

Executive Summary 1

Technology advancement and deployment in the last five years together have revolutionized the U.S. natural gas and oil production industry. This report quantifies the economic impacts of recent upstream technologies, such as hydraulic fracturing and horizontal drilling, which have allowed recovery and production of previously inaccessible domestic resources.

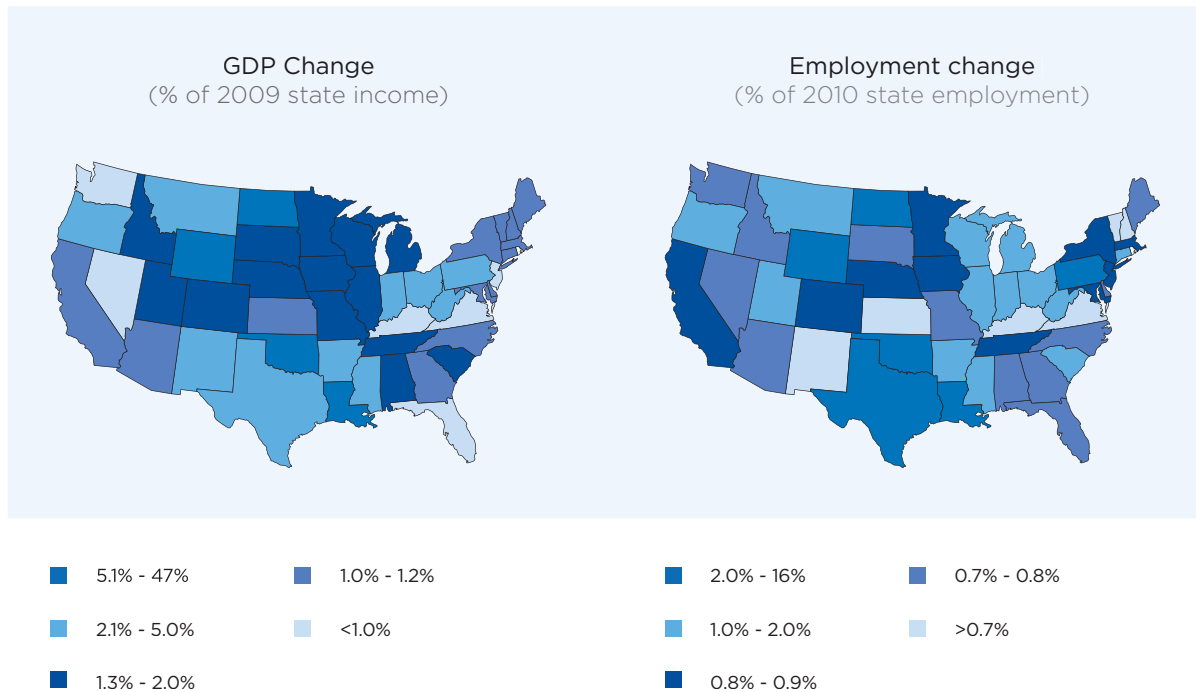
The U.S. has vast reserves of natural gas. ICF estimates that the U.S. Lower-48 has a recoverable gas resource base of over 3,500 trillion cubic feet (Tcf) and 200 billion barrels of crude oil and lease condensate liquids, up from 1,100 Tcf

of natural gas and 150 billion barrels of liquids in 2008. The current recoverable gas resource base represents approximately 150 years of U.S. gas demand at current levels. This striking climb in the recoverable resource base of natural gas and crude oil and condensate liquids is already reflected by the production over the past five years, which is, in turn, having a tremendous impact on the overall economy.

The economic benefits include growth in Gross Domestic Product (GDP) and employment gains, lower energy prices, additional tax revenues, and a revival in U.S. production of industrial goods.

Exhibit 1-1

U.S. Map of GDP and Employment Impacts



Major Findings

In a period of just a few years, technological innovations have transformed the U.S. oil and gas industry into a powerhouse that is providing a substantial growth impetus to the national economy and the economies of many states. Among the major findings of this report are:

- **Upstream technology gains will lead to long-term economic growth:** Unconventional activity is underpinned by such a large resource base that expanded production is expected to continue for decades, providing a base for solid growth and long-lasting well-paying jobs.
- **Increasing natural gas production through 2017:** U.S. natural gas production in 2017 will be over 6 trillion cubic feet (Tcf) per year higher due in part to the use of the new technologies and representing a volume that is nearly double U.S. gas imports in 2011 (of 3.5 Tcf).¹ These gains reflect a 30-percent increase over 2017 production projections made in 2008.
- **Added oil production reduces oil imports:** Oil and liquids production is also increasing rapidly, totaling an additional 630 million barrels in 2017, a volume that is nearly equal to total 2011 U.S. crude imports from the Persian Gulf (of 680 million barrels).²
- **Industry gains a boon for the U.S. economy:** Upstream technology developments have impacts that affect all sectors of the economy, including the oil and gas service sector, oil and gas material suppliers, oil and gas equipment manufacturers, consumer goods, industries that use natural gas, and the businesses that supply all of these sectors.
- **Significant GDP gains:** The study forecasts a net increase of \$167 billion to \$245 billion in GDP in 2017 due to recent upstream technology advances, equivalent to between 1.2 percent and 1.7 percent of the 2010 U.S. GDP (of \$14.5 trillion).^{3,4}
- **Long-term jobs in gas and oil production and related industries:** The modeled incremental production of approximately 1.7 billion barrels of oil equivalent per year by 2017 (including 6.2 trillion cubic feet per year of gas) results in an increase of 330,000 direct and indirect jobs in the upstream and midstream sectors alone. For each one billion cubic feet per day of incremental gas production (or a Btu-equivalent amount of liquids), approximately 13,000 upstream and midstream jobs are added to the economy.
- **Total employment gains exceed the entire U.S. auto manufacturing industry employment:** The study projects significant additional annual employment gains; by 2017, 835,000 to 1.6 million jobs will be created nationwide. That is more than the number of jobs currently in the entire U.S. auto manufacturing industry (including parts suppliers) at the low end.⁵ Sectors of the economy experiencing the greatest employment gains include the service sector, manufacturing, wholesale and retail trade, and the oil and gas sector itself.
- **Large positive job impacts at the state level:** For example, in the year 2017, Texas should see a gain of up to 236,000 jobs and Pennsylvania up to 145,000 jobs. States that do not have significant shale gas resources are also expected to gain tens of thousands of jobs, due largely to supply chain businesses. Examples include Florida (59,000 jobs), New Jersey (36,000 jobs), and Missouri (21,000 jobs).
- **Far-reaching midstream and downstream impacts:** Evaluation of the entire impact of shale development on the U.S. economy shows that the effects go far beyond local areas and regions with drilling. Industrial expansion involves facilities such as gas and liquids pipelines, gas processing plants, petrochemical plants, steel manufacturing, sand mining, ammonia production, methanol production, and LNG export terminals.

1. U.S. Energy Information Administration (EIA). "U.S. Natural Gas Imports by Country." EIA, July 2012: Washington, D.C. Available at: http://www.eia.gov/dnav/ng/ng_move_imp_s1_a.htm

2. U.S. Energy Information Administration (EIA). "U.S. Imports by Country of Origin." EIA, July 2012: Washington, D.C. Available at: http://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbb1_a.htm

3. All dollar figures are in 2010 real dollars unless otherwise specified.

4. U.S. Bureau of Economic Analysis. "Gross Domestic Product (GDP): Current-Dollar and 'Real' GDP." U.S. Department of Commerce Bureau of Economic Analysis, 2012: Washington, D.C. Available at: <http://www.bea.gov/national/index.htm#gdp>

5. 789,500 "motor vehicle and parts manufacturing" seasonally adjusted employment as of July 2012. U.S. Bureau of Labor Statistics (BLS). "Automotive Industry: Employment, Earnings, and Hours." BLS, July 2012: Washington, D.C. Available at: <http://www.bls.gov/iag/tgs/iagauto.htm>

- **Billions of dollars in consumer gains:** The rise in natural gas production has resulted in large price reductions to both direct and indirect end-users. This results in direct savings to natural gas consumers, and indirect savings through lower electricity prices and lower prices for industrial products. Consumers are expected to experience a net benefit of \$41 billion in 2017, enough to cover the electricity bill on 30 million homes.⁶
- **GDP gains occur in every state:** The economic impact is widely distributed across the U.S. and has already had very large positive GDP impacts in major production growth areas. Additionally, energy-consuming states without production gain substantially from lower energy prices that free up family budgets for consumer spending for non-energy goods and services.
- **Tax revenues increased at all levels of government:** State, federal, and local governments are experiencing increased revenues resulting from both receipts from the oil and gas industry, as well as from related economic activity flowing through their economies. Incremental tax receipts from all sources of government taxes are expected to be up to \$85 billion per year by 2017. In addition, increases in royalty payments to individuals/governments should reach \$12 billion annually in 2017.
- **Growing net exports help realign the U.S. trade balance:** The GDP gains are associated with roughly \$120 billion additional net exports annually by 2017, which equates to nearly one-quarter of the U.S. 2010 international trade deficit (of nearly \$500 billion).⁷

State Impacts

Economic gains are widely distributed across all states (Exhibit 1-1). The largest GDP and employment impacts are seen in production areas, such as North Dakota, Texas, Oklahoma, and Louisiana, among others, while states such as Wisconsin and Ohio also benefit from the production side in the form of the goods

and services (e.g., steel, sand) they provide to the upstream and midstream sectors. Downstream activities, such as manufacturing, which benefit from lower natural gas fuel and feedstock prices, further promote GDP and employment growth in states such as California (high-tech manufacturing) and Iowa (fertilizer plants). States that use natural gas for power generation, or see new construction of gas-fired power plants, such as Alabama and Georgia, will benefit from lower natural gas prices. Overall, the economy will benefit from the GDP and employment gains produced through induced economic activity as the impacts generated by more production make their way through the rest of the economy.

Industrial Sector Impact

This study evaluated the impacts of increased natural gas production and lower prices on a range of industries.

- Demand for steel tubular goods has soared, contributing to a revitalization of the domestic steel industry. Steel demand from the oil and gas industry is expected to total over 66 million tons between 2008 and 2017. For comparison, current annualized U.S. steel production is 89 million tons. Low energy prices are also helping to make the steel sector more competitive internationally.
- Ammonia is the basic material for nitrogen-based fertilizer. Natural gas is used both as a feedstock and a fuel in ammonia production. Low gas prices are bringing about a turnaround in the fortunes of U.S. ammonia producers. With natural gas prices under \$4 per MMBtu, U.S. producers are becoming internationally price competitive, thereby creating U.S. jobs and reducing the need for imports.
- Natural gas liquids are used as feedstocks to produce certain chemicals. Rapidly increasing production of ethane, a component of natural gas, is creating a transformation of the U.S. petrochemical sector. Ethane is used in the production of ethylene, a building block for plastics. U.S. manufacturers have a large

6. Assumes 11,500 kilowatt-hours (kWh) per home and a residential electricity price of \$0.118/kWh. Sources: U.S. Energy Information Administration (EIA). "How much electricity does an American home use." EIA, 2010: Washington D.C. Available at: <http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3>. EIA. "Electricity Explained." EIA, 2011: Washington, D.C. Available at: http://www.eia.gov/energyexplained/index.cfm?page=electricity_factors_affecting_prices

7. U.S. Census Bureau. "Historical Series: U.S. International Trade in Goods and Services." U.S. Census Bureau, June 2012: Washington, D.C. Available at: <http://www.census.gov/foreign-trade/statistics/historical/>

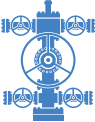
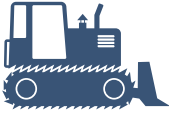


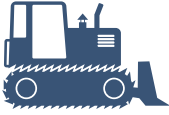


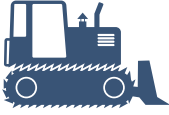




advantage over European and Asian firms, who must use higher cost feedstocks.

- Methanol has many industrial uses and is used as a transportation fuel through blending or the manufacture of biodiesel. The economics of methanol production are highly dependent upon the price and availability of natural gas. Low U.S. natural gas prices have incentivized methanol producers to expand operations or move their operations to the United States.
- Increased volumes of shale gas are expected to result in large volumes of exports of liquefied natural gas, likely beginning around 2016. LNG import facilities are being converted to allow for LNG exports and new facilities may be built. These are capital intensive projects that generate large direct and indirect impacts on the economy.

The impact on U.S. jobs through 2017 can be viewed in terms of number of jobs per billion cubic feet per day (Bcf/day) of natural gas production. This study finds that approximately 13,000 upstream and midstream jobs are created for each incremental Bcf/day of gas production. Also, additional jobs are created downstream in the general categories of construction and operations. The (Exhibit 1-2) diagram shows the jobs generated for four major categories of industrial gas use that are experiencing increases due to the additional gas production. For example, a gas to liquids plant would represent 18,000 direct and indirect jobs per Bcf/day, consisting of 13,000 from the upstream and midstream, 4,000 from construction (annualized), and 900 from operations. Including multiplier effect jobs, the total for gas to liquids ranges from 30,000 to 53,000 jobs per Bcf/d.

Exhibit 1-2

Domestic Job Impacts of Alternative Uses of Natural Gas (Per Bcf/d of Production)

	UPSTREAM & MIDSTREAM JOBS	CONSTRUCTION JOBS	OPERATIONS JOBS	TOTAL
Gas to Liquids Plants	 13,000 Jobs	+  4,000 Jobs	+  900 Jobs	→ Direct & Indirect 18,000 Jobs All Jobs 30,000 - 53,000
Liquefied Natural Gas Plants	 13,000 Jobs	+  1,700 Jobs	+  200 Jobs	→ Direct & Indirect 15,000 Jobs All Jobs 25,000 - 44,000
Methanol Plants	 13,000 Jobs	+  3,000 Jobs	+  1,800 Jobs	→ Direct & Indirect 18,000 Jobs All Jobs 30,000 - 52,000
Ammonia Plants	 13,000 Jobs	+  4,200 Jobs	+  3,400 Jobs	→ Direct & Indirect 21,000 Jobs All Jobs 34,000 - 62,000

Note: Construction-period jobs include jobs associated with production of construction materials and plant equipment and would last for a period of approximately four years. Total jobs are computed by spreading construction jobs over a 20 year plant operating period. The term "D&I Jobs" refers to direct and indirect jobs and "All Jobs" refers to direct, indirect and induced jobs.

Exhibit 1-3 How This Study is Different

To better measure and document the economic transformation spurred by expanded oil and gas technology innovation, ICF International dug deep, studying business plans, expert forecasts and both state and federal government reports.

Building on this growing body of research using various assumptions and methodologies, this study quantifies the economic impacts attributable to recent upstream technological improvements, rather than the total impacts (based on the entire oil and gas industry or a particular resource type such as shale gas). A comparison of our report with three recent studies highlights some key differences (see Exhibit 1-4).

To estimate the impacts of these upstream technology changes, this study compares a forecast preceding the revolutionary deployment of U.S. unconventional natural gas and oil drilling technologies to a current outlook. The difference between these two outlooks illuminates economic impact from the recent technology and production gains.

Specifically, this study quantifies the net impact on GDP, employment by state and industry group, consumer benefits, government revenues, and international trade from 2008 through 2017. The current study:

- Includes the impacts on the economy of oil, gas, and coal.

- Looks at the entire value chain of the oil and gas industry from upstream and its suppliers to end use of oil and gas.
- Evaluates specific impacts for major sectors.
- Employs a comparison between recent history and a current forecast of likely production and prices, and an analysis of what would have occurred without upstream technological advances since 2007.
- Evaluates the impact on GDP in terms of the price and quantity of increased gas and oil supplies with and without the technology advances.

This report develops supply and demand curves for the two scenarios and the comparison of various areas (expenditures, revenues and surpluses) defined by those curves. Other studies primarily rely on estimation of economic impacts of capital and operating expenditures estimated through drilling forecasts. This study and the other approaches rely, in part, on use of the IMPLAN model to determine the flow of effects through the economy.

Overall the report depicts a more complete economic picture of the growing impact of the industry. See Appendices A and C for this study's methodology and other details.