System Capital Expenditure	5,701	8,063	9,919	17,883	279,326
TOTAL UPSTREAM CAPITAL EXPENDITURE	**87,301**	**126,288**	**172,542**	**353,076**	**5,148,509**

NOTES: *2012-2035 represents the total for all years including those years not reported.

**Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

***Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

Source: IHS CERA

Economic Contribution Assessment

Approach and Methodology

How to Define the Economic Contribution

The objective of measuring the economic contribution is to fully "size" the industry's economic influence by capturing all of the supply-chain and income effects associated with upstream unconventional oil and unconventional natural gas activity in the United States. The results of the production and capital expenditure analyses discussed in the previous section were integrated into a modeling system to capture the comprehensive contribution of these sectors to the US economy.

The steps used to derive the economic contribution of any industry can be summarized as follows:

- Any dollar of industrial expenditure, in this case the upstream unconventional energy industry's capital expenditure and operating expenditure, represented by value of production, results in direct benefits to the economy.
- These expenditures also result in indirect effects on final demand. In theory, an increase of unconventional energy activity, with all else constant, would lead to more revenue and output among supplier industries, such as oil field machinery and professional services. This increase would also result in higher US demand for manufactured products such as pumps and compressors, which in turn require more fabricated metal and steel. These are a few of the numerous reverberations in the supply chain resulting from the change in the target industries, in this case upstream unconventional oil and natural gas.

Unconventional oil and natural gas drilling and production use many different types of products and services from various industrial sectors of the economy. As a result, a change in unconventional activity would result in both a direct contribution (through production and capital expenditures) and an indirect contribution (via supply-chain dynamics) across a broad spectrum of sectors. The contribution of these supplier industries has implications for each supplier industry's own supply chains, magnifying the indirect contribution.

As explained below, the net effects on the US economy and its industrial sectors, due to these contributions, are divided into three stages: the **direct** contribution, the **indirect** contribution and the **induced economic** contribution.

For each stage in the analysis, the economic contribution is quantified in terms of employment, value added contribution to GDP, and labor income. Overall estimates of federal, state and local tax revenues are also calculated:

- The **direct contribution** is the effect of the core industry's output, employment, and income. For example, unconventional oil and natural gas direct contributions are generated by the exploration, production, transport, and delivery of their products to downstream elements or by providing critical on-site services. Investments in these activities result in a direct contribution to production output, the number of workers employed by the industry and how much those workers are paid and otherwise compensated.
- Any changes in the purchasing patterns or activities by the unconventional oil and natural gas segment initiate the **indirect contributions** to all of the supplier industries that support unconventional activities. Changes in demand from the direct industries lead to corresponding changes in output, employment, and income throughout their supply chains and inter-industry linkages. The affected supplier activities span the majority of industries in the US economy.

- Finally, workers and their families in both the direct and indirect industries spend their income on food, housing, leisure, autos, household appliances, furniture, clothing, and other consumer items. The additional output, employment, and income effects that result from their consumer spending activities are categorized as the **induced economic contribution**.

Modeling the Economic Contribution

As discussed in a prior section of this report, production and associated capital expenditures reflect market forces in the economy that take into account supply and demand conditions and market-clearing prices. Therefore, a team from IHS CERA and IHS Global Insight collaborated to develop two "profiles." The first profile aggregated the projected number of wells to be drilled and the expected production during each year of the forecast's time horizon. A second profile, for capital expenditures, summarized the anticipated annual expenditures on drilling, completion, facilities, gathering and processing. By incorporating the timing and sequencing of changes in production levels and the various classes of capital expenditures, this resulted in a nuanced set of "bottom-up" production and capital spending assumptions associated with unconventional activity.

IHS Global Insight utilized the IMPLAN model to evaluate changes, within the context of a comprehensive, linked industrial structure of an economy. To capture tailored capital expenditures, we decided not to enter data in the standard, aggregate categories of the IMPLAN model (i.e., drilling). Using our proprietary industry data and analyses, IHS instead focused on the unique mix of equipment, materials, and services to create a customized set of industry activities within the IMPLAN model. In this manner, we developed modified production functions for oil- and natural gas-related industries reflecting the unique purchasing and investment characteristics of each subsector. The capital expenditure profiles were used to compile customized technology requirements for each relevant activity. This process transformed the following subcategories of capital expenditures into a set of sector-level transactions for commodities and services that serves as inputs to the IMPLAN model.

Components of Unconventional Oil and Gas Capital Expenditures

Drilling	Completion	Facilities	Gathering & Processing
Steel	Equipment	Materials	Pipelines
Consumables (incl. bits)	Hydraulic Fracturing Other	Fabrication	Machinery
Rigs	Hydraulic Fracturing Rental	Project Management	
Rig Labor	Labor	Other	
Cement	Other		
Well Wireline Services			
Other			

Source: IHS CERA

NOTE: Other includes Architectural & Engineering Services, Truck Transportation, Insurance, etc.

This approach provided more focused and appropriate estimates of capital expenditures for unconventional oil and natural gas, which were used as inputs to the IMPLAN model. For example, the requirements for drilling are comprised of cement, manufactured steel products, and construction, while the other drilling category reflects mostly architectural, engineering, and insurances services. Similarly, each capital expenditure category was examined in detail to designate the best corresponding industry categories of the model (Appendix D contains more details).

The IMPLAN model was used to quantify the direct and indirect contributions of unconventional oil, shale gas and tight gas. When combined, the direct and indirect contributions represent all of the production, marketing, and sales activities required to bring primary products to the marketplace in a consumable form. IMPLAN's input-output framework allows one to enter direct contributions, by industry, in order to analyze and quantify direct and indirect contributions. The sum of all contributions relative to the total size of the economy provides initial benchmark estimates to evaluate the importance of a given industry.

The induced economic contributions represent the changes in consumer spending when their incomes are altered. The broad range of consumer spending means that induced contributions tend to be dynamic and reactive to shifts in consumer sentiment and employment outlooks. For the purposes of this study, IHS Global Insight utilized its US Macroeconomic Model (Macro Model) to enhance IMPLAN's standard methodology of measuring the induced economic contributions. The Macro Model's dynamic equilibrium modeling methodology provides a more robust determination of the induced economic contributions than could be obtained from IMPLAN's static modeling approach.

IHS Global Insight established an algorithm for linking IMPLAN's and the Macro Model's direct and indirect contributions. Both models were run using the initial set of input assumptions to produce direct and indirect contributions. The results were evaluated, and both the IMPLAN and Macro Model were refined and calibrated and run again in an iterative fashion, repeating the refinement and calibration process, until IMPLAN's and the Macro Model's direct and indirect contributions were consistent. Finally, the Macro Model was solved endogenously to produce the total economic contribution. The difference between the Macro Model and IMPLAN results (direct plus indirect) represents the expenditure-induced contributions of value added, labor income and employment.

Measuring the Economic Contributions

A baseline macroeconomic forecast of the US economy was used to evaluate and assess the contribution of the unconventional oil and natural gas industries over the next 25 years. The US economy is resilient and self-adjusts to a long-run state of full equilibrium. Hence, any contributions, policy changes, and external shocks will initially change the economic state with a longer-term convergence to the baseline. In other words, the economic ripples that result from a one-time shock this year, such as a federal stimulus program or natural disaster, will dissipate over the long term and bring the US economy back to its equilibrium state.

Consistent with this framework, the IHS Global Insight US macroeconomic baseline forecast has the unemployment rate in the short term at well above its long-term equilibrium growth level, with unemployment at 7.8% in 2012, 7.0% in 2015, and not dropping below 6% until 2020. Eventually the unemployment rate reaches its long-term growth equilibrium level in 2035, at 5%. The high unemployment rate is an indicator of short-term growth in GDP below its long-term potential.

In 2012, employment in the entire unconventional upstream sector will account for more than 1.7 million jobs, increasing to over 2.5 million jobs in 2015, almost 3 million jobs in 2020, and almost 3.5 million jobs by 2035, the end of the forecast period. Value added and labor income mirror this uninterrupted upward trend, with value added increasing from approximately $238 billion in 2012 to an average of $400 billion between 2020 and 2035. Labor income is forecast to double from about $125 billion in 2012 to $250 billion in 2035. A sector-by-sector discussion of each of these measures is presented in the next section.

US Lower 48 Economic Contribution Summary				
Employment				
(Number of workers)				
	2012	**2015**	**2020**	**2035**
Unconventional Oil Activity*	845,929	1,209,485	1,345,987	1,390,197
Unconventional Gas Activity**	902,675	1,301,178	1,639,181	2,108,481
Shale Gas Activity	605,384	848,856	1,096,040	1,404,510
Tight Gas Activity	297,291	452,322	543,141	703,971
Total Unconventional Activity	**1,748,604**	**2,510,663**	**2,985,168**	**3,498,678**
Value Added				
(2012 $M)				
Unconventional Oil Activity*	116,014	169,146	191,081	187,858
Unconventional Gas Activity**	121,670	180,387	225,470	287,127
Shale Gas Activity	80,899	118,583	151,690	195,039
Tight Gas Activity	40,771	61,804	73,780	92,088
Total Unconventional Activity	**237,684**	**349,533**	**416,551**	**474,985**
Labor Income				
(2012 $M)				
Unconventional Oil Activity*	60,488	87,260	97,779	98,709
Unconventional Gas Activity**	64,053	93,509	117,353	150,248
Shale Gas Activity	42,798	61,229	78,704	100,996
Tight Gas Activity	21,255	32,280	38,650	49,252
Total Unconventional Activity	**124,541**	**180,770**	**215,132**	**248,957**

NOTES: Numbers may not sum due to rounding.

*Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

**Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

Source: IHS Global Insight

Employment Contribution

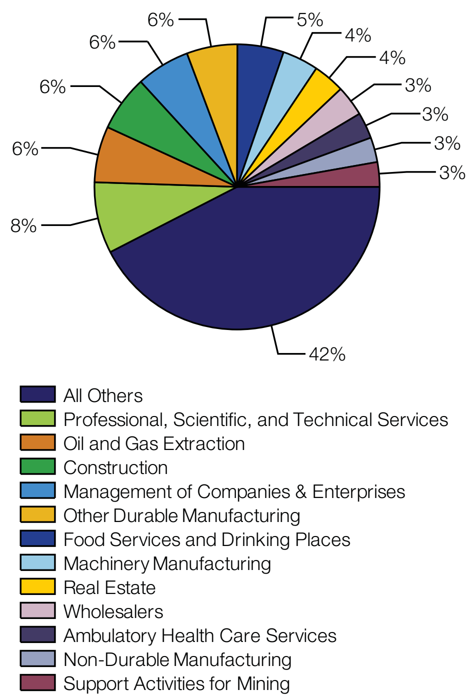
IHS Global Insight estimates that unconventional *oil* activity in 2012 will contribute more than 845,000 jobs to the US economy. By 2015 that figure will increase more than 40%, to more than 1.2 million jobs, reflecting the expected expansion of unconventional production and capital expenditures. By 2020, it will contribute an estimated 1.3 million jobs.

Unconventional *natural gas* activity will contribute 900,000-plus jobs in 2012, increasing by more than 44% in 2015 to nearly 1.3 million jobs. This estimate will exceed 1.6 million jobs in 2020 and 2 million jobs by the end of the forecast period in 2035. It is important to mention that the production processes across both unconventional oil and natural gas activity are fundamentally the same, permitting those who can work in the unconventional oil sector to move easily to the unconventional natural gas activity sector and vice versa, depending on each sector's market-driven growth.

Again, the two sectors combined show uninterrupted job growth over the entire 2012-2035 forecast period. In the very short-term, through 2015 and beyond, these sectors could provide help to offset the significant unemployment and underemployment rates in the overall economy.

Unconventional oil and natural gas activities generate infrastructure on an almost continuous basis. Unlike other industries in the US economy in which infrastructure activity represents only the front end of an overall project and its effect reduced in the steady-state operating phase, infrastructure development continues on a recurring basis for the unconventional oil and natural gas industries. The resulting production at a given site is capital intensive; however, infrastructure related activity moves to another location, on a year in and year out basis. Thus, unconventional oil and natural gas is an investment-intensive industry with continuing infrastructure requirements.

Employment by Industry, 2012



Source: IHS Global Insight

This phenomenon is consistent with the significant employment results of this study. The substantial levels and growth of employment are related to the nature of capital investment requirements for the upstream unconventional sectors. Employment shares, by industry, for the combined upstream unconventional sector in 2012 are virtually consistent with employment shares throughout the forecast interval. This relatively consistent share of employment by industry is an indication that the infrastructure phase will continue unabated as production expands. Specific industries that are sustained throughout the forecast period include construction, machinery manufacturing, and support activities for mining.

Another key reason for the profound economic contributions associated with unconventional oil and natural gas activity is the "employment multiplier." The employment multiplier measures the contribution that jobs make to the economy through the indirect and induced jobs created relative to direct jobs to support an industry. Some individual industries generate a larger contribution than other industries. The larger the multiplier, the greater the ripple effect of every dollar spent within an industry in terms of creating residual economic benefits across the broader economy. Upstream unconventional oil and natural gas activity, on average, demonstrates one of the larger employment multipliers placing it ahead of such notable industries as finance, construction, and many of the manufacturing sectors. This is the result of two primary factors that drive the industry's indirect and induced job creation.

US Lower 48 Employment Contribution
(Number of workers)

2012	Direct	Indirect	Induced	Total
Unconventional Oil Activity*	173,096	259,775	413,058	845,929
Unconventional Gas Activity**	187,360	277,888	437,427	902,675
Total Unconventional Activity	360,456	537,663	850,485	1,748,604
2015				
Unconventional Oil Activity*	242,607	371,062	595,816	1,209,485
Unconventional Gas Activity**	263,288	399,379	638,511	1,301,178
Total Unconventional Activity	505,895	770,441	1,234,327	2,510,663
2020				
Unconventional Oil Activity*	265,612	412,777	667,598	1,345,987
Unconventional Gas Activity**	334,808	503,011	801,362	1,639,181
Total Unconventional Activity	600,420	915,788	1,468,960	2,985,168
2035				
Unconventional Oil Activity*	287,606	428,459	674,132	1,390,197
Unconventional Gas Activity**	436,773	645,696	1,026,012	2,108,481
Total Unconventional Activity	724,379	1,074,155	1,700,144	3,498,678

NOTES: Numbers may not sum due to rounding.

*Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

**Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

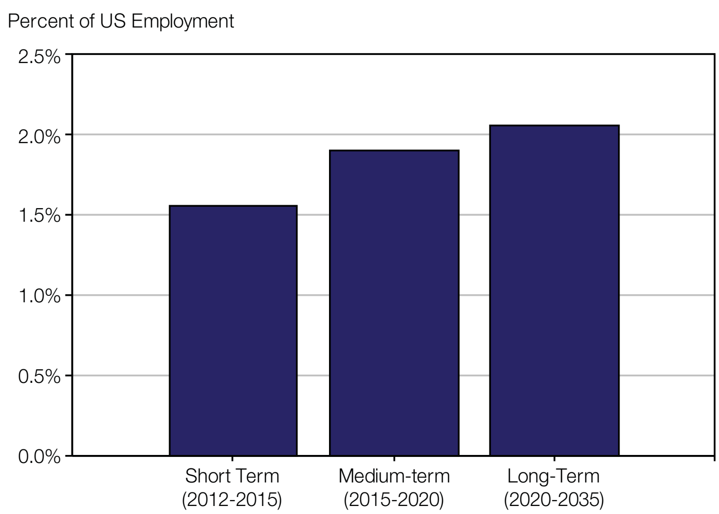
Source: IHS Global Insight

First, unconventional oil and natural gas activity is capital intensive, with nearly 50% of the revenues generated spent on construction, fabricated metals, and heavy equipment suppliers. Additionally, their operating expenses span a broad range of other materials and service sectors such as legal and financial services.

However, it is not just the large capital expenditures or the wide-ranging supplier base that increase economic contributions. Another critical reason is the strength of domestic suppliers—the United States is a world leader in all aspects of the unconventional oil and natural gas activity. Unlike other industries in this country, there is an extensive domestic supply chain, which means a larger portion of the dollars spent here stay here and support American jobs.

As a result of these factors, IHS Global Insight estimates that the employment contribution of upstream unconventional activity as a proportion of total US employment will average 1.5% over the

Unconventional Oil and Gas Contribution to Employment



Source: IHS Global Insight

short-term (2012-2015), 1.9% over the intermediate term (2015-2020), and 2% over the long-term (2020-2035).

Second, the economic contribution does not end with jobs within the industry and among its suppliers. It also includes induced employment from the contribution of income expenditures from direct and indirect sources. The quality of these jobs is a reflection of the higher income expenditure levels originating from direct and indirect jobs linked to unconventional activity. Given the technologically innovative nature of unconventional oil and natural gas activities, the jobs attributed to these activities stand out from other employment opportunities. Using BLS total annual salary payments for all employees, including supervisory workers, and number of employees by sector in extraction and drilling one can calculate an average hourly wage rate for all workers that implies $51.00 per hour. At the same time, we can compare BLS average hourly wage rates for production workers in the oil and natural gas extraction sector, where it is $35.15 per hour, to other industries—it is more than the hourly wage in the general economy (at $23.07 per hour) and more than wage rates paid in manufacturing (at $23.70 per hour), wholesale trade, education and many other industries.[13] This creates a larger multiplier and induced impact because more income is spent on general goods and services by workers in unconventional oil and natural gas activity than in other industries or in the economy generally.

The extent of high-quality employment in the unconventional sector extends beyond traditional white-collar occupations to include both skilled and semi-skilled blue-collar jobs. An examination of the occupations accounting for nearly 75% of employment in upstream unconventional activity reveals the extent of these high-quality jobs. While traditional white-collar occupations and related professions are paid at the highest level—$35 to more than $67 dollars per hour (for petroleum engineers)—there are nonetheless robust hourly wages for skilled and semi-skilled blue-collar occupations. Skilled workers include plumbers, pipefitters and steamfitters, cement masons and concrete finishers, industrial machinery mechanics, and petroleum pump operators. Some semi-skilled workers, such as welders, inspectors, and testers, earn almost $20 per hour. For many of these occupations, the educational requirement is often a high school diploma or equivalent plus some amount of vocational and/or on-the-job training, opening positions to a wider range of candidates.

[13] Bureau of Labor Statistics, Employment Statistics Survey

Average Hourly Wages by Occupation in the Oil and Gas, and Related Industries*		
Occupation	Occupation Code	Avg. Hourly Wages
Management, Business and Financial		
General and Operations Managers	111021	$63.03
Construction Managers	119021	$45.42
Engineering Managers	119041	$64.74
Cost Estimators	131051	$32.12
Accountants and Auditors	132011	$34.83
Professional and Related		
Architects, Except Landscape and Naval	171011	$37.79
Surveyors	171022	$27.44
Civil Engineers	172051	$40.18
Electrical Engineers	172071	$43.98
Mechanical Engineers	172141	$39.42
Petroleum Engineers	172171	$67.55
Engineers, all other	172199	$47.99
Architectural and Civil Drafters	173011	$24.00
Civil Engineering Technicians	173022	$23.22
Surveying and Mapping Technicians	173031	$19.98
Geoscientists, Except Hydrologists and Geographers	192042	$63.61
Geological and Petroleum Technicians	194041	$27.65
Sales and Related		
Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products	414012	$31.85
Office and Administrative Support		
First-Line Supervisors/Managers of Office and Administrative Support Workers	431011	$27.62
Bookkeeping, Accounting, and Auditing Clerks	433031	$17.56
Secretaries and Administrative Assistants	436010	$18.60
Office Clerks, General	439061	$14.95
Skilled Blue Collar		
First-Line Supervisors/Managers of Construction Trades and Extraction Workers	471011	$32.63
Carpenters	472031	$23.29
Cement Masons and Concrete Finishers	472051	$19.33
Paving, Surfacing, and Tamping Equipment Operators	472071	$18.97
Operating Engineers and Other Construction Equipment Operators	472073	$21.70
Electricians	472111	$27.49
Plumbers, Pipefitters, and Steamfitters	472152	$26.99
Derrick Operators, Rotary Drill Operators and Service Unit Operators, Oil and Gas	475010	$23.28
Mobile Heavy Equipment Mechanics, Except Engines	493042	$22.22
Industrial Machinery Mechanics	499041	$24.36
Maintenance and Repair Workers, General	499071	$19.96
Petroleum Pump System Operators, Refinery Operators, and Gaugers	518093	$26.83

Average Hourly Wages by Occupation in the Oil and Gas, and Related Industries* (Continued)		
Occupation	Occupation Code	Avg. Hourly Wages
Crane and Tower Operators	537021	$24.55
Pump Operators and Wellhead Pumpers	537070	$21.59
Semi-skilled Blue Collar		
Roustabouts, Oil and Gas	475071	$16.72
Helpers--Extraction Workers and Other Extraction Workers	475080	$17.62
Welders, Cutters, Solderers, and Brazers	514121	$19.08
Inspectors, Testers, Sorters, Samplers, and Weighers	519061	$19.39
Truck Drivers, Heavy and Tractor-Trailer	533032	$18.37
Excavating and Loading Machine and Dragline Operators	537032	$19.25
Unskilled Blue Collar		
Construction Laborers	472061	$16.54
Fence Erectors	474031	$15.25
Laborers and Freight, Stock, and Material Movers, Hand	537062	$13.62

NOTE: *Average hourly wages by occupation in 2011 were calculated utilizing weights based on 2010 employment estimates for the following industries: Oil and Gas Extraction (NAICS 2111); Support Activities for Mining (NAICS 2131); Nonresidential Building Construction (NAICS 2362); Other Specialty Trade Contractors (NAICS 2389); Agriculture, Construction, and Mining Machinery Manufacturing (NAICS 3331); and Architectural, Engineering, and Related Services (NAICS 5413).

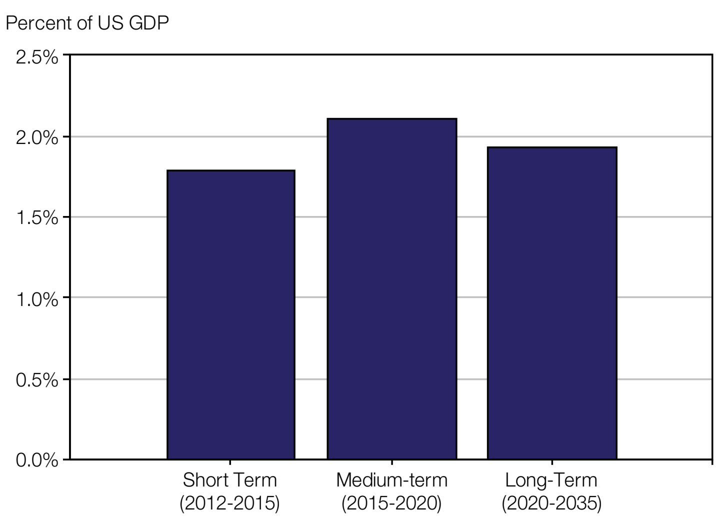
Source: Bureau of Labor Statistics, May 2011 Occupational Employment Statistics

Additionally, the growth in unconventional exploration and production activity has pushed up earnings for blue-collar oil and natural gas workers regardless of their educational attainment. US Bureau of Labor Statistics data for 2010 indicate median annual wages for extraction and for oil and natural gas workers exceed the national median wage by 15% and 11%, respectively. State economies driven by employment in unconventional upstream activity include North Dakota, Oklahoma and Texas; these states also reflect stronger oil and NGL-rich play activity as a result of the widening price spread between oil and natural gas over the past few years.

Value Added Contribution to GDP

Value added is the difference between the production costs of products or services and the sales prices. The constantly cited GDP measure is simply the sum of value added across all products and services produced in the United States. GDP is generally considered the broadest measure of the health of the US economy. The value-added contribution of unconventional oil and natural gas activity demonstrates the vital role it plays in the overall economy. On a total direct, indirect, and induced basis, IHS Global Insight expects value added for overall upstream unconventional activity to average almost 1.8% of GDP over the short-term (2012-2015), 2.1% over the intermediate term (2015-2020), and more

Unconventional Oil and Gas Value Added Contribution to GDP



Source: IHS Global Insight

than 1.9% over the long-term (2020-2035). The timing and path of the unconventional activity fits well with the growth of the US economy during next 20 years. The unconventional activity will initially fuel the economy to recover and support the path in the later decade. While IHS Global Insight's outlook for the US economy through 2020 is moderate compared to the value added contribution of the unconventional activity, economic growth accelerates during the last 15 years of the forecast, outpacing a relatively slower growth of jobs from unconventional upstream activity during the same period.

US Lower 48 Value Added Contribution

(2012 $M)

2012	Direct	Indirect	Induced	Total
Unconventional Oil Activity*	47,605	32,563	35,846	116,014
Unconventional Gas Activity**	49,096	34,608	37,967	121,670
Total Unconventional Activity	**96,700**	**67,171**	**73,813**	**237,684**
2015				
Unconventional Oil Activity*	70,584	46,861	51,701	169,146
Unconventional Gas Activity**	74,697	50,282	55,409	180,387
Total Unconventional Activity	**145,281**	**97,142**	**107,110**	**349,533**
2020				
Unconventional Oil Activity*	80,726	52,432	57,924	191,081
Unconventional Gas Activity**	92,766	63,159	69,545	225,470
Total Unconventional Activity	**173,492**	**115,591**	**127,469**	**416,551**
2035				
Unconventional Oil Activity*	75,958	53,390	58,510	187,858
Unconventional Gas Activity**	117,272	80,806	89,049	287,127
Total Unconventional Activity	**193,230**	**134,195**	**147,559**	**474,985**

NOTES: Numbers may not sum due to rounding.

*Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

**Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

Source: IHS Global Insight

A common measure of the relative contribution of an industry to the overall economy is the worker productivity– the higher the ratio, the greater each worker's individual contribution to GDP. Worker productivity is calculated as the ratio of value added to employment, so a higher ratio reflects more efficient labor. In 2012, the average worker directly employed in the unconventional oil industry will contribute $275,000 to GDP. That is projected to increase to over $303,000 per employee in 2020 and $264,000 in 2035. For unconventional natural gas, the estimates are $262,000, $277,000 and $268,000 in 2012, 2020, and 2035, respectively. The contribution by indirect and induced jobs to overall GDP growth will be more subdued. For the entire economy, the most recent estimate of national average value added per employee is $116,000. Thus, the unconventional upstream sector stands in stark contrast to value-added measures for the general economy, with a 137% higher contribution for unconventional oil and a 126% higher contribution for unconventional natural gas.

Labor-Income Contributions

Workers' earnings from all unconventional upstream activities is estimated at over $124 billion in 2012, $215 billion in 2020, and almost $250 billion in 2035. On a direct basis, labor income per employee for all unconventional activity is estimated at over $121,000 in 2012, nearly twice as high as labor income on an economy-wide basis at $64,500 per employee and almost 52% higher than the average wage in the manufacturing sector.[14]

In 2020, 65% of unconventional oil economic activity will be related to production, while 35% will be related to capital investment. By 2035, 56% of unconventional oil economic activity will be related to production and 44% will be related to capital investment. This shift in the mix of employment type will lead to a decrease in average labor productivity, which leads to an increase in employment without a corresponding increase in labor income.

US Lower 48 Labor Income Contribution

(2012 $M)

2012	Direct	Indirect	Induced	Total
Unconventional Oil Activity*	21,272	18,974	20,242	60,488
Unconventional Gas Activity**	22,337	20,276	21,440	64,053
Total Unconventional Activity	**43,608**	**39,250**	**41,682**	**124,541**
2015				
Unconventional Oil Activity*	30,915	27,150	29,195	87,260
Unconventional Gas Activity**	33,006	29,215	31,289	93,509
Total Unconventional Activity	**63,921**	**56,365**	**60,484**	**180,770**
2020				
Unconventional Oil Activity*	34,827	30,243	32,709	97,779
Unconventional Gas Activity**	41,304	36,778	39,272	117,353
Total Unconventional Activity	**76,131**	**67,021**	**71,981**	**215,132**
2035				
Unconventional Oil Activity*	34,424	31,245	33,040	98,709
Unconventional Gas Activity**	52,780	47,183	50,286	150,248
Total Unconventional Activity	**87,204**	**78,428**	**83,326**	**248,957**

NOTES: Numbers may not sum due to rounding.

*Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

**Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

Source: IHS Global Insight

[14] Bureau of Labor Statistics—Current Employment Statistics and National Compensation Survey.

US Lower 48 Labor Income Per Employee
(2012 $)

2012	Direct	Indirect	Induced	Total
Unconventional Oil Activity*	122,889	73,040	49,006	71,504
Unconventional Gas Activity**	119,218	72,966	49,013	70,959
Total Unconventional Activity	**120,981**	**73,002**	**49,010**	**71,223**
2015				
Unconventional Oil Activity*	127,429	73,168	49,000	72,147
Unconventional Gas Activity**	125,359	73,150	49,003	71,865
Total Unconventional Activity	**126,352**	**73,159**	**49,002**	**72,001**
2020				
Unconventional Oil Activity*	131,120	73,267	48,995	72,645
Unconventional Gas Activity**	123,366	73,115	49,006	71,593
Total Unconventional Activity	**126,796**	**73,184**	**49,001**	**72,067**
2035				
Unconventional Oil Activity*	119,692	72,923	49,012	71,004
Unconventional Gas Activity**	120,840	73,073	49,011	71,259
Total Unconventional Activity	**120,384**	**73,013**	**49,011**	**71,158**

NOTES: Numbers may not sum due to rounding.

*Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

**Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

Source: IHS Global Insight

Government Revenues and Taxes

Increased activity in the unconventional oil and gas sectors will also increase federal, state and local government taxes paid by energy producers, their employees, the energy supply chain and companies in ancillary industries. IHS Global Insight estimates that annual government revenues from all unconventional activity will increase from almost $62 billion in 2012 to more than $91 billion in 2015 and $111 billion in 2020. By 2035, the last year of the forecast period, government revenues will exceed $124 billion. Over the entire forecast interval, more than $2.5 trillion will be collected by government entities.

How Big is $31 Billion in Federal Revenues?

The $31 billion in associated federal taxes and royalties in 2012 is sufficient to fund close to 80% of the U.S. Department of Interior annual budget ($11 billion), the U.S. Department of Commerce budget ($11 billion), and NASA's budget ($18 billion) combined.

Source: US Office of Management and Budget.

For all of the activities combined, another $711 million in private lease payments paid by operators will be realized by 2015 and will surpass $1.2 billion by 2035. Lease payments over the entire forecast period will total more than $23 billion. While private lease payments will have an income effect on the economy, royalties paid to the federal government will, in addition to the income effect, contribute to federal and state and local budgets. In addition, state budgets will benefit from direct federal payments based on each state's participation in production on federal lands. In fact, the nearly $31 billion in state and local tax receipts in 2012 represent approximately 5% of the US lower 48 US states' total expenditures—$647 billion—and 41% of the estimated 2012 budget gaps—$75 billion.

Contribution to US Lower 48 Government Revenue
(2012 $M)

	2012	2015	2020	2035	2012-2035*
Unconventional Oil Activity**					
Federal Taxes	**14,076**	**20,379**	**22,898**	**22,917**	**502,486**
Personal Taxes	10,726	15,438	17,271	17,538	381,337
Corporate Taxes	3,351	4,940	5,628	5,379	121,149
State and Local Taxes	**15,769**	**23,256**	**28,054**	**27,526**	**617,495**
Personal Taxes	1,718	2,479	2,779	2,802	61,180
Corporate Taxes	9,403	13,854	15,771	15,089	339,682
Severance Taxes	2,963	4,458	6,081	6,166	138,414
Ad Valorem Taxes	1,686	2,465	3,423	3,469	78,219
Federal Royalty Payments	**974**	**1,365**	**1,845**	**950**	**37,069**
Total Government Revenue	**30,820**	**45,000**	**52,798**	**51,393**	**1,157,049**
Lease Payments to Private Landowners	**243**	**341**	**387**	**507**	**10,178**
Unconventional Gas Activity**					
Federal Taxes	**14,860**	**21,804**	**27,330**	**34,928**	**635,116**
Personal Taxes	11,384	16,564	20,811	26,676	483,860
Corporate Taxes	3,476	5,240	6,519	8,252	151,256
State and Local Taxes	**15,162**	**23,326**	**29,676**	**37,441**	**700,011**
Personal Taxes	1,818	2,656	3,333	4,266	77,469
Corporate Taxes	9,748	14,685	18,253	23,097	423,482
Severance Taxes	2,487	4,199	5,688	7,276	141,469
Ad Valorem Taxes	1,109	1,786	2,403	2,803	57,590
Federal Royalty Payments	**990**	**1,274**	**1,359**	**644**	**25,073**
Total Government Revenue	**31,012**	**46,404**	**58,366**	**73,013**	**1,360,199**
Lease Payments to Private Landowners	**261**	**370**	**526**	**726**	**13,421**
Total Unconventional Activity					
Federal Taxes	**28,936**	**42,183**	**50,229**	**57,846**	**1,137,602**
Personal Taxes	22,110	32,003	38,082	44,214	865,197
Corporate Taxes	6,827	10,180	12,147	13,631	272,405
State and Local Taxes	**30,931**	**46,582**	**57,731**	**64,967**	**1,317,506**
Personal Taxes	3,536	5,136	6,112	7,067	138,650
Corporate Taxes	19,150	28,539	34,024	38,186	763,165
Severance Taxes	5,450	8,657	11,769	13,442	279,882
Ad Valorem Taxes	2,795	4,251	5,825	6,272	135,809
Federal Royalty Payments	**1,964**	**2,639**	**3,204**	**1,593**	**62,141**
Total Government Revenue	**61,832**	**91,404**	**111,164**	**124,406**	**2,517,248**
Lease Payments to Private Landowners	**504**	**711**	**913**	**1,232**	**23,599**

NOTES: *2012-2035 represents the total for all years including those years not reported.

**Unconventional oil activity represents the production of oil and condensate and associated gas recovered from tight oil plays.

***Unconventional gas activity represents the production of gas and liquids recovered from shale gas and tight gas plays.

Source: IHS Global Insight

Conclusion

Unconventional oil and natural gas activity is already revolutionizing America's energy future and bringing enormous benefits to the US economy. Unlocking unconventional energy will generate millions of jobs and billions in government receipts. It will make significant contributions to the US economy through direct employment, the many and diverse connections it has with supplier industries, the amount of spending this direct and indirect activity supports throughout the entire economy, and the revenues that flow to federal and state and local governments. As the production of unconventional oil and gas expands over the next 25 years, the economic contribution of the industry will also expand.

To support the expansion of production within the unconventional sector, IHS Global Insight expects substantial growth in capital expenditures and employment to occur:

- More than $5.1 trillion in capital expenditures will take place between 2012 and 2035 across unconventional oil and natural gas activity. Of this:
    - Over $2.1 trillion in capital expenditures will take place between 2012 and 2035 in unconventional oil activity.
    - Close to $3 trillion in capital expenditures will take place between 2012 and 2035 in unconventional natural gas activity.
- Employment attributed to upstream unconventional oil and natural gas activity on a direct, indirect, and induced basis will support more than 1.7 million jobs in 2012, 2.5 million jobs in 2015, 3 million jobs in 2020, and 3.5 million jobs in 2035.
- On average, direct jobs will represent about 20% of all jobs contributed by unconventional production activity with the remainder provided by indirect and induced jobs.

This IHS baseline view of expanded domestic unconventional oil and natural gas activity and the economic contributions stemming from that expansion rests on the assumption of an unchanged policy framework governing unconventional activity, including environmental policies and regulations. IHS has not examined, in this report, the impact of policies that would either inhibit unconventional production or expand production beyond our baseline view.