ENERGY ACCOUNTABILITY SERIES

U.S. CHAMBER OF COMMERCE
INSTITUTE FOR 21ST CENTURY ENERGY

WHAT IF...

America's Energy Renaissance Never Actually Happened?

About the ENERGY ACCOUNTABILITY SERIES

This paper marks the second in a series of reports that we will be releasing this fall, each taking a substantive look at what might have happened in the past – or could happen in the future – if certain energy-related ideas and policy prescriptions put forth by prominent politicians and their supporters were actually adopted. We're calling it the Energy Accountability Series.

Certainly, one doesn't need to look far these days to find platforms or outlets that claim to be definitive "fact-checkers" of all manner of utterances candidates make on the campaign trail. On that, the Energy Accountability Series will not seek to reinvent the wheel. What we are much more interested in – and what we think will be much more valuable to voters, as well – is taking a step back to better understand (and quantify where possible) the real-world, economy-wide consequences of living in a world in which candidates' rhetoric on critical energy issues were to become reality.

Too often, there is a temptation to dismiss statements made by candidates as things said "off the cuff," or in the "heat of the moment," or offered up merely to "appeal to their base." This is incredibly cynical, and it needs to change. A candidate's views and the things he or she says and does to win the support of interest groups have a real impact on how policy is shaped, and ultimately implemented. That is especially true on energy issues today, as groups continue to advance a "Keep It In the Ground" agenda that, if adopted, would force our country to surrender the enormous domestic benefits and clear, global competitive advantages that increased energy development here at home have made possible. Accordingly, candidates and public opinion leaders should be taken at their word, and this series will evaluate what those words would mean for America.

The Energy Accountability Series will ask the tough questions and provide quantitative, clear-eyed answers on the full impacts and implications of these policies, and it will do so irrespective of which candidates, groups or political parties happen to support or oppose them. Our hope is that these reports help promote and inform a fact-based debate of the critical energy issues facing our country. Armed with this information, voters will have the opportunity this fall to make the right choices for themselves and their families.

OUR MISSION

The mission of the U.S. Chamber of Commerce's Institute for 21st Century Energy is to unify policymakers, regulators, business leaders, and the American public behind a common sense energy strategy to help keep America secure, prosperous, and clean. Through policy development, education, and advocacy, the Institute is building support for meaningful action at the local, state, national, and international levels.

The U.S. Chamber of Commerce is the world's largest business federation representing the interests of more than 3 million businesses of all sizes, sectors, and regions, as well as state and local chambers and industry associations.

What If America's Energy Renaissance Never Actually Happened?

America's relatively recent energy revolution has fundamentally transformed the way we find, access, transport, and consume the energy resources that power our economy. Moving from an Era of Energy Scarcity to an Era of Energy Abundance has caught many by surprise and upended global energy markets.

The revolution initially took place outside the public eye, led by relatively unknown companies making huge technological leaps thousands of feet underground. The energy revolution began quietly, mostly on private and state lands, but momentum built up quickly. It occurred as a result of the work of entrepreneurs and the application of technology and cutting edge innovation. One thing is certain: the energy revolution took place in spite of—not because of—U.S. energy policy.

Today, the impacts of the energy revolution are everywhere, turning energy markets on their heads, underpinning a historic resurgence in manufacturing, shifting the center of gravity of energy geopolitics, and improving our international competitiveness and balance of trade. It's a far cry from the situation that existed as recently as 2008, when energy scarcity was the prevailing theme and peak-energy theories dominated conventional political discourse. Those days are over—or at least they should be.

But it would be folly to believe that the energy revolution's continued growth and advancement is a fait accompli. Indeed, there are many politicians and groups in the United States whose "Keep it in the Ground" philosophy informs their ongoing work to scuttle the energy revolution. Had they had the opportunity, these groups would have prevented the revolution from happening in the first place.

The truth is that the advent of the energy revolution in the United States was not inevitable, and its future upward trajectory is not a foregone conclusion.

It is heartening to see some politicians embracing the far-reaching benefits that American energy abundance has made possible. But over the last few years, that rhetoric has not been matched by progress on policy. It is also true that many policymakers, despite the benefits, seek to restrict or even ban the deployment of the pioneering technologies that enabled the revolution to take hold in the first place.

Examples of these troublesome policies include: a ban on hydraulic fracturing technology, restricting the development of energy resources on federal lands, opposing private sector investments in critical new pipeline infrastructure, and advancing punitive tax policies aimed at punishing an industry that added hundreds of years of new energy reserves to the country's supply.

Had these policies been adopted in the past, there would be no energy renaissance today. If they are adopted in the future, the energy revolution that has provided so many benefits to so many Americans will never realize its full potential.

The second report of the Energy Institute's Energy Accountability Series imagines what the American economy would look like today had the American energy revolution not occurred. The report quantifies the real world impacts and consequences that would have been created had nor nation's abundant energy resource base been kept in the ground.

To estimate the economic impact of the energy renaissance, we compared data from 2015 to similar data in 2009, when domestic energy production started to accelerate in earnest and the public began to take notice. We examined data on jobs, capital investments, energy prices and other key indicators, and then used the IMPLAN model to estimate the overall macroeconomic effects of the dramatic energy-sector growth that took place during the 2009-2015 period. The IMPLAN model was chosen because it quantifies the "ripple" (or multiplier) effect through the economy to suppliers, and ultimately, households. As explained in this report, the economic effects of the energy renaissance have been truly astonishing.

Below are just a few examples of the type of political rhetoric we continue to see from those who seek to turn the clock back to a time when domestic energy was less abundant, less reliable and more expensive:

"I'm going to pledge to stop fossil fuels."

Hillary Clinton, Democratic nominee; Feb. 5, 2016

"By the time we get through all of my conditions, I do not think there will be many places in America where fracking will continue to take place."

Hillary Clinton, Democratic nominee; Mar. 6, 2016

"Let me make it as clear as I can be ... we are going to ban fracking in 50 states of this country."

U.S. Sen. Bernie Sanders (D-Vt); June 1, 2016

"We can, and we must, and we will keep that coal and gas and oil underground."

Bill McKibben, founder of 350.org & DNC platform committee member; Feb. 15, 2016

"The Obama-era 'all of the above' energy policy needs to end, beginning with the party platform."

Climate Hawks Vote; June 8, 2016

"We're also asking for an immediate halt to leasing public lands and waters for fossil fuel extraction [and] local, state, and federal policies to stop fracking."

Greenpeace; June 18, 2016

"Putting a halt to new [fossil fuel] extraction is needed to tilt the global scale towards clean energy and away from fossil fuels."

Sierra Club; June 18, 2016

"I want to create a Strategic Energy Fund that would be funded by taking money away from the oil companies."

Hillary Clinton, Democratic nominee; Aug. 10, 2007

"[W]e must protect our health and climate from this dirty drilling by banning it altogether, and keeping fossil fuels safely in the ground."

Margie Alt, Environment America. April 29, 2016

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EXECUTIVE SUMMARY

In the space of less than a decade, the United States has experienced an astonishing energy renaissance. Once deeply dependent on foreign and often more expensive sources of energy to power its economy and employ its workforce, the United States recently surpassed Russia as the largest producer of oil and natural gas in the world, extending benefits to nearly every segment of the U.S. economy in the process.

This dramatic reversal of fortunes could not have been accomplished absent game-changing advances in the way producers find, produce and deliver energy resources.

In this report, we conduct an in-depth examination of the nation's energy renaissance and how it has changed the country in ways big and small. Two clear findings emerge. First: Our economy is much stronger, more businesses are growing and more people are working higher-paying jobs because America is producing more energy here at home. Second, the impact on our economy, consumers pocketbooks, and employment is enormous. If this renaissance had not happened, or had been prevented, more than four million American jobs that were created would not exist today. Hundreds of billions of dollars in GDP would similarly have never materialized.

This report provides a much-needed reality check on the rhetoric coming from some politicians and interest groups this election season. By opposing fossil-fuel production in general and hydraulic fracturing in particular, they are opposing the energy renaissance itself, and all the associated economic benefits that have come and continue to come. In a sense, they are arguing the country would be better off if the energy renaissance never happened.

Against this backdrop, and at a critical juncture in the ongoing national debate over what our energy landscape will look like in the future, we offer the following perspective and analysis. It's time for politicians to be held accountable for what they do, say, and support. This report represents a starting point for one of the most important debates of our generation.

WHAT IF THE ENERGY RENAISSANCE HAD NOT OCCURRED?

__4.3 Million Jobs__ Would Not Have Been Created

Our analysis shows that had the energy renaissance not occurred, 4.3 million jobs — which were generated both as a direct result of energy development and because of the gains realized by the broader economy thanks to the renaissance — may not have been created. Had that scenario come to pass, our nation's employment picture would look a lot worse today.

The U.S. Economy Would Be a __Half-Trillion Dollars__ Smaller Today

Our analysis shows that $548 billion in annual GDP simply would not exist today absent the growth made possible by the energy renaissance.

Electricity Prices Would Be __31% Higher,__ and Motor Fuels Would Cost __43% More__

Our analysis shows that U.S. households would be paying 31 percent more for their electricity today and 43 percent more for motor fuels if the energy renaissance had not occured. Those savings hit the bottom line for most households, allowing consumers the choice to spend that additional money on other goods and services.

Residential Natural Gas Prices Would Be __28% Higher__; Industrial Natural Gas Prices Would Be __94% Higher__

Our models show that consumers would be paying nearly 30 percent more for their natural gas today if the energy renaissance had not occurred, and industrial users would be paying nearly double today's rates.

America's Comeback in Manufacturing Would Have Stalled

Without the lower energy prices made possible by the energy renaissance, our analysis finds the industrial sector would have lost almost **$47 billion** in economic opportunity, nearly **$25 billion** in labor income, and the equivalent of **387,500 jobs** in 2015. Within the industrial sector, impacts to energy-intensive manufacturers would have been especially pronounced.

States that Saw the Biggest Gains from the Renaissance Would Have Been the Hardest Hit

In this report, we take a closer look at how the energy renaissance has impacted **Pennsylvania, Ohio, Texas and Wisconsin** – four states that, in slightly different ways, have realized some of the greatest benefits associated with expanded U.S. energy development. Had this renaissance never occurred, **we find that more than 950,000 jobs would not have been created** in these four states. Jobs lost in these states would have come from a number of different and regionally important sectors, including steel, paper, and cheese manufacturing. All told, our analysis finds that **Pennsylvania** would have lost **$13 billion** in state GDP; **Ohio** would have lost **$9.9 billion**; **Texas** would have lost **$122.8 billion**; and **Wisconsin** would have lost **$3.8 billion**.

Finally, we find that very few jobs and very little GDP growth would have been realized in other economic sectors under a scenario in which the renaissance had not taken place. This is an important finding, in that it directly contradicts those who might claim that lost or otherwise unrealized energy-renaissance related jobs and revenue might have simply been "picked up" by competitor sectors or industries.

Our analysis finds that if the technologies that led to the energy revolution had not been allowed, the corresponding jobs they created would not exist today.

BUT, BECAUSE THE ENERGY RENAISSANCE DID OCCUR...

*U.S. Import Levels for Oil and Gas Have Fallen by **62%** and **73%**, Respectively*

As recently as a decade ago, 60 percent of the oil consumed in the United States came from foreign sources. Today, the country only imports 24 percent of its overall consumption. Natural gas import levels have also dropped from 16 percent to three percent during that same period. This is directly attributable to increased domestic production from the energy renaissance and would not have occurred had this influx of new supply not been discovered and produced in the United States.

Despite Growth in Energy Demand, Carbon Dioxide Emissions have Decreased 19%

Natural gas has gradually replaced coal as the primary fuel choice for U.S. power generation. This shift has contributed to a net decrease of power-sector carbon dioxide emissions of 19 percent over the past decade.

CHAPTER 1

SETTING THE STAGE FOR AMERICA'S ENERGY RENAISSANCE

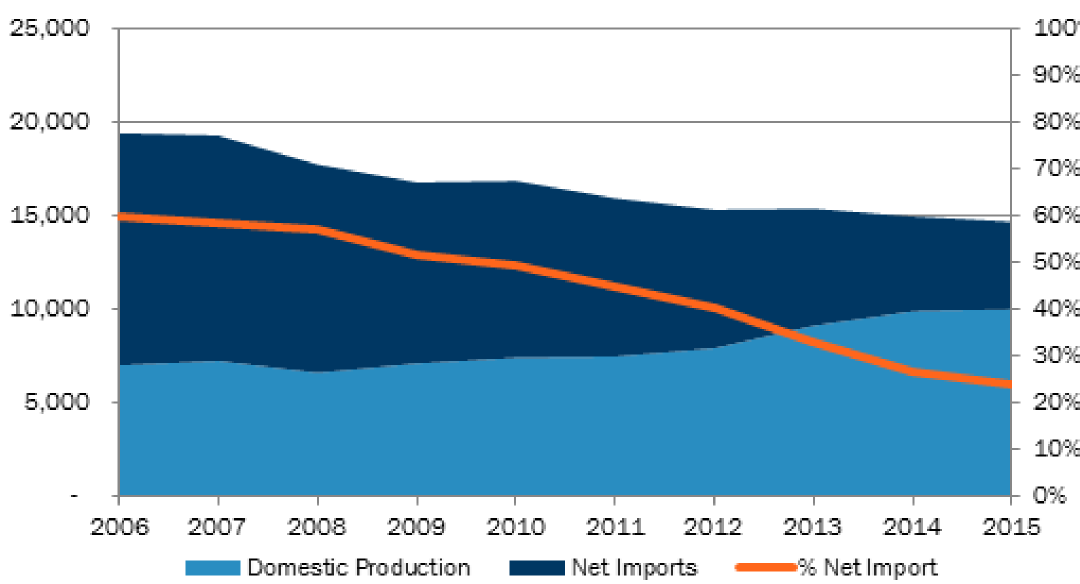
In the span of only a few short years, the United States has experienced an energy renaissance led in large part by advancements in the discovery and production of oil and natural gas. It is difficult to overstate the impact this renaissance has had on our economy and national security. As a result of this enormous growth in production, energy prices have plummeted, saving residential customers and businesses billions of dollars. At the same time, investments in oil and gas infrastructure have generated hundreds of thousands of jobs and added billions more to our country's GDP. When combined with affordable and abundant coal reserves, America enjoys an energy supply and price advantage that is the envy of many of our friends and competitors around the world, especially in Europe.

As recently as 10 years ago, the United States relied on imports to meet 60 percent of total domestic demand of crude oil and petroleum products. As overall petroleum consumption has slightly declined in recent years, the great majority of U.S. demand is now being met by domestic production, with only 24 percent of total U.S. consumption supplied by imports (Figure 1). The year 2012 marked the first time in decades when the majority of consumption was met by domestic sources rather than imports.

Increases in U.S. petroleum and natural gas production over the past several years are directly attributable to production from tight oil and shale gas formations, resulting in the United States becoming the dominant producer of crude oil and natural gas in the world (Figure 2). America surpassed Russia as the largest crude oil and natural gas producer in 2012 and has only widened the gap since, while Saudi Arabia remains a distant third.[1]

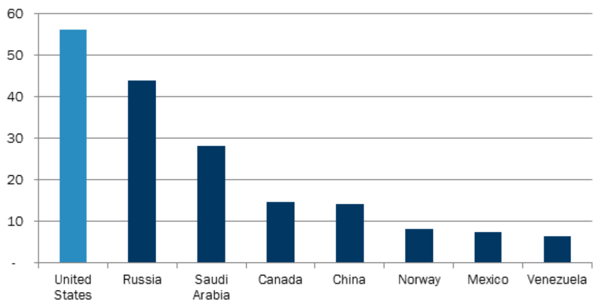
Although references to "tight" oil and gas are often used interchangeably when referring to resources produced from shale formations, it is worth noting that not all tight reservoirs are comprised of shale. Rather, tight intervals can also include formations made up of sandstone, limestone, marlstone, and composite rock, in addition to coalbed seams from which methane is produced. The aspect that all of these

Figure 1: U.S. Petroleum Consumption Sources: Domestic Production vs Net Imports



Source: EIA

Figure 2 - Estimated Oil and Natural Gas Production 2014 (Quadrillion Btu)



Source: EIA

formations and reservoirs have in common is that they require advanced stimulation technology (typically hydraulic fracturing) to be made viable, and it is this aspect in particular that is being referred to whenever these terms are used in this report.

Technical nomenclature aside, the complete change in our energy profile that has been made possible by the development of resources from all varieties of tight formations has dramatically lowered energy prices for consumers and helped the economy recover from the recession of 2008. Lower prices at the pump and in home heating bills have left more money in the pockets of consumers. Lower energy prices for industrial users have increased investment and manufacturing output. And the production of natural gas and oil has provided higher-than-average paying jobs in states such as Pennsylvania, Ohio, Texas, and North Dakota.

QUANTIFYING THE AGGREGATE ECONOMIC IMPACT OF THE ENERGY RENAISSANCE

Combining the incremental economic impacts across the value chain and the residential and industrial impacts spurred on by lower energy prices, our analysis finds that the energy renaissance added nearly **$550 billion in GDP** to the U.S. economy in 2015 and **4.3 million jobs.**

THE DRAMATIC INCREASE IN U. S. ENERGY PRODUCTION HAS ADDED JOBS AND GDP

Our analysis shows that increased oil and gas production itself, separate and apart from all the economy-wide benefits that lower energy prices make possible, was responsible for generating approximately two million jobs that would not have been otherwise created (Table 1). As part of this project, we calculated job additions across several sectors throughout the entire oil and gas value chain.

- **Upstream:** Oil and natural gas extraction
- **Midstream:** Oil and gas pipeline investments
- **Downstream:** Chemical industry investments

In addition to all of the direct jobs created in and by each sector, the job totals include those workers employed indirectly by suppliers to the industry and the induced jobs generated from the earnings spent by employees, contractors, and suppliers. Most of these new jobs were tied to activities in the upstream sector. Midstream

Table 1: U.S. Oil and Gas Value Chain Jobs from the Energy Renaissance, 2015

Type	Upstream	Midstream	Downstream	Total
Direct	389,100	99,600	70,100	558,800
Indirect	260,000	75,100	61,800	396,900
Induced	808,300	102,200	83,100	993,600
Total	**1,457,400**	**276,900**	**215,000**	**1,949,300**

Table 2: U.S. Aggregate Economic Impacts Due to the Energy Renaissance, 2015

	OIL AND GAS VALUE CHAIN IMPACT	LOWER ENERGY PRICE IMPACT	TOTAL IMPACT
GDP	$319.5 BILLION	$228.2 BILLION	$547.7 BILLION
Annual Employment	1.9 MILLION JOBS	2.4 MILLION JOBS	4.3 MILLION JOBS

Table 3: U.S. Oil and Gas Value Chain GDP from the Energy Renaissance, 2015 ($billion)

Type	Upstream	Midstream	Downstream	Total
Direct	$164.9	$7.9	$6.3	$179.1
Indirect	$38.5	$7.6	$6.6	$52.7
Induced	$71.2	$9.0	$7.4	$87.6
Total	**$274.7**	**$24.5**	**$20.3**	**$319.5**

impacts were calculated by estimating the incremental capital investments that were made to install new pipeline infrastructure in 2015 to transport additional oil and natural gas supplies produced from unconventional sources. Downstream impacts were calculated based on incremental investments that the chemical industry made in 2015 in response to increased natural gas supply and lower natural gas prices.

The upstream impacts are significantly greater than those generated by the midstream and downstream sectors, both because oil and gas development are more labor-intensive activities and because of the sequential build out of the value chain. Upstream operations are immediately impacted by increased drilling and production, while midstream and downstream investments tend to occur later in reaction to the increased supply. To that point, the figures generated for the midstream and downstream sectors must be considered a "starting point" for fully understanding and quantifying the impacts – additional benefits will continue to accrue over a longer and more sustained period relative to upstream impacts.

In addition to the large number of jobs created, increases in oil and gas production also added **$319.5 billion in GDP** to the economy in 2015 (Table 3).

For working families, the nation's energy turnaround came at a particularly opportune time. Jobs tied to domestic energy production were "one of the few, if not only, bright spots" when the construction industry was facing "a depression," Sean McGarvey, president of the North America's Building Trades Unions, said in 2014. And the jobs themselves also happen to be particularly high-paying, with labor income in the oil and gas industry 199 percent higher than the national average.[2]

LOWER ENERGY PRICES HAVE SPURRED SUSTAINED ECONOMIC GROWTH

Increased production of oil and natural gas has helped drive down the price consumers and businesses pay for energy. Our analysis shows that residential natural gas prices would have been 28 percent higher if the energy renaissance never took place; industrial natural gas prices would have been 94 percent higher; motor fuel prices 43 percent higher; and electricity prices 31 percent higher. These lower prices have increased residential consumer disposable incomes and lowered manufacturing costs – benefits that have flowed through the whole economy and led to increased job creation, labor income, and added GDP. As a result of lower energy prices in 2015, the economy added **$228.2 billion in GDP, $127.1 billion** in labor income, and **2.4 million jobs** (Table 4).

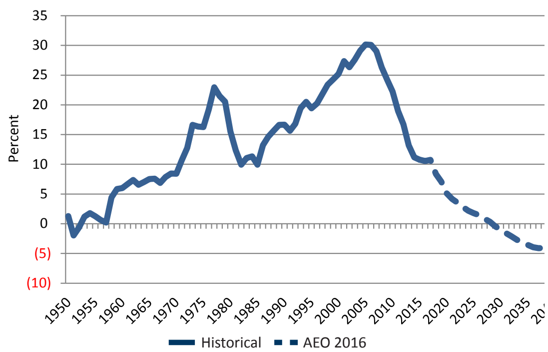
These wide-ranging benefits have even been acknowledged by *The New York Times,* which reported last year that most households and businesses "have benefited from a sharp drop in gasoline prices and other energy costs."

ENHANCED SECURITY

The positive impacts generated by the energy renaissance have extended beyond cost-savings for consumers and additional disposable income for American families. The renaissance has also made the United States much more energy secure – strengthening its ability to control its own destiny by securing future sources of supply. This new energy reality was reflected in the 2015 edition of our Index of U.S. Energy Security Risk, which showed that America's energy security risk ratings have improved three consecutive years largely because of the shale-powered energy revolution.

Assuming no major changes in public policy, these positive economic and security-related impacts should continue into the future. According to the U.S. Energy Information Administration (EIA), domestic energy production accounted for 91 percent of energy consumption in 2015.[3] EIA says we now have "the potential to eliminate net U.S. energy imports sometime between 2020 and 2030."[4] EIA data shows the precipitous decline of foreign energy imports as a share of total U.S. energy demand over the past several years (Figure 3).

Figure 3: Net Energy Imports as Share of Total U.S. Energy Demand: 1950 - 2040



Source: EIA

Table 4: U.S. Economic Impacts Due to Lower Energy Prices, 2015

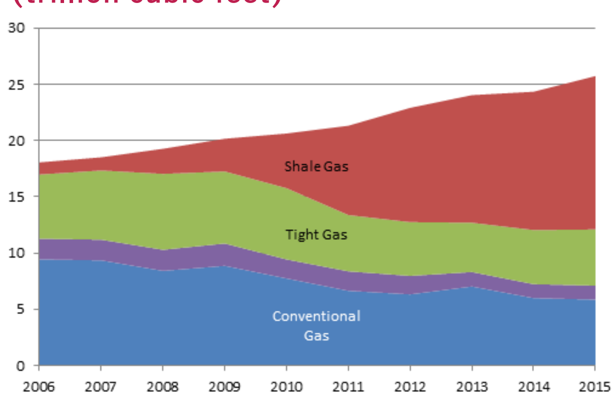
	Residential Impact	Industrial Impact	Total Impact
GDP	$181.6 billion	$46.6 billion	**$228.2 billion**
Labor Income	$102.6 billion	$24.5 billion	**$127.1 billion**
Annual Employment	2.0 million jobs	387,500 jobs	**2.4 million jobs**

The benefits all add up to a "once-in-a-generation opportunity to change the nation's economic and energy trajectory," according to a joint report issued by the Harvard Business School and Boston Consulting Group.[5] The United States now has a "global energy advantage" that provides "major benefits for industry, households, governments, and communities, while reducing America's trade deficit and geopolitical risks." In fact, thanks in part to America's low energy costs, the United States and China were just five percentage points apart in the overall cost of manufacturing goods last year – the smallest recorded gap in almost two decades.

THE ENERGY RENAISSANCE HAS REVOLUTIONIZED AMERICA'S ENERGY SYSTEM

Hydraulic fracturing and directional drilling have changed the way producers approach the task of finding and producing hydrocarbon-derived energy. Instead of relying on vertical wells to reach energy deposits in relatively shallow and confined rock formations, producers can now access much larger reserves stored in deeper and much more diffuse formations.

Figure 4: U.S. Conventional vs Unconventional Natural Gas Production (trillion cubic feet)



Source: EIA

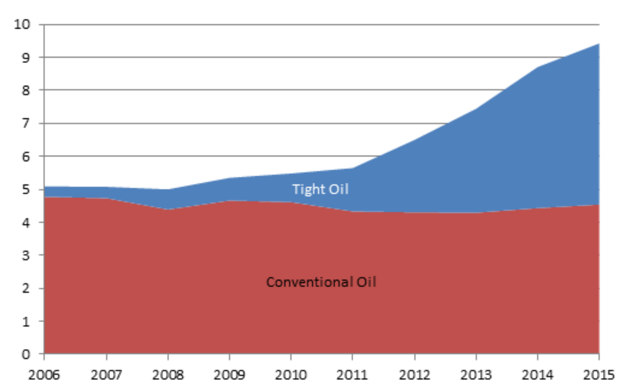
The results of these technological advancements have been stunning. In the last 10 years, U.S. natural gas production has increased by 43 percent – outpacing gains made by other countries that started producing commercial quantities of natural gas for the first time in their histories. According to EIA data, virtually all of this growth has come from the development of natural gas from shale and other tight formations (Figure 4).

U.S. oil production has experienced even more dramatic growth, having jumped 85 percent from roughly five million barrels per day in 2006 to 9.4 million barrels per day in 2015. As EIA data shows, all of this growth has come from tight oil, which is extracted using hydraulic fracturing and horizontal drilling technologies (Figure 5).

STATE LEVEL IMPACTS: PENNSYLVANIA, OHIO, TEXAS AND WISCONSIN

In addition to modeling the national impact of the energy renaissance, we researched the impacts on four states that continue to see significant gains (direct and indirect) as a result of the recent upward trend in energy production: Pennsylvania, Ohio, Texas and Wisconsin. These results are summarized in Table 5.

Figure 5: U.S. Conventional Oil vs Tight Oil Production (million barrels/day)



Source: EIA

Table 5: State Level Impact Summary, 2015

Economic Impact	Pennsylvania	Ohio	Texas	Wisconsin
State GDP	$13.0 billion	$9.9 billion	$122.8 billion	$3.8 billion
Labor Income	$7.2 billion	$5.8 billion	$59.4 billion	$2.2 billion
Annual Employment (FTE)	117,900	114,500	675,700	46,100

Each of these states was selected because it plays a critical role in contributing additional energy supplies to the nation or has a strong manufacturing base heavily impacted by energy prices, or both.

Pennsylvania and Ohio have greatly increased their production of natural gas in recent years — Pennsylvania is now the second-largest natural gas producing state in the country — and manufacturing remains the backbone of each state's economy.

Texas was selected because it leads the nation in both oil and gas production. It also has a large manufacturing sector, including robust petrochemical and fuels manufacturing segments.

While Wisconsin does not produce much oil or gas, its sand mines serve as an important supplier to service companies and operators that deploy hydraulic fracturing technology, and it has a large manufacturing base that has directly benefitted from the lower energy and feedstock prices that have resulted from the energy revolution.

To better understand how these phenomena have broadly affected these states, we first estimated how lower residential energy prices have impacted each state's economy.

In addition, our analysis examined the potential economic value "at risk" for the top 25 energy-intensive industries, as well as for oil and gas extraction, in these four states. Here, we define economic value at risk as the total economic contribution that an industry provides, inclusive of multiplier or ripple effects that could be placed at jeopardy if external circumstances were to impact the viability of relevant activities. Energy-intensive industries near or at marginal profitability [7] would be at risk of idling, moving or shutting down entirely under a scenario in which they were forced to endure higher input prices.

For example, Pennsylvania's paper mill industry, a large energy consumer, would have been put at risk if energy prices had not dropped during the time period studied. Rather than continue production activities in Pennsylvania, the industry could have made a rational decision to move its operations to a region or country with lower input and energy costs. For Pennsylvania, the at-risk impact would not only result in a **$600 million direct GDP** loss, but an additional **$1.1 billion in state-wide GDP losses** (for a total of **$1.7 billion in GDP losses**) due to the economic ripple effect from lost sales in the supply chain and lost employment income throughout the state's economy.

Table 6: State Level Industrial Economic Value at Risk, 2015

Economic Metric	Pennsylvania	Ohio	Texas	Wisconsin
GDP at Risk	$69.9 billion	$61.0 billion	$576.4 billion	$40.6 billion
Labor Income at Risk	$39.9 billion	$32.6 billion	$257.5 billion	$25.1 billion
Annual Employment at Risk (FTE)	546,900	545,600	2,900,000	447,800

Table 6 demonstrates the economic value at risk more broadly if the top 25 energy-intensive industries were adversely impacted in the four states examined.

The energy renaissance has fundamentally changed the nation's energy and economic landscape and vastly improved its energy security. It has dramatically lowered energy input costs for businesses and energy retail costs for consumers, helping the economy to recover much more quickly from the 2008 recession than had been previously believed.

CITATIONS

1 http://www.eia.gov/todayinenergy/detail.cfm?id=26352

2 IMPLAN analysis

3 https://www.eia.gov/todayinenergy/detail.cfm?id=25852

4 https://www.eia.gov/todayinenergy/detail.cfm?id=20812

5 http://www.hbs.edu/competitiveness/Documents/america-unconventional-energy-opportunity.pdf

6 All monetary figures in this report, with the exception of historical fuel prices, are in real 2015 dollars.

7 http://350.org/press-release/keep-it-in-the-ground-act-sets-the-new-bar-for-climate-leadership/

8 https://www.washingtonpost.com/news/post-politics/wp/2016/06/01/sanders-challenges-white-house-and-dnc-over-fracking/

CHAPTER 2

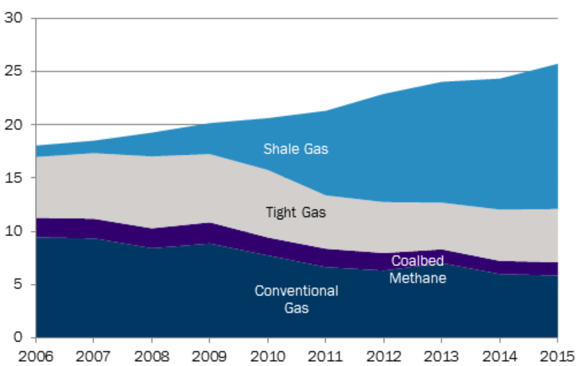
THE NEW U.S. ENERGY PORTFOLIO

America's energy renaissance has led to a dramatic rise in domestic energy production, which has precipitated a dramatic change in the make-up of the U.S. energy portfolio.

NATURAL GAS

As seen in Figure 6, domestic natural gas production is now dominated by contributions from unconventional sources, making up 77 percent of total production. The dramatic increase in shale gas production from 2006 — when only 1 trillion cubic feet (Tcf) were produced compared to 13.6 Tcf in 2015 — can be attributed to continuous improvements in production and completion technologies. This increase in unconventional production has more than made up for the declining production volumes from conventional sources.

Figure 6: U.S. Conventional vs Unconventional Natural Gas Production (trillion cubic feet)



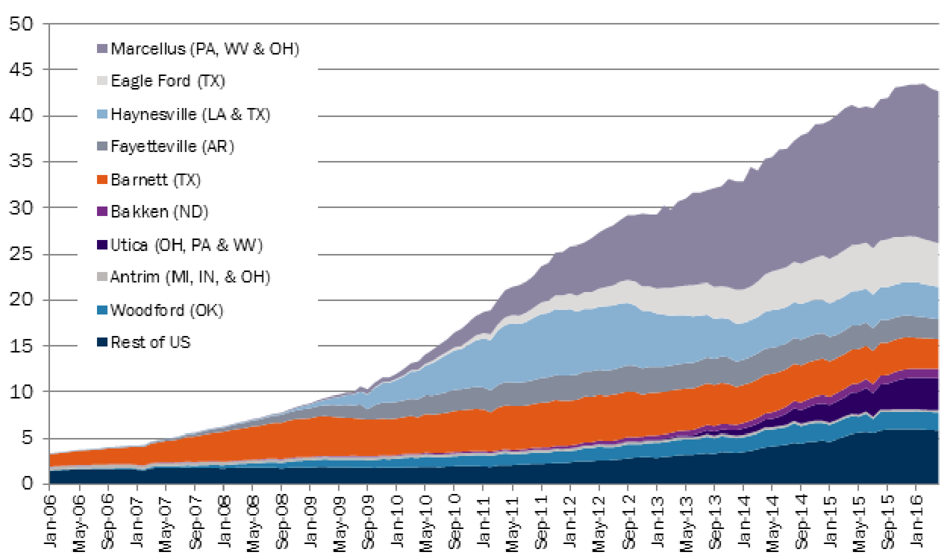
Source: EIA

Figure 7 shows the growth in shale gas production by basin. The Marcellus Shale has been responsible for the largest portion of this growth, bringing with it a significant number of investments and jobs to Pennsylvania, West Virginia, and Ohio. The Eagle Ford, Haynesville, and Fayetteville fields in Texas, Louisiana, and Arkansas, respectively, have also seen significant growth in production. In some cases, these are fields that produced virtually no natural gas as recently as 10 years ago.

CRUDE OIL

The significant growth in new oil production also underscores the changing energy landscape in the United States. A decade ago, the vast majority of crude oil produced in the United States came from conventional sources. In 2006, tight oil made up only six percent of the country's total oil portfolio. Today, much like

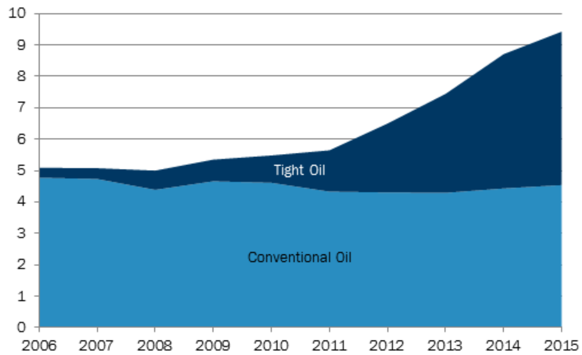
Figure 7: U.S. Dry Shale Gas Production (Bcf per day)



Source: EIA

natural gas, the massive increase in production is coming not from conventional sources, which have remained largely flat over the past 10 years, but from tight reservoirs, which now make up more than half of all U.S. oil production (Figure 8).

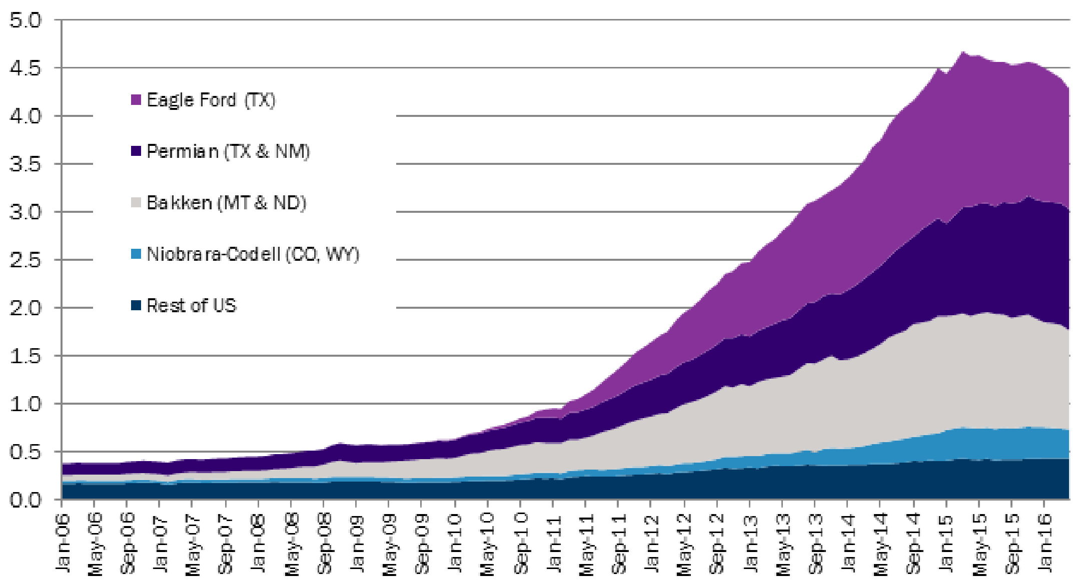
Figure 8: Conventional Oil vs Tight Oil Production (million barrels/day)



Source: EIA

Figure 9 shows the growth in tight oil production by field. Texas has been responsible for the largest portion of this growth, thanks in large part to production from the Eagle Ford and Permian basins, most of which reside underneath Texas. The Bakken field has transformed the economy of North Dakota by increasing production by more than one million barrels per day, although production there has begun to slow as oil prices have fallen. Indeed, if North Dakota were a country, it would have ranked among the top 20 crude oil producers in 2015.

Figure 9: U.S. Tight Oil Production (million barrels per day)



Source: EIA

CHAPTER 3

BENEFITS OF THE ENERGY RENAISSANCE

It was only a few short years ago that experts were declaring that we had reached "peak oil" and forecasted disaster scenarios where oil supplies would be depleted and prices would skyrocket. That fear seems like a distant memory today as the United States has experienced a renaissance in domestic production.

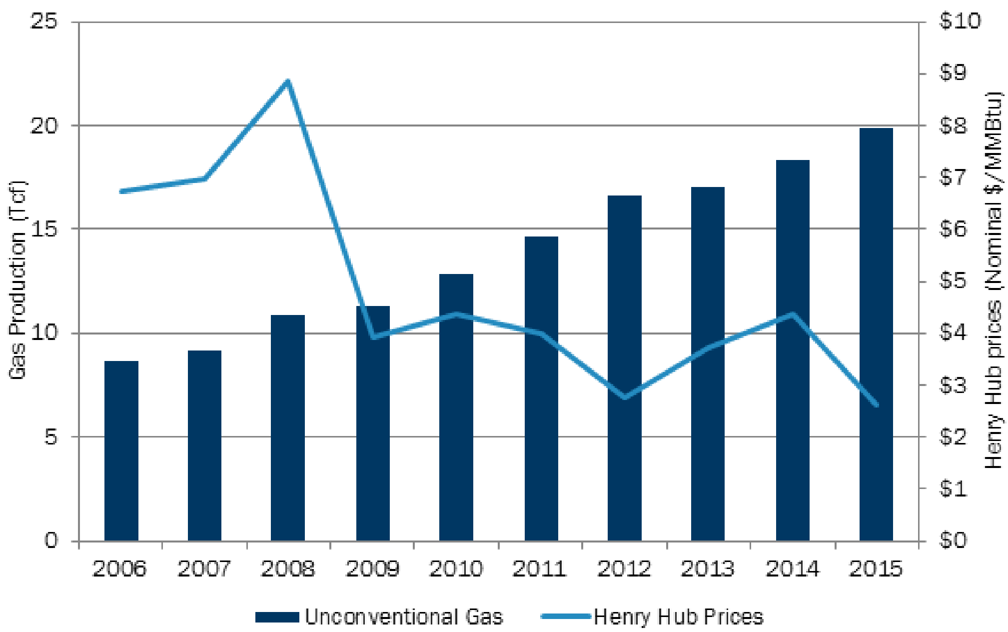
The rise in production has accrued to the benefit of American families, lowering prices across the board for consumers. Figure 10 shows that natural gas prices have dropped considerably from their peak in 2008 at $8.69/MMBtu (nominal) to $2.62/MMBtu in 2015 — a 70 percent reduction.[1] For many Americans, this has translated into much lower electricity costs and enabled consumers to increase spending in other areas.

As new supplies of natural gas have entered the U.S. market, demand for that natural gas has increased as well – and particularly so in the electricity sector. A decade ago, roughly half of all electricity generated and consumed in the United States was derived from coal. For a variety of reasons, including regulatory intervention and market economics, natural gas has increased its contribution to the nation's electricity generation mix from 20 percent 10 years ago to 33 percent today. At the same time, coal's contribution has been reduced from 49 percent to 33 percent.

It is worth noting that carbon dioxide emissions from natural gas generation are as much as 50 percent lower than coal-fired generation. While total electricity generation has stayed relatively constant, increasing only by one percent since 2006, carbon dioxide emissions have decreased by 19 percent in that same time frame.

Lower-cost natural gas has not only benefitted residential consumers, it has also stimulated manufacturing activity. For example, the U.S. plastics industry has benefited from lower natural gas prices, since natural gas is used as both a fuel and natural gas liquids (NGLs) are the primary feedstock for plastics manufacturing. As

Figure 10: U.S. Unconventional Natural Gas Production & Henry Hub Prices



Source: EIA

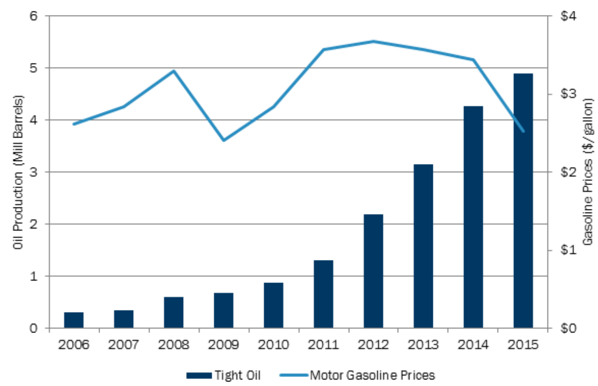
recently as a decade ago, America was among the highest-cost producers of plastics in the world. But with the recent increase in natural gas production, it has become one of the lowest-cost producers globally – completely flipping the script.

The recent plunge in natural gas commodity prices has shifted the competitive advantage back in favor of the United States. The industry has responded in kind with substantial investments to increase plastics production in this country. According to the American Chemistry Council, over the past five years the chemicals industry has announced plans for more than $130 billion in investment in new manufacturing capacity. In the next 10 years, these investments are expected to generate roughly 462,000 new jobs for American workers.[2]

The increase in tight oil production has also contributed to a drop in oil prices as the market responds to the increased supply, benefiting consumers and businesses alike (Table 11). American producers proved so adept at finding and producing unconventional oil that Saudi Arabia and the Organization of Petroleum Exporting Countries' felt compelled to abandon their defense of a $100+ price-point for a barrel of oil and work to solidify its market share instead, adding even more oil supplies to world markets and putting increasing downward pressure on prices.

As a result of the renaissance, EIA estimates that motorists have pocketed roughly $700 per year in savings as gasoline prices have dropped to their lowest levels in more than a decade.[3] This price drop has also spurred increased travel, with Americans logging a record number of miles driven in 2015.[4] More and more Americans are taking the savings from the pump and using that money to boost their savings, pay down debt and increase travel and leisure activity spending.[5]

Figure 11: Tight Oil Production (million barrels) & Motor Gasoline Price ($/gallon)



Source: EIA

The increase in energy production has increased economic activity for midstream and downstream industries tied to the oil and gas sector as well. For example, crude oil pipeline construction grew by 65 percent, or more than 25,000 miles, between 2006 and 2015. Likewise, billions of dollars are being invested in downstream chemical plants and LNG export terminals based on the expectation of continued low natural gas prices.

CITATIONS

1 All monetary figures in this report, with the exception of historical fuel prices, are presented in real 2015 dollars.

2 https://plastics.americanchemistry.com/Education-Resources/Publications/The-Rising-Competitive-Advantage-of-US-Plastics.pdf

3 http://www.eia.gov/todayinenergy/detail.cfm?id=20752

4 https://research.stlouisfed.org/fred2/graph/fredgraph.jpg?hires=1&g=3tIZ

5 http://www.wsj.com/articles/lower-gas-prices-yield-uneven-benefits-1441390917

CHAPTER 4

SECTOR ANALYSIS: ECONOMIC IMPACT

ANALYTICAL METHODOLOGY

To estimate the economic impact of the energy renaissance, data from 2009 was used as a baseline, focusing in particular on jobs, capital investments and energy price forecasts. That data was then compared to 2015 data to calculate the incremental differences that resulted from increases in oil and natural gas production. Then the IMPLAN model was used to estimate the overall macroeconomic effects of this dramatic change in the energy sector. IMPLAN quantifies the "ripple" (or multiplier) effect through the economy to suppliers and ultimately to households.

The analysis presented in this section estimates the potential impacts in a single year – 2015 – of the energy renaissance.[1] This single year serves as a proxy for the potential impact to the economy in future years if policies were to change. Our analysis is divided into four distinct modules:

- Upstream: Oil and natural gas extraction
- Midstream: Oil and gas pipeline investments
- Downstream: Chemical investments and export infrastructure
- End Users: Residential and industrial impacts of lower energy prices

UPSTREAM : ECONOMIC IMPACT OF INCREASED PRODUCTION OF OIL AND GAS

To assess the impact that the upstream segment of the oil and gas industry has had on the economy, we estimated the number of additional jobs that were created by 2015 owing to the energy revolution compared to a baseline in 2009. We first estimated the number of oil and gas jobs that were involved in shale gas and tight oil extraction back in 2009. Bureau of Economic Analysis (BEA) data shows 581,000 workers in the oil and gas extraction segment, which includes both drilling and extraction (NAICS codes 211111 and 213111).[2] We allocated the number of workers between new sources (shale gas and tight oil) and traditional sources (conventional, tight gas and coal bed methane) based on the relative production levels, on an energy equivalent basis. Data from EIA shows that shale gas and tight oil represented 14 percent of domestic natural gas and oil production in 2009, so we attributed 14 percent (81,000) of the 581,000 industry workers to new sources.[3] This sets the baseline to compare to 2015.

We used the same approach to estimate the number of shale gas and tight oil jobs in 2015. However the most recent BEA data is from 2014, so we adjusted that figure down to 2015 levels to account for the reduction of the oil and gas workforce as production began to level off and decline as a result of lower commodity prices.

BEA data shows that the number of oil and gas workers had grown from 581,000 to 922,000 between 2009 and 2014. Using available BLS data, which show a three percent decline in average monthly direct oil and gas employment from 2014 to 2015, we adjusted the 2014 total number to our 2015 estimate of 894,800 jobs.

Workforce reductions have continued into 2016, although the recent stabilization of world oil markets has had the effect of spurring additional development, often measured in the form of increased rig counts and higher numbers of drilled-but-uncompleted wells (DUCs) brought into production. [4] By 2015, shale gas and tight oil's share of total production had grown to 53 percent, so we attributed 53 percent (470,100) of the 894,800 industry workers to new sources. Two results of these calculations are presented in Table 7.

Table 7: Job Creation: "Renaissance" Jobs vs. Traditional, 2009-2015

	2009	2015	Diff
Conventional, Tight Gas and Coalbed Methane	500,000	424,700	(75,300)
Shale Gas and Tight Oil	81,000	470,100	389,100
Total Oil and Gas	**581,000**	**894,800**	**313,800**

The number of direct workers attributable to the energy renaissance is the difference between our estimate in 2009 (81,000) and our estimate in 2015 (470,100). These 389,100 direct jobs, which would not have been created if the energy renaissance never happened, serve as our input to the IMPLAN model, which was used to calculate the overall economic impact of the sector. IMPLAN breaks out drilling from extraction, so we allocated the two industries based on the percentage of total workers in each industry

MIDSTREAM: ECONOMIC IMPACT OF OIL AND GAS PIPELINE INVESTMENTS

The midstream economic impact is focused on oil and natural gas pipeline investments. To calculate the net effect from unconventional production on investment, we started with a projection of natural gas pipeline capital expenditures in 2015, which came from a 2009 study released by the Interstate Natural Gas Association of America (INGAA).[5] The 2009 study was written before the full extent of the energy renaissance was understood. We then compared that forecasted figure from the 2009 study to an updated INGAA study that included actual pipeline investment levels for 2015. We assumed that the difference between the two capital expenditure levels (projected vs. actual) represented the natural gas portion of investment attributable to new unconventional energy sources coming online.

A slightly different approach was used for oil pipelines, since projections for future oil pipeline construction from 2009 were not available. To create an alternative case, we calculated the compound annual growth rate (CAGR) in pipeline mileage data published by the Pipeline and Hazardous Materials Safety Administration (PHMSA) from 2005 to 2009 and applied that rate to each year through 2015.[6]

This calculation served as our forecast of pipeline mileages under a scenario in which the energy renaissance did not take place. This figure was then compared to 2015 actual pipeline construction data to determine the net growth in pipeline construction due to the energy revolution. The consulting and advisory firm IHS estimated that the total investment for 2015 was $11.6 billion.[7] Dividing that by the total number of miles constructed in 2015 allowed us to determine a dollar investment per mile rate. This rate was then applied to the net difference in oil pipeline construction miles to determine the net investment difference. The totals for both natural gas and oil pipeline differences are shown in Table 8.

The total net investment of $18 billion was then fed into IMPLAN to model the impacts of additional midstream investments across the economy.

Table 8: 2015 Projected vs Actual Pipeline Investments

	Natural Gas Pipeline Investment	Oil Pipeline Investment	Total
2015 Projected	$2.9 billion	$2.0 billion	$4.9 billion
2015 Actual	$11.3 billion	$11.6 billion	$22.9 billion
Net Difference	**$8.4 billion**	**$9.6 billion**	**$18.0 billion**

DOWNSTREAM: IMPACTS OF CHEMICAL INVESTMENTS AND EXPORT INFRASTRUCTURE

Many downstream sectors benefited from increased oil and gas production and the lower input prices that it made possible, but our analysis is focused on quantifying the build-outs of chemical plants — among the largest investments that were made during the period studied. We estimated the economic impacts by calculating the projected capital expenditures that were made in 2015 in constructing new chemical plants.

The American Chemistry Council released a report in 2013 on the impact of shale development on the chemical industry. The report included a forecast of incremental U.S. chemical industry capital expenditures due to the rise of unconventional development. The majority of these investments came in the form of petrochemical plants, but they also included plastic resin and fertilizer facilities. We used the forecast for 2015 of $15.1 billion in our analysis (ACC figures were adjusted for inflation to represent current day dollars).[8]

The total figure was then broken out into various sectors within IMPLAN based on asset type. The full breakdown of the distribution of investments is outlined in this report's Technical Appendix.

END USERS: RESIDENTIAL AND INDUSTRIAL IMPACTS OF LOWER ENERGY PRICES

We focused our analysis of lower energy prices on the residential and industrial sectors since they account for approximately 64 percent of total U.S. electricity consumption and 52 percent of total U.S. natural gas consumption. Additionally, the residential sector accounts for 85 percent of the total U.S. petroleum consumption for transportation use.[9]

To model the overall macroeconomic impact of lower prices, we needed to approximate prices without the increased supply of oil and natural gas that the energy revolution has brought into the market.

For oil and gas prices, we used EIA's Annual Energy Outlook (AEO) from 2009 as our source for forecasted 2015 prices. This report represents EIA's expected 2015 prices for energy back in 2009, before the impact of the energy renaissance was fully understood. The 2009 report was also chosen, rather than prior editions, because it incorporated the impacts of the economic downturn from the previous year.

The impact of lower natural gas prices also has an effect on electricity prices, but the connection between the two is not as direct given the range of other factors that impact electricity prices, including generation mix, coal prices and

Table 9: Residential Retail Energy Price Differentials, 2015

	U.S. Price (USD/unit)	Alt. Scenario Price (USD/unit)	% Difference
Natural Gas (MMBtu)	$10.07	$12.93	28%
Motor Fuels (MMBtu)	$20.91	$29.80	43%
Electricity (MWh)	$125.20	$164.19	31%

environmental regulations. We therefore used an electricity market model to calculate the wholesale electricity prices across the United States under an alternative scenario.

We first ran the model using actual 2015 natural gas prices as an input for gas-fired generating units. We then ran the model using the forecasted 2015 natural prices in the AEO 2009 as an input, and compared the differences. We translated wholesale electricity prices into retail prices based on historical wholesale-retail differentials for each region.

Each of these modules serves as an input into our IMPLAN model to determine the economy-wide impacts of the alternative scenario.

RESIDENTIAL IMPACT OF LOWER ENERGY PRICES

We calculated the percentage differences between actual energy prices in 2015 and the forecasts for that year made in 2009 using the following data:

- Bureau of Labor Statistics' Consumer Expenditure Survey for historical U.S. consumer expenditures.[10]
- EIA for actual U.S. prices – electricity, natural gas and motor fuels.[11]
- EIA's 2009 AEO for prices under a scenario without the energy renaissance.
- Electricity market model for electricity prices (PLEXOS).

IMPLAN modeling illustrates how much higher residential retail energy prices would have been without the energy renaissance having taken place. Natural gas prices would have been 28 percent higher; motor fuels prices would have been 43 percent higher; and electricity prices would have been 31 percent higher based on our analysis (Table 9).

We applied these price increases to consumer energy spending data from the BLS Consumer Expenditure Survey, broken down by income level. Critically, we assume that under the higher-price scenario, consumption stays constant, implying that most Americans would attempt to maintain their same standard of living (to the extent possible) under a higher-priced energy scenario.

Of course, demand isn't completely inelastic, but studies have shown that short-term demand is highly static under even significant incremental price increases. For example, one study finds that "demand is relatively inelastic to price [and that] in the past 20 years, this relationship has not changed significantly."[12] Another study notes that "electricity price elasticities in general are expected to be fairly inelastic due to limited substitution possibilities for electricity."[13]

Overall, residential consumers saved an estimated **$172 billion** in 2015 as a result of lower prices made possible by the energy renaissance. This amount represents additional

Table 10: Industrial Retail Energy Price Differential Impacts, 2015

	U.S. Price (USD/unit)	Alt. Scenario Price (USD/unit)	% Difference
Natural Gas (MMBtu)	$3.72	$7.22	94%
Electricity (MWh)	$71.00	$93.11	31%

resources that each household has available to spend on other goods and services. We used these figures to evaluate the indirect impact on the economy via the IMPLAN model. A more detailed breakdown of residential energy cost differences by income level is available in the Technical Appendix.

INDUSTRIAL IMPACT OF LOWER ENERGY PRICES

We calculated the percentage differences between actual energy prices in 2015 and the forecasts for that year made in 2009 using the following data:

- U.S. Census Annual Survey of Manufacturers (ASM)[14] and EIA's Manufacturing Energy Consumption Survey (MECS)[15] for industrial energy expenditures and fuel consumption shares.
- EIA for actual U.S. prices – electricity and natural gas.[16]
- EIA's 2009 AEO for under a scenario without the energy renaissance.
- Electricity market model for electricity prices (PLEXOS).

Table 10 shows how much higher industrial retail energy prices would have been in the alternative scenario. Natural gas prices would have been 94 percent higher and electricity prices would have been 31 percent higher had the energy renaissance not occurred.

To calculate how these price increases impact the industrial sector, we ordered the top 25 industries based on total electricity and fuel consumption using the U.S. Census's Annual Survey of Manufacturers (ASM). We also used EIA's Manufacturing Energy Consumption Survey (MECS) data to calculate the percentage of fuel that was derived from natural gas.

As with our residential analysis, we assumed that energy consumption stays constant while prices change. Thus, we increase the average energy expenditure for electricity and natural gas by the values presented in Table 10. The total cost impact to these industries is $53.8 billion, or slightly more than double actual energy expenditures. We used these figures to model the impact on the economy in IMPLAN.

A more detailed breakdown of industrial energy cost differences for each of the top 25 industries is available in the Technical Appendix.

ECONOMIC IMPACT MODELING RESULTS

To conduct this analysis, the IMPLAN model was used to estimate the overall macroeconomic effects of lower energy prices and increased oil and gas production. IMPLAN is a commonly used and highly regarded input-output modeling software and data system that tracks the movement of money and resources through an economy, looking at linkages between industries along the supply chain to measure the cumulative effect of spending in terms of

Table 11: U.S. Oil and Gas Jobs (Upstream) from the Energy Renaissance

Type	Employment (2015)	GDP (2015 - billions)
Direct	389,100	$164.9
Indirect	260,000	$38.5
Induced	808,300	$71.2
Total	**1,457,400**	**$274.7**

job creation, income, production, and taxes. These aspects of the IMPLAN model help us understand and quantify the economic "ripple" (or multiplier) effect that tracks how each dollar of input, or direct spending, cycles through the economy to suppliers and ultimately to households.

UPSTREAM: ECONOMIC IMPACT OF INCREASED PRODUCTION IN OIL AND GAS EXTRACTION

Not surprisingly, oil and gas extraction is the sector that experienced the most significant growth thanks to the energy renaissance. The sector supported 1.46 million jobs in 2015 and added $274.7 billion to the nation's GDP, as shown in Table 11.

Roughly 389,100 of these jobs are directly tied to oil and gas development and extraction, counting both direct employees and contractors. Another 260,000 workers are employed indirectly by suppliers to the oil and gas industry. In addition, the earnings spent by the sector's employees, contractors, and suppliers contribute to employment in downstream economic sectors. These "induced" jobs contribute an additional 808,300 jobs to the U.S. economy.

Of the estimated $274.7 billion in incremental GDP, the majority of this, $164.9 billion, is a direct effect of drilling and extraction activities. An additional $38.5 billion comes from indirect impacts, and $71.2 billion is generated through induced impacts to the downstream economy.

The increased production of oil and gas not only has generated millions of jobs, but it produces high income and wages for those who work in these industries. Table 12 shows labor income in the oil and gas industry is 199 percent higher than the national average. The indirect jobs, or jobs created among suppliers, have an income level that is 50 percent higher than the national average.

MIDSTREAM: ECONOMIC IMPACT OF OIL AND GAS PIPELINE INVESTMENTS

The growth in energy production also has meant an increase in midstream investments to facilitate the transport of oil and gas products to their desired markets. Significant job creation and income opportunities tend to follow large increases in capital expenditures.

As shown in Table 13, oil and gas pipeline investments made in response to unconventional production are responsible for 276,900 jobs across the United States. Of these jobs, 99,600 are directly employed by the midstream sector. Another 75,100 workers are employed indirectly by suppliers of pipeline materials. In addition, the earnings spent by employees, contractors, and suppliers contribute to employment in sectors that provide them with goods and services. These induced jobs contribute an additional 102,200 jobs to the U.S. economy.

Table 12: Labor Income from Oil and Gas (Upstream) Jobs

Type	Labor Income (2015)	Above U.S. Average
Direct – Oil &Gas	$173,300	199%
Indirect	$87,000	50%
U.S. Average	**$57,900**	--

Table 13: U.S. Oil and Gas Pipeline (Midstream) Jobs from the Energy Renaissance

Type	Employment (2015)	GDP (2015 - billions)
Direct	99,600	$7.9
Indirect	75,100	$7.6
Induced	102,200	$9.0
Total	**276,900**	**$24.5**

Incremental pipeline investments from the energy renaissance contributed an estimated $24.5 billion in GDP in 2015. The direct and indirect effects contribute similar impacts at $7.9 and $7.6 billion respectively, while the biggest impact comes from the induced effect at $9 billion.

These incremental jobs created from investments in new pipeline infrastructure tend to be high-paying jobs, with labor income from the construction of oil and gas pipelines 18 percent higher than the national average (Table 14). The indirect jobs, or jobs created among suppliers, have an income level that is four percent higher than the national average.

DOWNSTREAM: IMPACTS OF CHEMICAL INVESTMENTS AND EXPORT INFRASTRUCTURE

Downstream investments such as those made to build chemical plants and LNG export terminals have also grown in response to increased energy production. Much like upstream production and midstream infrastructure, the downstream facilities' growth has resulted in jobs, increased labor income and benefits to the overall economy.

As shown in Table 15, the construction of new chemical plants as a result of the energy revolution is responsible for an additional 215,000 jobs across the country. Of these jobs, 70,100 are directly involved in the construction of these facilities and of the equipment used in the plants. Another 61,800 workers are employed indirectly by suppliers. In addition, the earnings spent by employees, contractors, and suppliers contribute to employment in downstream service sectors. These induced jobs contribute an additional 83,100 jobs to the U.S. economy.

Incremental chemical investments in response to the energy renaissance contributed an estimated $20.3 billion in GDP. The direct and indirect effects contribute similar impacts at $6.3 and $6.6 billion respectively. Induced impacts had the biggest effect, registering at $7.4 billion.

These incremental jobs created from new investments in chemical plants generate higher-than-average wages for workers. As Table 16 shows, labor income for these direct jobs is 27 percent higher than the national average. The

Table 14: Labor Income from Oil and Gas Pipeline (Midstream) Jobs

Type	Labor Income (2015)	Above U.S. Average
Direct	$68,100	18%
Indirect	$60,000	4%
U.S. Average	**$57,900**	**–**

Table 15: U.S. Chemical (Downstream) Jobs from the Energy Renaissance

Type	Employment (2015)	GDP (2015 - billions)
Direct	70,100	$6.3
Indirect	61,800	$6.6
Induced	83,100	$7.4
Total	**215,000**	**$20.3**

Table 16: Labor Income from Chemical (Downstream) Investment Jobs

Type	Labor Income (2015)	Above U.S. Average
Direct	$73,700	27%
Indirect	$64,700	12%
U.S. Average	**$57,900**	—

indirect jobs, or jobs created among suppliers, have an income level that is 12 percent higher than the national average.

Another downstream industry that continues to see significant growth as a result of the energy renaissance is the liquefied natural gas (LNG) export segment. The first export facility in the Lower 48, Sabine Pass in Louisiana, shipped its first cargo load in February 2016. The facility reportedly cost approximately $20 billion to construct, which brought an influx of jobs and investment in and around Cameron Parish, located on Gulf Coast along Louisiana's border with Texas. The construction of the facility is estimated to have created 13,700 jobs (in person-years) in the local area and an additional 82,400 jobs across the rest of the country.[17]

An additional 10 export terminals have been approved by FERC, six of which are presently under construction.[18] These new facilities are expected to add 15.4 bcfd of export capacity. Overall, the construction and operation of LNG export terminals is expected to generate an annual average of up to 450,000 jobs over the next 20 years and annual GDP gains of up to $80 billion (2015$).[19]

END USERS: RESIDENTIAL AND INDUSTRIAL IMPACT OF LOWER ENERGY PRICES

RESIDENTIAL

We ran IMPLAN to calculate the macroeconomic impacts of increased residential household incomes resulting from lower energy prices. IMPLAN calculated the indirect and induced economic impacts of this extra money in Americans' pockets, finding $181.6 billion in increased GDP opportunities, more than $102.6 billion in increased labor income, and two million jobs added (Table 17).

Table 17: Aggregate Residential Economic Impacts due to Lower Energy Prices, 2015

	Economic Impact
GDP	$181.6 billion
Labor Income	$102.6 billion
Annual Employment	2.0 million jobs

Our modeling indicates that lower energy prices increased overall economic output, increased labor income, and created significant and broad-based benefits for the entire U.S. economy. Figure 12 shows the top 10 most impacted North American Industry Classification System (NAICS) sectors and the added GDP opportunity each sector experienced under lower energy prices in the residential sector.

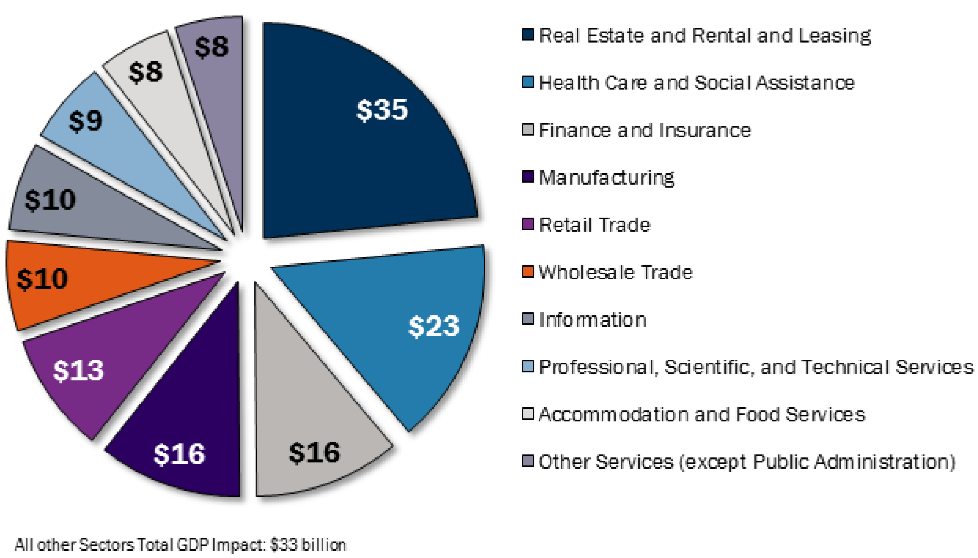
For example, the Real Estate and Rental/Leasing sector added approximately $35 billion, while the Health Care and Social Assistance sector added $23 billion. As it relates to Real Estate in particular, real-world evidence strongly points to home values increasing in areas where shale development has taken place, with inventories pushed lower and additional jobs in the Real Estate sector created to help facilitate additional home-purchasing.[20]

INDUSTRIAL

For the industrial sector, we found that the overall impact of lower energy prices equated to $46.6 billion in additional GDP in 2015. This economic benefit also translates to over $24.5 billion in added labor income and over 387,500 jobs, as shown in Table 18.

These figures are somewhat conservative given that the impact was modeled only on the top 25 industrial sectors. Furthermore, because we assume for the purposes of this study that an increase in price does not retard consumer demand or consumption, we discount any induced and indirect losses associated with the oil, natural gas, and electric generation industries.

Figure 12: GDP Impacts of the Top 10 NAICS Industry Sectors from Residential Price Decreases, 2015 ($Billions)



For example, the model outputs show that lower energy costs in the industrial sector translate to an increase in purchases from the natural gas distribution sector. However, under the assumption that consumption does not change, these indirect and induced effects do not occur. As such, we adjust the outputs to reflect this. Had we taken a different approach and not zeroed-out those values, the impacts would have likely been even more significant.

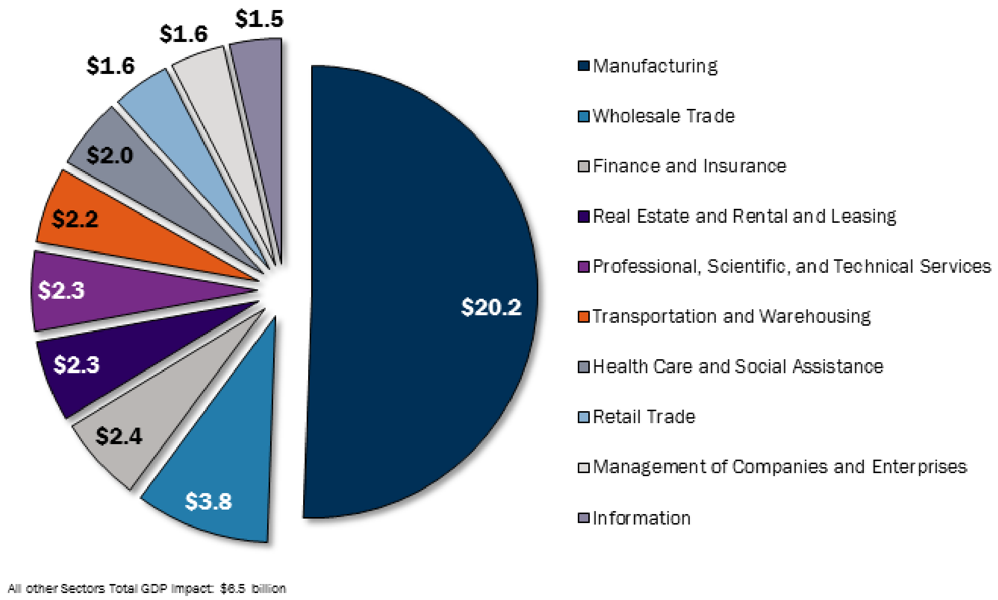
Table 18: Aggregate Industrial Economic Impacts due to Lower Energy Prices, 2015

Economic Impact	Aggregate Economic Lost Opportunity
GDP	$46.6 billion
Labor Income	$24.5 billion
Annual Employment	387,500 jobs

As with the residential sector, the impacts of lower prices on U.S. industries were felt across a number of sectors. Figure 13 shows the top 10 most impacted NAICS sectors and the added GDP opportunity each sector experienced under lower energy prices in 2015.

Not surprisingly, several well-known energy-intensive industries are represented on the list of the most impacted sectors below. We calculate that the manufacturing sector added approximately $20 billion on an annual basis due to lower energy prices.

Figure 13: GDP Impacts of the Top 10 NAICS Industry Sectors resulting from an Energy Price Increase to Energy-Intensive Industries, 2015 ($Billions in losses)



CITATIONS

1 2015 was chosen because it is the year in which the most recent and complete data is available for all energy consumption and prices.

2 We used BEA data rather than BLS data since the latter does not include contract workers, which make up approximately 80 percent off all workers in the oil and gas industry.

3 Chamber analysis on historical EIA Annual Energy Outlook (AEO) production data for oil and gas supply (Table 14).

4 https://www.zacks.com/stock/news/221222/us-rig-count-up-by-10-more-drilling-activity-seen-on-land

5 http://www.ingaa.org/file.aspx?id=10509

6 http://www.phmsa.dot.gov/pipeline/library/data-stats/annual-report-mileage-for-hazardous-liquid-or-carbon-dioxide-systems

7 http://www.nam.org/Issues/Energy-and-Environment/Crude-Oil-Pipeline-Impact-Study.pdf

8 https://chemistrytoenergy.com/sites/chemistrytoenergy.com/files/shale-gas-full-study.pdf

9 See https://www.eia.gov/totalenergy/data/monthly/pdf/sec3_26.pdf.

10 See tables for 2014 "Income Before Taxes" and "Higher Income Before Taxes" at: http://www.bls.gov/cex/csxcombined.htm.

11 See http://www.eia.gov/. Used data from Annual Energy Outlook "Energy Prices by Sector and Source"

12 Bernstein, M. and Griffin, J., *Regional Differences in the Price-Elasticity of Demand for Energy,* February 2006.

13 Madlener, R. et al., *Econometric Estimation of Energy Demand Elasticities,* Volume 3, Issue, E.ON Energy Research Center Series.

14 http://factfinder.census.gov/bkmk/table/1.0/en/ASM/2014/31GS101

15 https://www.eia.gov/consumption/manufacturing/

16 See http://www.eia.gov/. Used data from Annual Energy Outlook "Energy Prices by Sector and Source"

17 https://www.perrymangroup.com/wp-content/uploads/Perryman-Cheniere-Sabine-Pass-9-27-13.pdf

18 http://www.ferc.gov/industries/gas/indus-act/lng.asp

19 http://www.api.org/~/media/files/policy/lng-exports/api-lng-export-report-by-icf.pdf

20 http://powersource.post-gazette.com/powersource/companies/2014/06/17/Shale-boom-puts-pressure-on-housing/stories/201406170009

5
STATE-LEVEL IMPACTS (PA, OH, WI, TX)

Pennsylvania Economic Impacts

In Pennsylvania, 95 percent[1] of produced power comes from low-cost sources such as coal, natural gas, or nuclear energy. In 2014, Pennsylvania generated $658 billion in state GDP[2], had nearly 5.8 million people in the workforce[3] and had an unemployment rate of 5.9 percent, which is below the national average of 6.2 percent.[4] Notably, Pennsylvania is among the leading natural gas producing states in the country.[5]

The impact the energy renaissance has had (and continues to have) on Pennsylvania's economy is difficult to overstate. It starts with the benefits tied directly to the expansion of the oil and gas industry itself in the commonwealth, which in 2015 alone delivered $4.5 billion in additional state GDP, $2.3 billion in worker wages, and generated 27,500 direct jobs – GDP, wages and jobs that would not have been created otherwise.

Add to these totals the significant energy cost savings that were realized both by residential and industrial energy consumers across the state, and ***under a scenario in which the energy renaissance had not come to pass, $13 billion in state GDP, $7.2 billion in labor income, and more than 117,000 jobs would not have been created, as shown in Table 19.***

In addition to the impacts described above, we examined the level of potential economic value at risk for the top 25 energy-intensive industries and for the oil and gas sector. Industries within each state that are "on the margin" would have been at risk of idling or shutting down completely if not for lower energy prices. Therefore, we estimate the potential economic risk of that impact.

To do this, we started with IMPLAN data for state GDP, labor income, and annual employment for each of the top 25 energy-intensive industries. We then used IMPLAN's multipliers to understand the total value at risk (the multiplier includes how direct, indirect, and induced impacts flow through the economy given a scenario change).

As shown in Table 20, a significant portion of Pennsylvania's economic output would have been "at risk" of being lost were it not for the energy renaissance. All told, we calculate that nearly $70 billion in state GDP would have been placed at risk under this scenario; nearly $40 billion in wages would have as well; and nearly 550,000 jobs that exist today might not have otherwise been created.

One specific industrial sector that would have been placed at considerable risk if energy prices had remained high is Pennsylvania's paper industry, which directly contributes $640 million in annual state GDP as of 2015. Rather

Table 19: Pennsylvania State Impacts, 2015

Economic Impact	Upstream Oil and Gas Industry	Lower Residential Energy Prices	Lower Industrial Energy Prices	Total Impact
State GDP	$4.5 billion	$5.8 billion	$2.7 billion	**$13.0 billion**
Labor Income	$2.3 billion	$3.4 billion	$1.5 billion	**$7.2 billion**
Annual Employment	27,500 jobs	69,400 jobs	21,000 jobs	**117,900 jobs**

Table 20: Pennsylvania State Industrial Value at Risk, 2015

Economic Impact	Industrial Value at Risk
State GDP	$69.9 billion
Labor Income	$39.9 billion
Annual Employment	546,900 jobs

than continue production in Pennsylvania, one can assume that the paper manufacturing industry could have moved operations to a region or country with lower energy costs, or been forced to close altogether. The impact would not only have been $640 million in direct state GDP losses, but an additional $1.1 billion in state GDP losses (for a total of $1.7 billion in state GDP losses) due to the economic ripple effect from lost sales in the supply chain and lost employment income across the Pennsylvania economy.

Pennsylvania also imposes an "impact fee" from shale production that generates additional revenue streams that are shared with municipalities across the commonwealth.

Through 2014, Pennsylvania governments have collected and distributed $835.5 million since the enactment of the fee in 2011.

Sixty percent of the impact fee revenue stays at the local level, going to counties and municipalities where development activities are taking place. The rest goes to various state agencies involved in regulating development and also to the Marcellus Legacy Fund – which is spread around the state for environmental and infrastructure projects as well as disbursements to all 67 counties regardless of drilling activity. This total represents more than the state receives from public transportation assistance and highway and bridge funds combined. [6]

Of the $223.5 million generated in 2014, Washington County (in the southwest portion of the state) and its municipalities received $17.63 million in disbursements. According to Washington County Commission Chairman Larry Maggi, "It gives us and the municipalities an opportunity to do projects we might not otherwise be able to do. We're taking care of our bridges, rehabbing roads and rehabbing infrastructure. The impact fee is, and continues to be, of great importance to the county".[7]

Ohio Economic Impacts

Almost all of the power produced in Ohio (96 percent)[8] comes from conventional and low-cost sources – coal, natural gas, and nuclear. Ohio is also a major manufacturing state – the manufacturing sector alone represents 17 percent of Ohio's GDP, generates more than 660,000 jobs, and contributes $36 billion in labor income.[9]

To put this into perspective, Ohio generated $576 billion in state GDP in 2014[10], had nearly 4.9 million people employed (representing an employment rate of 73 percent)[11], and had an unemployment rate of 5.8 percent, lower than the national average of 6.2 percent.[12]

Ohio's economy is on track to continue its expansion, with significant future growth expected to come from oil and natural gas development in the Utica and Point Pleasant formations, in particular.[13] But the energy renaissance has already had a significant impact on the state.

All told, as shown in Table 21, our analysis finds that nearly $10 billion in state GDP, $6 billion in wages, and 114,500 jobs would not have been generated in Ohio had the energy renaissance not occurred. These figures account both for the losses that would have been experienced by the oil and gas industry under such a scenario, and the significant energy cost savings from which both residential and industrial energy users in Ohio benefited – money and savings that would not have been available to these consumers absent the energy renaissance.

In addition to these primary impacts, we examined the level of potential economic value at risk for the top 25 energy-intensive industries and for the oil and gas sector in Ohio. *Had* the energy renaissance not come to pass, we calculate that more than $60 billion in state GDP would have been placed at risk of either departing the state, or being lost altogether. In addition, we find that nearly $33 billion in wages would have been put at risk, and more than 545,000 jobs (Table 22).

Table 22: Ohio State Industrial Value at Risk, 2015

Economic Impact	Industrial Value at Risk
State GDP	$61.0 billion
Labor Income	$32.6 billion
Annual Employment	545,600 jobs

One of these "at risk" sectors worthy of special note is Ohio's iron and steel manufacturing industries, which contribute $2.2 billion in direct state GDP to the state. If energy prices had remained at their pre-renaissance highs, this sector would have been placed at immediate risk

Table 21: Ohio State Impacts, 2015

Economic Impact	Upstream Oil and Gas Industry	Lower Residential Energy Prices	Lower Industrial Energy Prices	Total Impact
State GDP	$2.0 billion	$5.5 billion	$2.4 billion	**$9.9 billion**
Labor Income	$1.4 billion	$3.1 billion	$1.3 billion	**$5.8 billion**
Annual Employment	21,500 jobs	71,100 jobs	21,900 jobs	**114,500 jobs**

(i.e., the industry may stop or move production elsewhere). Because of the iron and steel industries' ripple effect throughout the broader economy, the total economic value at risk increases to $5.9 billion.

Ohio also collects a severance tax from shale production. With the growing number of horizontal wells producing large volumes of natural gas and oil from shale, Ohio reported nearly $21.3 million in severance tax revenues for 2015 -- more than eight times the amount collected in 2010 ($2.5 million). Currently the tax money goes to the Ohio Department of Natural Resources and helps fund additional inspectors, emergency response staffers and other state priorities.

Wisconsin Economic Impacts

Wisconsin's economy remained relatively strong during the recent economic downturn, and rebounded more quickly than most starting in 2009. In 2014, the state generated $290 billion in state GDP[14], had more than 2.6 million people employed (representing an employment rate of 79 percent)[15], and had an unemployment rate of 5.4 percent, below the national average of 6.2 percent.[16]

A large part of Wisconsin's economic success can be traced back to its lower-than-average energy costs. Nearly 90 percent[17] of the electric power in Wisconsin comes from conventional and low-cost sources – coal, natural gas, and nuclear. The state's manufacturing sector is a large consumer of electricity, and represented nearly 19 percent of the state's GDP in 2014 and accounted for more than 16 percent of the state's workforce in 2015.

Average annual compensation in Wisconsin's manufacturing sector was more than $67,000 per employee in 2015,[18] well above the national average.

Wisconsin's economy would have been particularly vulnerable to decline if energy prices had not decreased during the energy renaissance. ***As shown in Table 23, nearly $4 billion in state GDP, over $2 billion in waves, and more than 46,000 jobs would not exist today in Wisconsin if not for the renaissance.*** More than $2 billion in worker wages and salaries would have never materialized. And more than 46,000 jobs that exist today in Wisconsin would never have been created.

As we did with the other states, we also examined what the potential economic value at risk would be for the top 25 energy-intensive industries in the state (Table 24). Our analysis finds that more than $40 billion in state economic output would have been placed at risk absent the energy cost-savings realized as a result of the downward pressure the energy renaissance put on energy prices. More than $25 billion in labor income generated among these industries would have been at risk as well, in addition to nearly 450,000 jobs.

Wisconsin's cheese manufacturing industry is a key sector worth noting, as it contributes over $1.5 billion in direct state GDP and just over $9.8 billion in GDP via its economic ripple effect. In fact, cheese manufacturing represents approximately one-quarter of the state GDP value at risk among Wisconsin's top 25 energy-intensive industry sectors. Without the lower prices created by the energy renaissance, this industry could find it difficult to compete against producers in other states or abroad.

Table 23: Wisconsin State Impacts, 2015

Economic Impact	Lower Residential Energy Prices	Lower Industrial Energy Prices	Total Impact
State GDP	$2.5 billion	$1.3 billion	**$3.8 billion**
Labor Income	$1.4 billion	$0.8 billion	**$2.2 billion**
Annual Employment	32,800 jobs	13,300 jobs	**46,100 jobs**

Table 24: Wisconsin State Industrial Value at Risk, 2015

Economic Impact	Industrial Value at Risk	Cheese Manufacturing Share of the Top 25
State GDP	$40.6 billion	24 percent
Labor Income	$25.1 billion	21 percent
Annual Employment	447,000 jobs	21 percent

Wisconsin's economy has also benefited directly from the oil and natural gas supply chain, especially in the production of sand proppants, which play an essential role in the hydraulic fracturing process. The growth of sand production in Wisconsin has spurred significant economic activity around construction, mining operations and rail transportation, according to an independent economic analysis prepared for Wood County in central Wisconsin. [19] This sector contributes over $620 million in direct state GDP and $846 million in total state GDP via its economic ripple effect. This industry would be at risk if the technologies behind the energy renaissance were to be halted

Texas Economic Impacts

In Texas, most of the power produced (over 81 percent)[20] comes from low-cost sources such as coal and natural gas. In 2014, Texas generated $1.64 trillion in state GDP[21], had 11.8 million people in the workforce[22], and had an unemployment rate of 5.1 percent, well below the national average of 6.2 percent.[23] Texas leads the nation in both natural gas and oil production and is home to sizable portions of three of the largest shale plays in the nation – the Barnett, Eagle Ford and Permian.[24]

It was in Texas where the energy renaissance began in earnest, and Texas today remains the nation's largest producer of oil and natural gas. As such, it's no surprise that Texas would have stood to lose the most under a scenario in which the energy renaissance never happened, starting with the losses that would have been realized by its oil and gas industry.

As shown in Table 25, more than $122 billion in state GDP that exists today in Texas would not have been created; nearly $60 billion in wages would have been lost, and more than 675,000 Texans would not have jobs that currently exist today had the energy renaissance not occurred.

The majority of these impacts come directly from the oil and gas industry itself, which would have lost more than $100 billion in state GDP, $50 billion in wages, and nearly 480,000 jobs. The remaining losses would come as a result of higher energy prices for both residential and industrial energy users.

In addition to these significant primary impacts, we examined the level of potential economic value at risk for the top 25 energy-intensive industries and for the oil and gas sector in Texas. Were it not for the energy renaissance, the prices these industries pay for energy would be higher today, putting energy-intensive industries at risk of idling, shuttering or moving out of the state entirely. Under a scenario in which the energy renaissance did not take place, we find in total that more than $576 billion in state economic output would have been placed at risk of being lost, along with $257.5 billion in wages and nearly three million jobs (Table 26).

One example of an industry sector that could be at risk if energy prices were to rise is Texas's petrochemical industry, which directly contributes $22.7 billion in annual state GDP (as of 2015).

Rather than continue production in Texas, the petrochemical industry could move operations to regions or countries with lower energy costs. The impact would not only be $22.7 billion in direct state GDP losses but an additional $52 billion in state GDP losses (for a total of $77.7

Table 25: Texas State Impacts, 2015

Economic Impact	Upstream Oil and Gas Industry	Lower Residential Energy Prices	Lower Industrial Energy Prices	Total Impact
State GDP	$101.6 billion	$13.2 billion	$8.0 billion	**$122.8 billion**
Labor Income	$48.5 billion	$7.5 billion	$3.4 billion	**$59.4 billion**
Annual Employment	478,400 jobs	156,700 jobs	40,600 jobs	**675,700 jobs**

Table 26: Texas State Industrial Value at Risk, 2015

Economic Impact	Industrial Value at Risk
State GDP	$576.4 billion
Labor Income	$257.5 billion
Annual Employment	2.9 million jobs

billion in GDP losses) due to the economic ripple effect from lost sales in the supply chain and lost employment income across the Texas economy. Furthermore, the planned construction of new petrochemical facilities in the state could be halted.

In addition to these energy-intensive industries, we included the impacts to the oil and gas sector itself in Texas, which includes approximately 360,000 direct employees and contractors and an additional 825,000 indirect and induced jobs. A large number of these jobs would be at risk if environmental policies limited or banned hydraulic fracturing use in Texas.

Finally, a direct benefit to the state of Texas is the tax revenues it collects from oil and gas production. For fiscal year 2015, Texas received $4.16 billion in oil and gas revenues, which represents over eight percent of all tax revenues collected and is the next largest revenue source for the state after sales tax. [25] This is more than 80 percent of the $5.1 billion of expenditures Texas has spent on highway construction and maintenance. [26]

CITATIONS

1 https://www.eia.gov/electricity/data/state/ "Net Generation by State by Type of Producer by Energy Source"

2 BEA, GDP by State. Available at: http://www.bea.gov/regional/

3 http://www.bls.gov/news.release/laus.t05.htm

4 BLS, 2014 average unemployment rate. Available at: http://www.bls.gov/lau/lastrk14.htm

5 EIA. See: https://www.eia.gov/state/analysis.cfm?sid=PA

6 http://www.revenue.pa.gov/GeneralTaxInformation/News%20and%20Statistics/Documents/MRR/2015/2015_12_mrr.pdf

7 http://marcelluscoalition.org/2015/06/natural-gas-impact-taxes-generate-223-5m-for-pa-communities-state-programs/

8 EIA-923 Report.

9 The Ohio Manufacturers' Association, *2014 Manufacturing Counts.* Available at: http://www.ohiomfg.com/ManufacturingCounts2014.pdf

10 BEA, GDP by State. Available at: http://www.bea.gov/regional/

11 BLS. The number employed includes those in the 20-64 years of age group. Employment rate is defined as the number of people employed divided by the number of people within the specific age group. Data available at: http://www.bls.gov/sae/

12 BLS, 2014 average unemployment rate. Available at: http://www.bls.gov/lau/lastrk14.htm

13 EIA, *Marcellus, Utica Provide 85% of U.S. Shale Gas Production Growth Since Start of 2012.* Available at: http://www.eia.gov/todayinenergy/detail.cfm?id=22252

14 BEA, GDP by State. Available at: http://www.bea.gov/regional/

15 BLS. The number employed includes those in the 20-64 years of age group. Employment rate is defined as the number of people employed divided by the number of people within the specific age group. Data available at: http://www.bls.gov/sae/

16 BLS, 2014 average unemployment rate. Available at: http://www.bls.gov/lau/lastrk14.htm

17 EIA-923 Report.

18 National Association of Manufacturers, *Wisconsin Manufacturing Facts*, available at: http://www.nam.org/Data-and-Reports/State-Manufacturing-Data/State-Manufacturing-Data/March-2016/Manufacturing-Facts--Wisconsin/

19 http://www.economicmodeling.com/2015/01/27/a-spot-on-assessment-emsi-measures-impact-of-frac-sand-mining-in-wisconsin/

20 https://www.eia.gov/electricity/data/state/ "Net Generation by State by Type of Producer by Energy Source"

21 BEA, GDP by State. Available at: http://www.bea.gov/regional/

22 http://www.bls.gov/news.release/laus.t05.htm

23 BLS, 2014 average unemployment rate. Available at: http://www.bls.gov/lau/lastrk14.htm

24 EIA. See: https://www.eia.gov/state/analysis.cfm?sid=TX

25 http://www.texastransparency.org/State_Finance/Budget_Finance/Reports/Revenue_by_Source/

26 http://www.texastransparency.org/State_Finance/Spending/

TECHNICAL APPENDIX

This technical appendix describes the economic impact modeling data, assumptions, and methodology for our upstream, midstream, downstream, residential/industrial sector analysis.

To estimate the economic impact of the energy renaissance, data from 2009 such as jobs, capital investments and energy price forecasts was used to create a baseline. We then compared those data points to 2015 data to calculate the incremental differences that resulted from the increased oil and natural gas production. We used the IMPLAN model to estimate the overall macroeconomic effects of this dramatic change in the energy sector. IMPLAN quantifies the "ripple" (or multiplier) effect through the economy to suppliers and ultimately to households.

UPSTREAM MODELLING ASSUMPTIONS & DATA

1. We first estimated the number of oil and gas jobs that were involved in shale gas and tight oil extraction back in 2009.
    a. Bureau of Economic Analysis (BEA) data shows 581,000 workers in the oil and gas extraction segment, which includes both drilling and extraction (NAICS codes 211111 and 213111).
    b. We allocated the number of workers between new sources (shale gas and tight oil) and traditional sources (conventional, tight gas and coal bed methane) based on the relative production levels, on an energy equivalent basis. Data from EIA shows that shale gas and tight oil represented 14 percent of domestic natural gas and oil production in 2009, so we attributed 14 percent (81,000) of the 581,000 industry workers to new sources.

Table TA-1: Total O&G vs. Fracking Production

Total O&G vs Fracking Production			
	2015 Actual (EIA)	Shale Gas & Tight Oil	Shale Gas & Tight Oil Total
NG Production (MMBTU)	29,610	53%	3,351
Oil Production (MMBTU)	19,955	52%	1,461
Total O&G Production (MMBTU)	49,565	53%	4,812

Fracking Jobs IMPLAN Input		
Sector	Jobs	Historical Weighting
Extraction of natural gas and crude petroleum	297,390	76%
Drilling oil and gas wells	91,710	24%

Table TA-2: Crude Oil Pipeline & Alternate Case (Mileage)

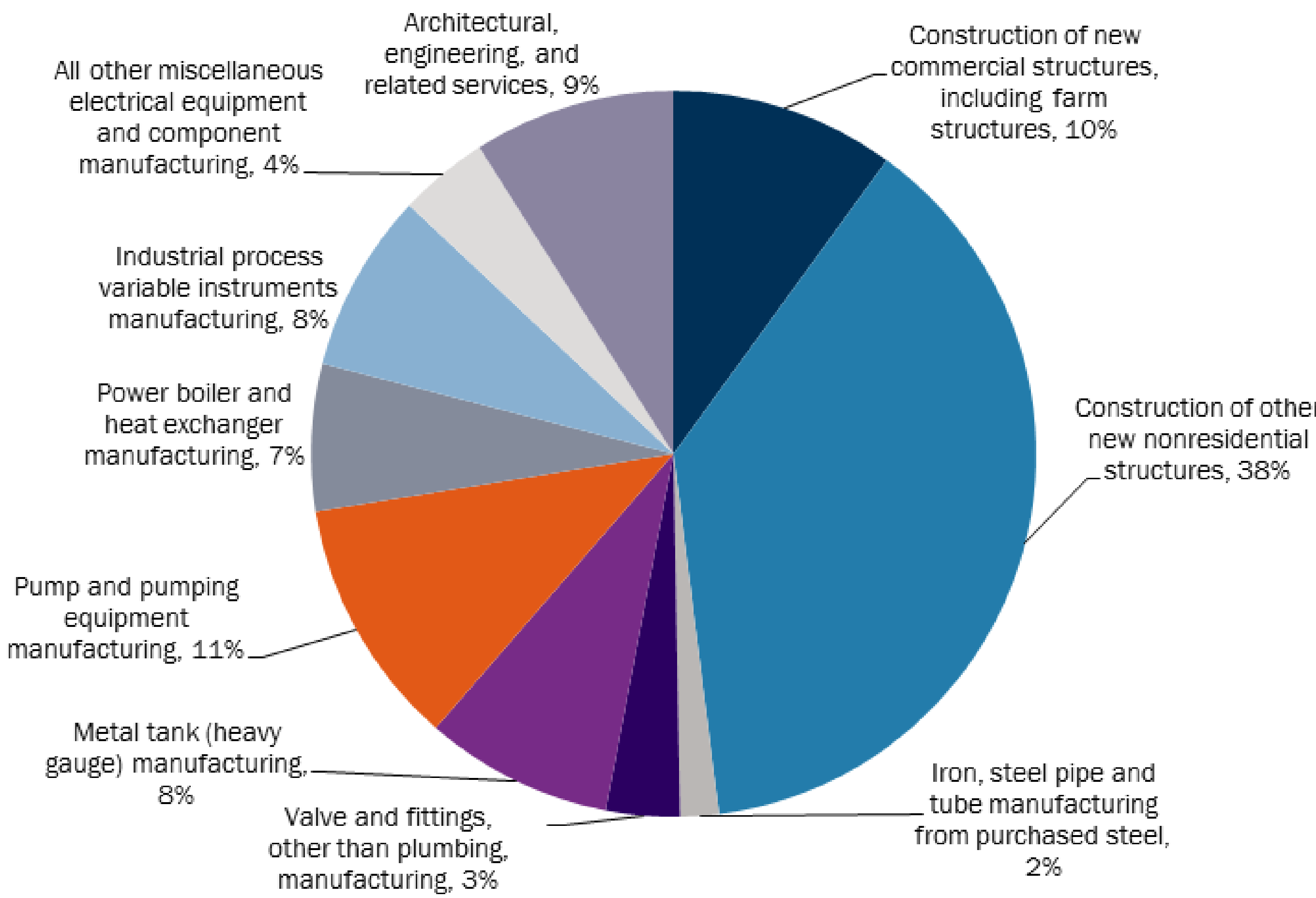
	CRUDE OIL	Annual Growth	Alt Case	Annual Growth
2005	48,732		48,732	
2006	48,453	-278	48,453	-278
2007	49,488	1,035	49,488	1,035
2008	50,963	1,475	50,963	1,475
2009	52,737	1,774	52,737	1,774
2010	54,631	1,893	**53,789**	1,052
2011	56,100	1,470	**54,862**	1,073
2012	57,463	1,363	**55,956**	1,094
2013	61,087	3,624	**57,072**	1,116
2014	66,742	5,655	**58,210**	1,138
2015	73,547	6,805	**59,371**	1,161

2. Then we estimated the number of oil and gas jobs that were involved in shale gas and tight oil extraction in 2015.
   a. Start with 2014 data from the BEA (922,000 oil and gas extraction jobs according to NAICS codes 211111 and 213111).
   b. Adjust to 2015 using BLS data, which showed a 3% decline in average monthly direct oil and gas employment from 2014 to 2015. After this adjustment, the 2015 estimate is 894,800 jobs.
   c. Prorate total oil and gas jobs by 53 percent (which is the ratio of oil and gas production due fracking on an energy equivalent basis) to approximate total jobs attributed to shale gas and tight oil (470,100).
4. Subtract the 2009 shale gas and tight oil jobs (81,000) from the 2015 estimate (470,100) to calculate the number of incremental jobs attributed to the energy renaissance – 389,100
5. Allocate the jobs attributed to the energy renaissance into two separate IMPLAN sectors as shown below in Table TA-1. The weighting represents the overall ratio of between extraction and drilling jobs.

MIDSTREAM MODELING ASSUMPTIONS & DATA

1. Natural gas projected investments for 2015 (in 2009) for the U.S. was $2.91 billion[1] compared to $11.28 billion investments in 2015.[2] These totals exclude any Canadian pipeline that was included in the totals.
2. Table TA-2 illustrates how crude oil pipeline growth without hydraulic fracturing impacts was calculated. The five year CAGR was calculated to be 2 percent using crude oil pipeline lengths from 2009 and 2005 respectively. This CAGR was applied to years 2010 through 2015 to create an "alternate case" scenario where the hydraulic fracturing impact was removed (seen in bold in Table TA-2).

Figure TA-1: Composition of New Capital Investment by Sector



3. The total dollar investment per mile rate is calculated using an IHS estimate of all 2015 pipeline construction to be \$11.57 billion[3] and \$1.7 million dollars per mile. This rate is then applied to the difference between actual annual growth vs the alternate annual growth scenario (6,805 – 1,161 = 5,644 incremental miles) to calculate the net effect of pipeline investment which is \$9.6 billion.
4. This net investment figure serves as the main input into IMPLAN under the "Construction of other new nonresidential structures" sector to model the economic impacts.

DOWNSTREAM MODELING ASSUMPTIONS & DATA

1. American Chemistry Council forecasts 2015 petrochemical investments to be \$15.1 billion in 2015 dollars (\$14.6 billion in 2012 dollars).[4]
2. This investment is broken out into the following sectors using the American Chemistry Council's weightings as shown in figure TA-1 and input into IMPLAN.

END USERS: RESIDENTIAL MODELING ASSUMPTIONS & DATA

To model the overall macroeconomic impact of higher energy prices, we use annual data for the year 2015. We model 2015 because it is the year in which all relevant and necessary data are available. We rely on the following data for the analysis:

- U.S. ENERGY PRICES -- EIA data tables include:[5]
  - Average Electricity Price by State by Provider[6] - We use "Residential" and "Industrial" (for industrial analysis) columns under the "Total Electric Industry" Industry Sector Category for prices.
  - Natural gas price delivered to residential consumers[7]
  - Natural gas industrial price[8] (for industrial analysis)
  - All grades all formulations retail gasoline prices[9]
  - No 2 Diesel prices[10]
- U.S. RESIDENTIAL ENERGY SPENDING: BLS Consumer Expenditure Survey for year 2014.[11] Data tables include:
  - "Income before taxes"[12] and "Higher income before taxes".[13] From these two data sets, we rely on the following:
    - Average (mean) natural gas expenditures by income level
    - Average (mean) electricity expenditures by income level
    - Average (mean) gasoline and motor oil expenditures by income level

Table TA-3: Residential Energy Price Differential Impacts, 2015

	U.S. Price (USD/unit)	No Energy Renaissance Price (USD/unit)	% Difference
Residential			
Electricity (MWh)	$125.20	$164.19	31%
Natural Gas (MMBtu)	$10.07	$12.93	28%
Motor Fuels (MMBtu)	$20.91	$29.80	43%

CALCULATIONS & ASSUMPTIONS

To run our IMPLAN model, we assume that the additional energy costs come in the form of lost consumer income. Our approach took the following steps:

1. Calculate the price difference between actual U.S. prices for electricity, natural gas, and motor fuels and those under a ban on fracking.
    a. Because the BLS data aggregates "Gasoline and motor oil" as an expenditure line item, we use a weighted average of the Gasoline and Diesel percent difference. The weighted average is based on EIA data for "product supplied for finished gasoline" and "No 2 diesel fuel sales/deliveries to On-highway customers" consumption figures.[14]
    b. Table TA-3 shows the difference in prices.
2. We apply the values in the table above to the average annual expenditure by energy type for each income level in the BLS survey data described above. For example, consumers in the <$5,000 income bracket spent an average of $189 on natural gas in 2015. For this analysis, we multiply this expenditure amount by the 128 percent difference from the table above to calculate a new expenditure value of $242 for this income bracket (Table TA-4).
    a. We assume that under the higher price scenario, consumption would stay constant. Implicitly, we are assuming that Americans would continue to have the same lifestyle (i.e., large homes, road miles traveled, etc.) under higher energy prices. Of course, demand isn't completely inelastic, but for simplicity and the purposes of this analysis, we assume it is.

Table TA-4: Average U.S. Residential Electricity, Natural Gas, and Motor Fuel Expenditure by Income Level, 2015, ($ Billions)

Income Bracket	2015 Actual Expenditure	Increased Price Scenario	Difference
Less than $10k	$22.2	$30.0	$7.9
$10k to 15k	$17.6	$23.8	$6.2
$15k to $25k	$42.0	$57.1	$15.0
$25k to $35k	$65.2	$88.6	$15.8
$35k to $50k	$62.1	$84.7	$22.6
$50k to $75k	$86.1	$117.7	$31.6
$75k to $100k	$60.0	$82.1	$22.1
$100k to $150k	$74.1	$101.5	$27.4
$150k and more	$64.1	$87.4	$23.3
Total	$493.4	$672.9	$171.8

3. After running the calculation above for each of the BLS income levels, we then group the income levels to match the income level breakdown in our retail electricity pricing model.[15] Table TA-4shows the final results of this calculation.

4. Finally, once we calculate how much additional consumer expenditures would have been under energy prices without fracking, we are able to run IMPLAN. The values in the table above are input into the U.S. national IMPLAN model for the year 2015 as a change in Household Income.

The same approach is used for each state's analysis. Table TA-5, Table TA-6, Table TA-7 and Table TA-8 show the inputs into IMPLAN for each state's analysis:

Table TA-5: Average PA Residential Electricity, Natural Gas, and Motor Fuel Expenditure by Income Level, 2015, ($ Billions)

Income Bracket	2015 Actual Expenditure	Increased Price Scenario	Difference
Less than $10k	$0.5	$0.6	$0.2
$10k to 15k	$0.4	$0.6	$0.1
$15k to $25k	$1.4	$1.8	$0.5
$25k to $35k	$2.3	$3.2	$0.6
$35k to $50k	$2.7	$3.6	$1.0
$50k to $75k	$4.4	$6.0	$1.6
$75k to $100k	$4.0	$5.4	$1.5
$100k to $150k	$5.2	$7.1	$1.9
$150k and more	$5.2	$7.1	$1.9
Total	$25.9	$35.5	$9.3

Table TA-6: Average Ohio Residential Electricity, Natural Gas, and Motor Fuel Expenditure by Income Level, 2015, ($ Billions)

Income Bracket	2015 Actual Expenditure	Increased Price Scenario	Difference
Less than $10k	$0.5	$0.6	$0.2
$10k to 15k	$0.4	$0.6	$0.1
$15k to $25k	$1.4	$1.8	$0.5
$25k to $35k	$2.3	$3.2	$0.6
$35k to $50k	$2.7	$3.6	$1.0
$50k to $75k	$4.4	$6.0	$1.6
$75k to $100k	$4.0	$5.4	$1.5
$100k to $150k	$5.2	$7.1	$1.9
$150k and more	$5.2	$7.1	$1.9
Total	$23.9	$32.7	$8.6

Table TA-7: Average Wisconsin Residential Electricity, Natural Gas, and Motor Fuel Expenditure by Income Level, 2015, ($ Billions)

Income Bracket	2015 Actual Expenditure	Increased Price Scenario	Difference
Less than $10k	$0.2	$0.2	$0.1
$10k to 15k	$0.2	$0.3	$0.1
$15k to $25k	$0.6	$0.9	$0.2
$25k to $35k	$1.1	$1.5	$0.3
$35k to $50k	$1.3	$1.8	$0.5
$50k to $75k	$2.2	$3.0	$0.8
$75k to $100k	$2.0	$2.8	$0.8
$100k to $150k	$2.4	$3.4	$0.9
$150k and more	$1.8	$2.5	$0.7
Total	$12.0	$16.4	$4.3

Table TA-8: Average Texas Residential Electricity, Natural Gas, and Motor Fuel Expenditure by Income Level, 2015, ($ Billions)

Income Bracket	2015 Actual Expenditure	Increased Price Scenario	Difference
Less than $10k	$1.1	$1.5	$0.4
$10k to 15k	$0.9	$1.2	$0.3
$15k to $25k	$3.0	$4.1	$1.1
$25k to $35k	$5.3	$7.2	$1.3
$35k to $50k	$5.9	$8.1	$2.2
$50k to $75k	$9.2	$12.7	$3.4
$75k to $100k	$8.1	$11.2	$3.1
$100k to $150k	$11.3	$15.6	$4.3
$150k and more	$12.1	$16.6	$4.5
Total	$56.9	$78.2	$20.7

END USERS: INDUSTRIAL MODELING ASSUMPTIONS & DATA

We relied on the following data to model the Industrial sector:

- U.S. ENERGY PRICES --EIA as described in Residential section.[16]
- U.S. INDUSTRIAL ENERGY SPENDING:
    - Used the U.S. Census Annual Survey of Manufacturers (ASM)[17] data from 2015 to identify electricity spending and fuel spending for each of the manufacturing industry codes in IMPLAN.
        - Matching was done by industry name, which corresponds to NAICS codes at the 4-, 5- and 6-digit levels.
    - Used the EIA's Manufacturing Energy Consumption Survey (MECS) to determine the percentage of total fuel spending that natural gas represents.[18]
        - Data is from 2010 (most recent year available)
        - MECS data is aggregated for some industries. Where data were not available for detailed industries (5-digit or 6-digit NAICS), more aggregated data were used. For example, MECS data were not available for Plastics Packaging Materials (NAICS 32611), so we used data for Plastics and Rubber Products (NAICS 326).

CALCULATIONS & ASSUMPTIONS

To calculate the impact of higher energy prices in the industrial sector, we took the following steps:

1. We ranked the top 25 industries based on total electricity and fuel spend from the ASM.
2. We increased the electricity and natural gas spend for the 25 industries by the percentage increase calculated for the Industrial sector (Table TA-9).
    a. We use a combination of EIA data for natural gas and electricity market modeling for wholesale electricity prices to determine an alternate pricing scenario assuming that there was no energy renaissance. We run the same calculation to compare actual U.S. prices with those without fracking. We translated wholesale electricity prices into retail prices based on historical wholesale-retail differentials for each region. The results of this calculation are shown in Table TA-10:
3. For each industry we reduced the Proprietor Income in IMPLAN to reflect the increase in energy expenses.

Table TA-9: Average Industrial Electricity and Natural Gas Expenditure, Top 25, 2015, ($ Billions)

Rank	Industry	NAICS	2015 Energy Spending (Billion $)	Alternative Price Scenario (Billion $)	Difference
1	Petroleum refineries	32411	$10.2	$22.2	$12.0
2	Other basic organic chemical manufacturing	32519	6.1	10.2	4.1
3	Iron and steel mills and ferroalloy manufacturing	3311	5.6	10.5	4.9
4	Paper mills	32212	3.3	6.3	3.1
5	Plastics material and resin manufacturing	325211	3.2	5.5	2.3
6	Paperboard Mills	32213	2.6	5.0	2.4
7	Petrochemical manufacturing	32511	2.5	4.4	1.9
8	Motor vehicle parts manufacturing	3363	2.1	4.7	2.7
9	Other plastics product manufacturing	32619	1.9	4.3	2.4
10	Semiconductor and related device manufacturing	334413	1.6	3.7	2.1
11	Industrial gas manufacturing	32512	1.5	3.6	2.0
12	Cement manufacturing	32731	1.5	2.6	1.1
13	Printing	32311	1.3	3.0	1.7
14	Alumina refining and primary aluminum production	331313	1.1	2.5	1.4
15	Lime and gypsum product manufacturing	3274	0.9	1.7	0.8
16	Plastics packaging materials and unlaminated film and sheet manufacturing	32611	0.9	2.0	1.1
17	Ferrous metal foundries	33151	0.9	1.8	0.9
18	Paperboard container manufacturing	32221	0.9	1.8	0.9
19	Poultry processing	311615	0.8	1.8	1.0
20	Wet corn milling	311221	0.8	1.5	0.7
21	Sawmills and wood preservation	3211	0.7	1.5	0.8
22	Pharmaceutical preparation manufacturing	325412	0.7	1.6	0.9
23	Fertilizer manufacturing	32531	0.7	1.6	0.9
24	Fruit and vegetable canning, pickling, and drying	31142	0.7	1.5	0.9
25	Other general purpose machinery manufacturing	3339	0.7	1.5	0.8
	Total		$53.0	$106.8	$53.8

Table TA-10: Industrial Energy Price Differential Impacts, 2015

	U.S. Price (USD/unit)	No Energy Renaissance Price (USD/unit)	% Difference
Industrial			
Electricity (MWh)	$71.00	$93.11	28%
Natural Gas(MMBtu)	$3.72	$7.22	94%

CITATIONS

1 http://www.ingaa.org/file.aspx?id=10509

2 http://www.ingaa.org/Foundation/Foundation-Reports/27958.aspx

3 http://www.nam.org/Issues/Energy-and-Environment/Crude-Oil-Pipeline-Impact-Study.pdf

4 https://chemistrytoenergy.com/sites/chemistrytoenergy.com/files/shale-gas-full-study.pdf

5 See http://www.eia.gov/

6 https://www.eia.gov/electricity/data/state/avgprice_annual.xls

7 https://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PRS_DMcf_a.htm

8 https://www.eia.gov/dnav/ng/ng_pri_sum_a_EPG0_PIN_DMcf_a.htm

9 https://www.eia.gov/dnav/pet/pet_pri_gnd_a_epm0_pte_dpgal_a.htm

10 https://www.eia.gov/dnav/pet/pet_pri_gnd_a_epd2d_pte_dpgal_a.htm

11 http://www.bls.gov/cex/csxcombined.htm

12 http://www.bls.gov/cex/2014/combined/income.xlsx

13 http://www.bls.gov/cex/2014/combined/higherincome.xlsx

14 See https://www.eia.gov/dnav/pet/pet_cons_psup_a_EPM0F_VPP_mbbl_a.htm and https://www.eia.gov/dnav/pet/PET_CONS_821USE_A_EPD2D_VHN_MGAL_A.htm

15 For example, the BLS survey data has income levels broken down (for the most part) by $5,000 increments (e.g., $15,000-$19,999). Some of the increments fit within the income levels described in Table 2, but others do not. As an example, the BLS survey has expenditure data for the $15,000-$19,999 and $20,000-$29,999 ranges. To get the total expenditure into the IMPLAN bucket of $15-$25k, we take all of the expenditures from the $15,000-$19,999 range plus half of the expenditures in the $20,000-$29,999 range.

16 See http://www.eia.gov/

17 http://factfinder.census.gov/bkmk/table/1.0/en/ASM/2014/31GS101

18 https://www.eia.gov/consumption/manufacturing/data/2010/xls/Table3_3.xls

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