**ENERGY ACCOUNTABILITY SERIES**

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

# WHAT IF...

## HYDRAULIC FRACTURING WAS BANNED?

# About the

# ENERGY ACCOUNTABILITY SERIES

This paper marks the fourth in a series of reports produced by the Energy Institute being released 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 comments and policy prescriptions put forth by prominent politicians and their supporters were actually adopted. We're calling it the Energy Accountability Series.

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 is not reinventing the wheel. What we're much more interested in – and what we think will be much more valuable to voters – 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 perhaps offered up merely to "appeal to their base." This is incredibly cynical, and it needs to change. A candidate's views and the things they say and do to win the support of interest groups have a real impact on how policy is shaped and implemented. That is especially true on energy issues, 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 global competitive advantages that affordable energy development have made possible.

The Energy Accountability Series asks the tough questions and provides clear-eyed, data-driven 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 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 Hydraulic Fracturing Was Banned?

The U.S. shale energy revolution was not an accident. It was the result of innovation, strategic investment, and old fashioned hard work. More than anything, it was an event made possible by the development, refinement and application of cutting-edge technology – technology developed by engineers, geologists, and other scientists who spent decades trying to "crack the code" of tight oil and gas. These efforts delivered nothing short of an energy renaissance. After years of projections that America's energy future would grow more dependent on imports, the U.S. energy landscape is now defined by abundance, not scarcity.

We don't have to look back very far to see the significance of this technological breakthrough. In July 2003, TIME Magazine carried a feature story entitled, "Why U.S. Is Running Out of Gas," which boldly predicted that the United States was heading to its "first big energy squeeze since the 1970s." The magazine claimed further that "the U.S. is finally beginning to run out of domestic oil and easily recoverable natural gas." A few years later, in 2008, oil was nearly $150 per barrel, and gasoline prices spiked to more than $4 per gallon. Henry Hub natural gas prices were also above $8 per million BTU, or about two and a half times what they are today.

While the media and politicians were busy asking questions about how this could happen, the energy industry was already developing answers. In the late 1990s, a Texas oil company called Mitchell Energy successfully used a decades-old process known as hydraulic fracturing ("fracking") in the Barnett Shale of North Texas. The process was paired with horizontal drilling to help unlock shale gas deposits all over the country, from the Niobrara in Colorado to the Marcellus and Utica in Pennsylvania, West Virginia, and Ohio. The combination would later be used to unlock tight oil deposits in North Dakota, Oklahoma, and south Texas, as well as the Permian Basin in west Texas and southeast New Mexico.

Between 2006 and 2015, the shale revolution turned the United States into an energy superpower. Only six percent of U.S. crude oil was developed with hydraulic fracturing in 2006. By 2015, that number had grown to 52 percent. For natural gas, 37 percent was produced with hydraulic fracturing in 2006. Today, nearly 70 percent of all natural gas produced in the United States is made possible through the use of these completions technologies.

Critics of oil and natural gas have not celebrated the shale revolution and its accompanying economic benefits. Some environmental groups actually used to praise natural gas as a clean energy option – but that support mysteriously disappeared. It seems environmental groups liked natural gas until they realized we had lots and lots of it.

Many environmental activist groups – acting as part of the "Keep It In the Ground" campaign to oppose the development of all fossil fuels – have now endorsed bans or other restrictions on fracturing technology. Unfortunately, some politicians have also joined that campaign, paradoxically calling for economically destructive bans while also claiming credit for the country's progress toward "energy independence."

While some may believe that instituting a ban on hydraulic fracturing is the right policy for the United States, few (if any) appreciate the full breadth and scale of the shale energy economy – and the enormous economic pain that such a program would impose. The economic recovery from the 2009 recession is still fragile. Banning fracking could easily undo much of the progress of the past seven years, putting millions of Americans out of work and destroying future job opportunities for the next generation.

In this report, we explore what would happen if the politicians and environmental activists got what they say they support: a complete ban on fracking. While many proponents of such a ban may choose to ignore these economic impacts, it is our hope that the general public – including in particular the constituents of the politicians supporting these bans – will not so casually dismiss these findings. The job loss numbers alone that would result from a ban on fracking are enough to encourage greater scrutiny of those who have allied themselves with the "Keep It In the Ground" campaign.

Here are a few notable examples of high-profile politicians and environmental activists endorsing fracking bans and the "Keep It In the Ground" campaign:

"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

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

Hillary Clinton, Democratic nominee; Feb. 5, 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

"There is an urgent need to keep fossil fuels in the ground if we want to protect the planet for future generations."

Rep. Jared Huffman (D-Calif.); Feb. 11, 2016

"[F]rom this point on, anyone proposing a new fracking field ... or oil well is, in effect, a climate denier."

Bill McKibben, founder of 350.org & DNC platform committee member; Sept. 29, 2016

"Until we fully understand the effects [of fracking], the only way to avoid these risks is to halt fracking entirely."

Rep. Mark Pocan (D-Wisc.); April 22, 2015

"We must keep our United States fossil fuel reserves, owned by the citizens, in the ground."

U.S. Sen. Jeff Merkley (D-Ore.); Nov. 4, 2015

"Any serious plan to combat climate change must include a ban on fracking."

Food & Water Watch; June 8, 2016

“[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

“Leave it all in the ground ... None of the above.”

Aaron Mair, Sierra Club president, Nov. 4, 2015

“We are growing the movement to ban fracking in Colorado.”

350 Colorado

“Tell the Governor to immediately halt all fracking in Ohio.”

Food & Water Watch

“This is Pennsylvania’s fracking boom, and it’s high time we shut it down.”

CREDO Action

“To address the environmental and public health threats from fracking across the nation, states should prohibit fracking.”

Environment Texas; April 14, 2016

# Contents

# EXECUTIVE SUMMARY

Since 2012, the United States has been the world's largest producer of oil and natural gas, a result of technological breakthroughs that allowed American innovators to develop hydrocarbons from shale and other tight rock formations underground.

These breakthroughs, including the combination of hydraulic fracturing with horizontal drilling, have also reduced energy costs for American families, resulting in lower prices at the pump and lower home heating bills, among other savings. This renaissance in domestic energy production has also been a crucial source of jobs for American workers. U.S. oil and gas employment surged almost 40 percent since the Great Depression while other U.S. non-farm employment only has grown about 3 percent.

This progress is under attack, however, as public figures, environmental activists, and politicians have called for bans or restrictions on hydraulic fracturing. In fact, the campaign against fracking has already achieved wins in various cities and counties, as well as the states of Vermont and New York. Many people recognize that local fracking bans would reduce local oil and natural gas production, but how much would a national ban harm the entire economy?

This report seeks to answer that question, exploring how a theoretical fracking ban in the United States – beginning on January 1, 2017 and running through the end of 2022 – would impact jobs, energy prices, incomes, domestic manufacturing, and American energy security.



## WHAT IF FRACKING WAS BANNED IN THE U.S., STARTING NEXT YEAR?

A fracking ban would be a disaster for the U.S. economy, exceeding the economic harm caused by the financial crisis, the housing bust, and the Great Recession – **combined**. Those concurrent events cost the United States around 8 million jobs. A ban on fracturing would destroy more than 14 million jobs, all while raising costs for families and considerably reducing American energy security.

Here are a few of the key impacts:

- **THE UNITED STATES WOULD LOSE 14.8 MILLION JOBS.**

If hydraulic fracturing was banned starting next year, 3.9 million jobs would evaporate in 2017 alone, rising from there to claim 14.8 million jobs by 2022.

- **GASOLINE PRICES WOULD ALMOST DOUBLE.**

We find that consumers would have to pay 53 percent more for petroleum products such as gasoline and diesel in 2017, with prices continuing to rise through 2022, when they would be roughly double what they are today.

- **NATURAL GAS PRICES WOULD SKYROCKET TO OVER $12 PER MMBTU.**

Natural gas prices would surge owing to vast swaths of shale suddenly being rendered off limits. This drives prices up for U.S. consumers, industry, and power generators – our analysis finds that natural gas prices would be 400 percent higher than what they would be otherwise by 2022.

- **U.S. ELECTRICITY PRICES WOULD NEARLY DOUBLE.**

Our modeling shows that U.S. households would pay almost 100 percent more for their electricity in 2022, driven in large part by rising natural gas prices.

- **COST-OF-LIVING WOULD GO UP BY NEARLY $4,000 A YEAR, WHILE HOUSEHOLD INCOMES WOULD DROP BY $873 BILLION**

Consumers would be forced to pay higher prices both for the energy they consume and the products and services they buy. Our analysis indicates that the average out-of-pocket, cost-of-living increase for U.S. families would approach $4,000 by 2022.

- **THE U.S. WOULD SURRENDER ITS STATUS AS A GLOBAL ENERGY SUPERPOWER**

The U.S. would be at the mercy of major international suppliers of oil and natural gas, including Russia and members of OPEC. Global price impacts from reduced supplies would benefit countries like Venezuela, at the expense of the U.S.

- **U.S. GDP WOULD BE REDUCED BY $1.6 TRILLION**

In 2017, GDP declines by $442 billion relative to the base case (a 2.5 percent decline from 2015 figures). This decline in GDP gradually escalates to $1.6 trillion in "missing" GDP by 2022.

- **OHIO, PENNSYLVANIA, COLORADO, AND TEXAS WOULD BE AMONG THE HARDEST HIT BY A BAN**

In this report, we take a closer look at Ohio, Pennsylvania, Colorado, and Texas – four states with a large energy economy and significant manufacturing sectors. Under a fracking ban, Ohio loses 397,000 jobs; Pennsylvania loses 466,000 jobs; Colorado loses 215,000 jobs; and Texas loses 1.49 million jobs. The cost-of-living for the average family rises $3,500 per year in Colorado and Pennsylvania, $4,000 per year in Ohio, and over $4,600 per year in Texas.

# CHAPTER 1
# WHAT DOES FRACKING DELIVER TODAY?

The shale renaissance has been an engine of growth across all sectors of the economy, not just for the oil and gas industry. Our previous modeling results ("What if America's Energy Renaissance Had Not Actually Happened?") revealed that the energy renaissance was responsible for 1.95 million jobs and $319.5 billion in GDP across the upstream, midstream and downstream sectors in 2015. The renaissance has also led to lower energy prices for businesses and residents, which increased household incomes and lowered residential costs. These impacts have translated into 2.4 million additional jobs and $228.2 billion in additional GDP.

But the continued realization of economic benefits from the renaissance are contingent on producers utilizing modern oil and gas extraction technologies, such as horizontal drilling and hydraulic fracturing, to produce energy resources used in almost every aspect of our daily lives. Our new report, however, shifts the focus from the past to the future to understand the economic implications of a possible prospective ban on hydraulic fracturing, as opposed to a retrospective one.

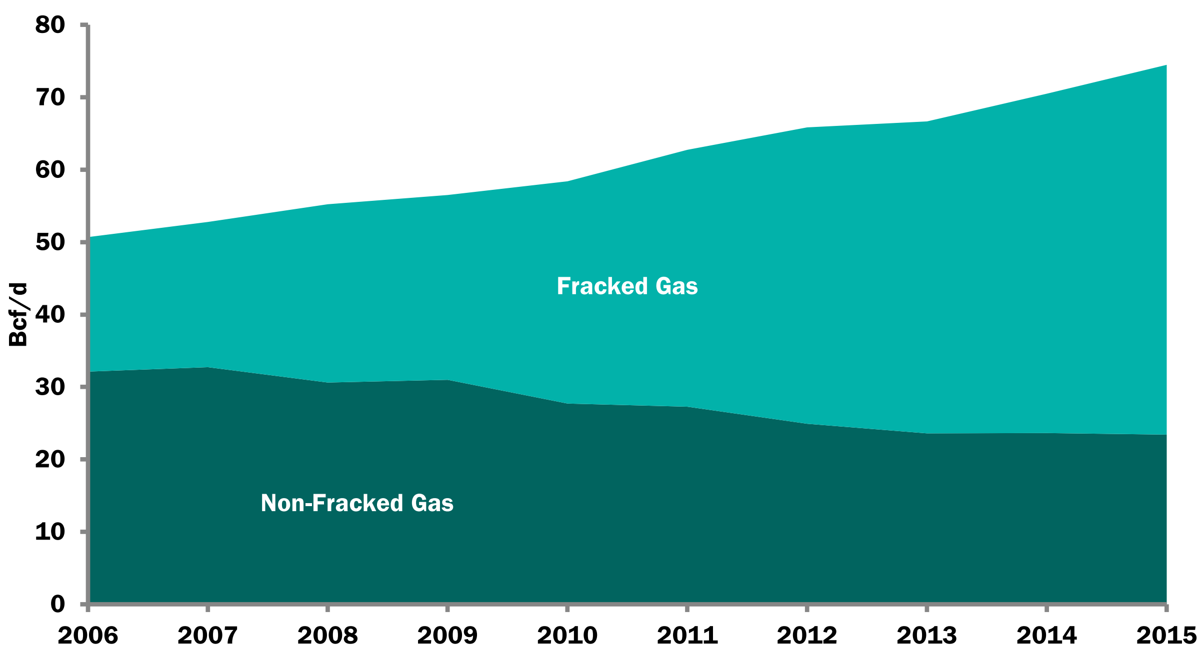
The technological advancements associated with fracking and other oilfield innovations have been driving factors in the energy renaissance. Hydraulic fracturing is a technique in which fluids under high pressure create fissures in rock formations to stimulate the flow of oil and natural gas.

For decades in many parts of the country, shales and other tight formations were an unsolved mystery: they were known to hold enormous quantities of oil and natural gas, but they were also considered too expensive to develop. Innovations in the late 1990s and early 2000s transformed these tight rocks from impenetrable fortresses into some of America's largest oil and natural gas fields.

Fracturing technology has been used for decades in vertical wells as a stimulation technique. Vertical wells are drilled perpendicular to the underground oil or gas formation, and fracturing increases their efficiency and output. More recently, fracturing has



**Figure 1: Historical Gas Production**




*Source: EIA Annual Energy Outlook 2016*

been used in combination with horizontal drilling in shale formations, and together they have been responsible for the huge increases in U.S. oil and gas production.

Figure 1 illustrates the importance of fracking as a contributor to U.S. natural gas supply. In 2006, only 37 percent of natural gas was developed via fracturing technology. By 2015, that number grew to 69 percent of production.

Similarly, Figure 2 shows fracturing's role in adding to crude oil inventories. In 2006, only six percent of U.S. crude oil was developed from wells that underwent fracture treatments. This grew to 52 percent by 2015.

## NATURAL GAS PRODUCTION AND PRICES

The United States has witnessed a dramatic increase in natural gas production thanks to the development of shale resources. A combination of improvements in fracking and directional drilling technologies has ushered in a new era for natural gas, and increasingly for oil as well.

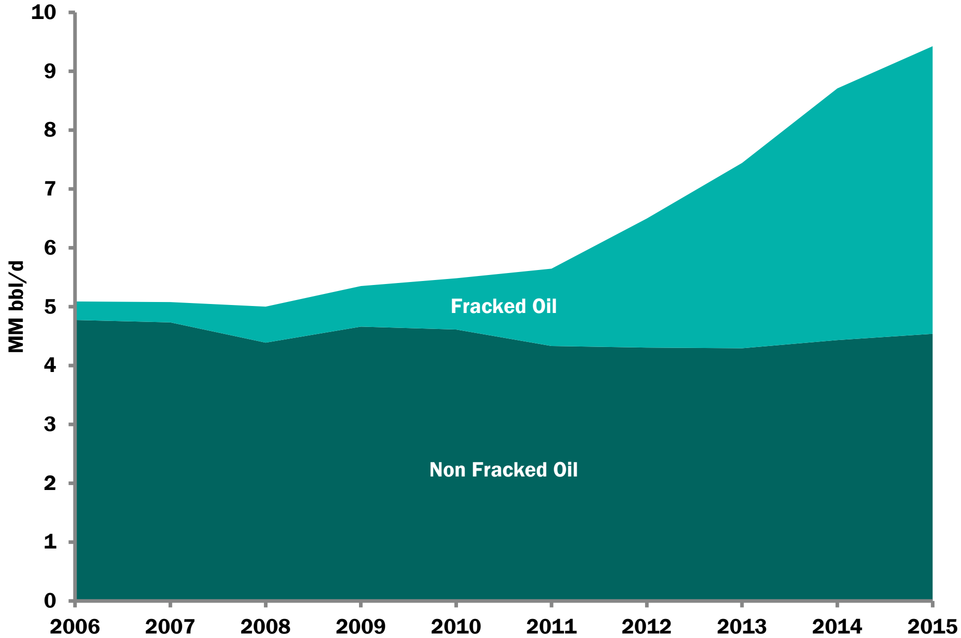
Figure 3 outlines the various sources from which our natural gas comes today, and is expected to come into the future. "Fracked gas" in the chart includes both shale and tight gas. While hydraulic fracturing is used as part of some coalbed methane production, for the purposes of this study, we conservatively include coalbed methane in the category of non-fracked gas.

Figure 3 above is a reproduction of Figure 1 but disaggregates "Fracked Gas" into "the categories of "Shale Gas" and "Tight Gas." Figure 3 shows that shale gas production, which is the predominant growth engine of "Fracked Gas," grew from just 2.9 billion cubic feet per day (Bcf/d) in 2006 to 37.4 Bcf/d in 2015. As it currently stands, shale gas is responsible for just over half of all U.S. gas production at 53 percent.

Under its Reference case, the EIA forecasts that natural gas production will grow to 87 Bcf/d by 2022, about a 17 percent increase relative to today's levels, driven almost entirely by increases in shale production. This estimate for 2022 is



**Figure 2: Historical Oil Production**




*Source: EIA Annual Energy Outlook 2016*

probably too low. Over the past few years, EIA has tended to underestimate oil and natural gas output from shale formations, with actual trends more closely matching EIA's High Oil & Gas Resource and Technology side case. If technology develops more rapidly and new resources are added in keeping with this EIA scenario, output could rise even more – to as much as 101 bcf/d in 2022, one-third (25 bcf/d) more than in 2016—again, driven entirely by increases in shale production.

Because EIA's High Resource & Technology scenario has done a better job of tracking reality, we have chosen to use it as the baseline for this analysis.

The rise in shale production has benefited American consumers and businesses greatly, lowering prices across the board. Figure 4 shows that delivered natural gas prices have dropped considerably from their peak in 2008. Industrial customers experienced a 63 percent decrease in prices while residential and commercial saw 32 percent and 41 percent respectively.[1] This reduction has translated into lower costs for businesses and families, freeing up spending to other value added areas.

## CRUDE OIL PRODUCTION AND PRICES

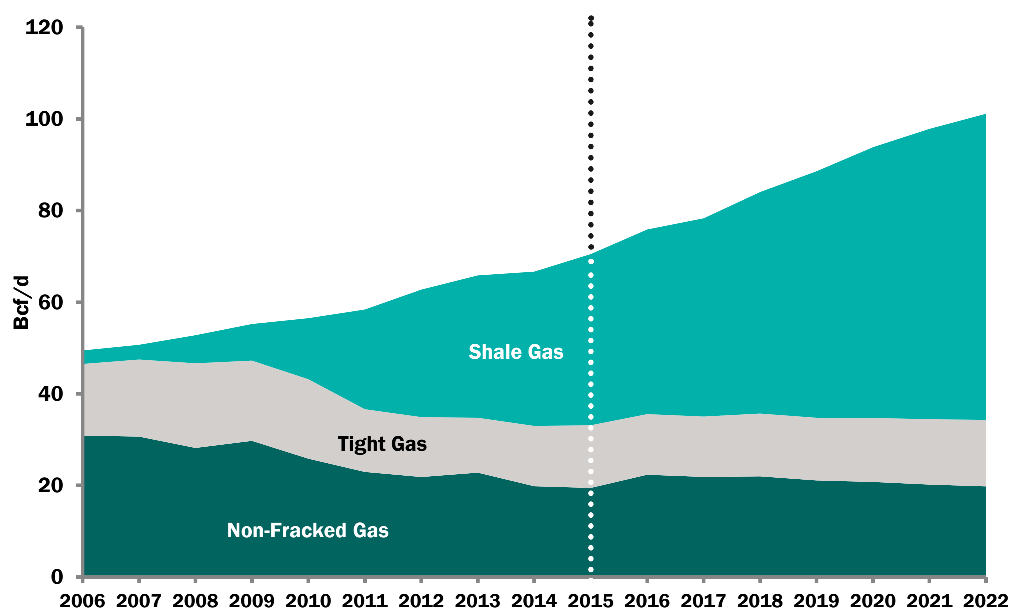
The significant growth in new oil production also underscores the changing energy landscape in the United States. A decade ago, the vast majority of crude oil produced in the United States came from conventional sources. In 2006, tight oil made up only six percent of the country's total crude oil production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

Today, much like natural gas, the massive increase in crude oil production is coming not from conventional sources, which have remained largely flat over the past 10 years, but from hydraulically fractured tight oil formations, which now make up more than half of all U.S. oil production.

Figure 5 shows that total U.S. crude production is expected to increase through 2022. This increase will be made possible by increases in tight oil production, which will more than offset

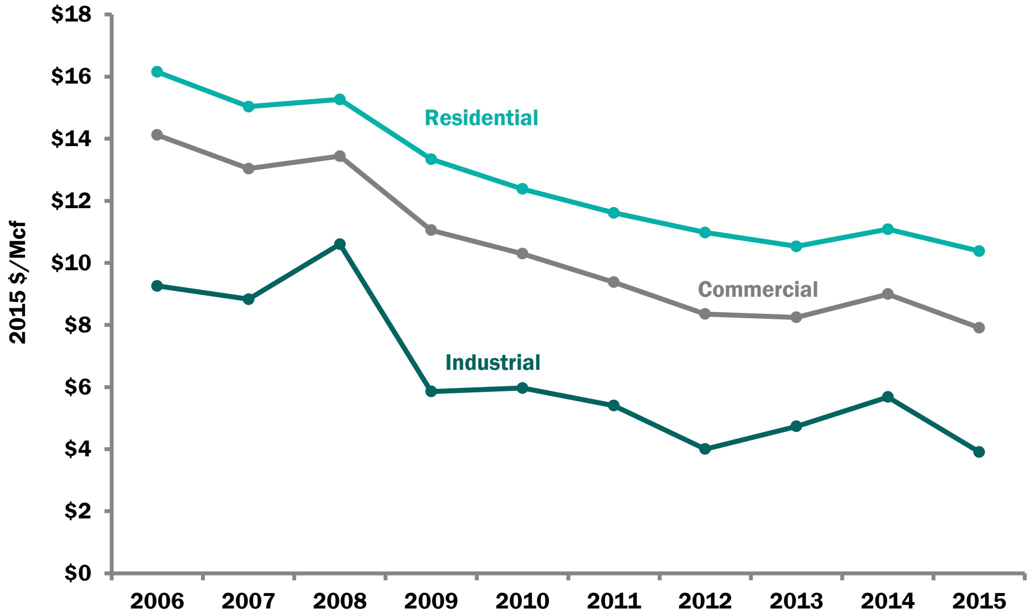


**Figure 3: Historical & Forecasted U.S. Gas Production**




*Source: EIA Annual Energy Outlook 2016*

**Figure 4 - U.S. Delivered Natural Gas Prices**




*Source: EIA Annual Energy Outlook 2016*

an expected slight decline from conventional sources.

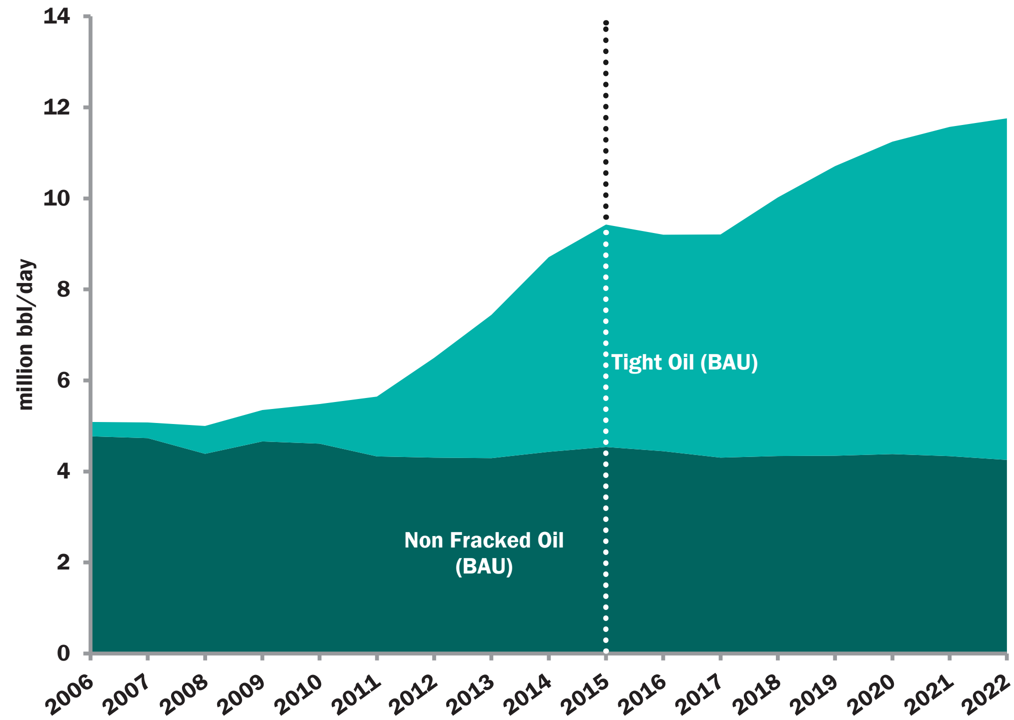
Over the past 10 years, dramatic fluctuations in the price of oil have become the norm. Prior to the recession in 2009, there were several years of strong economic growth which drove oil demand in developing nations. The huge increase in oil prices in 2008 was due in part to a drop in spare capacity among OPEC nations,[2] leaving a dearth of available production to meet growing demand. Fears of disruption to the global oil supply due to rebel activity in Nigeria as well as tensions in Iran further fueled the price increases in 2008.

The aftermath of the financial crisis slowed worldwide economic growth, and thus demand for oil. OPEC, which at one point was producing at peak capacity, reversed direction by slashing production goals in response to falling prices.[3]

Oil prices saw modest growth as the world economy climbed out of the recession. Arctic blasts in the winter of 2010-2011 created a spike in energy demand in North America and Europe. The year 2011 was marked by instability in the Middle East as political turmoil in Egypt, Libya, Yemen and Bahrain created uncertainty in oil supply.[4] The following years saw a return of oil demand with a corresponding response in production from OPEC and non-OPEC countries.

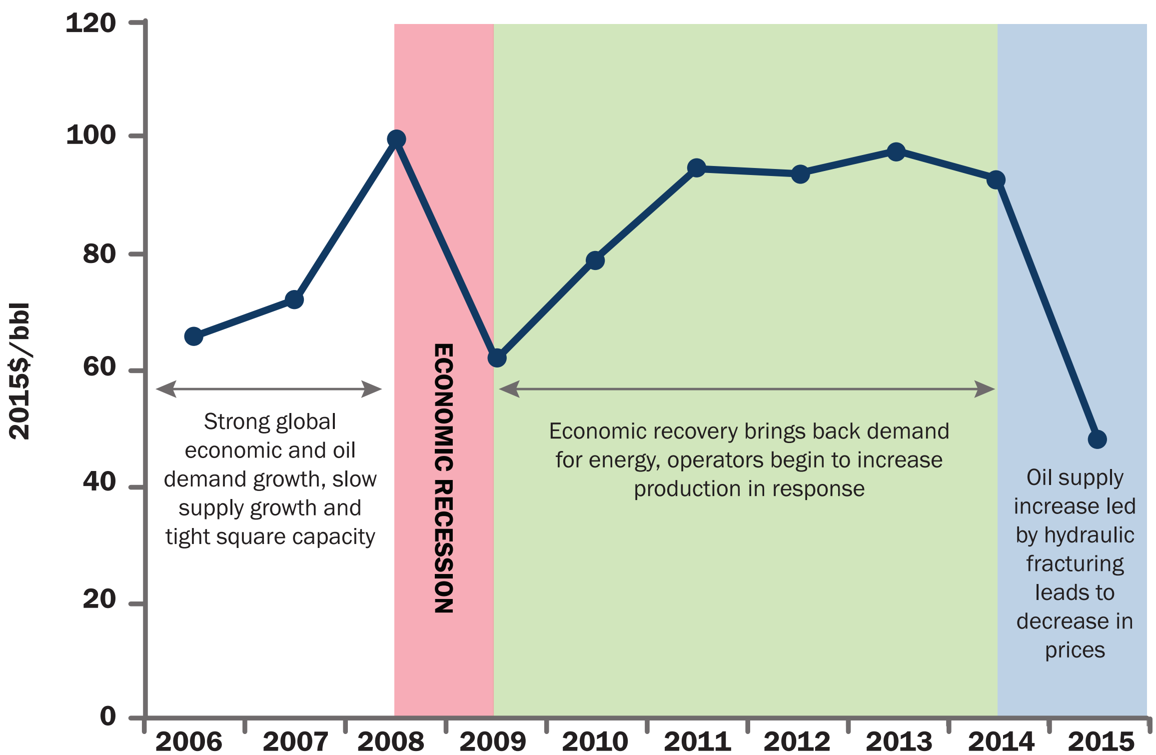
The subsequent decline in prices beginning in 2014 was pegged in large part to the emerging U.S. supply of shale oil adding to the worldwide surplus. Despite the price drop OPEC insisted that it would not cut production levels.[5] U.S. producers responded by reducing costs and increasing process efficiencies in order to remain profitable and retain market positions.[6] The wild swings in the primary U.S. oil benchmark over the past 10 years are captured in Figure 6.

## Figure 5: Historical & Forecasted U.S. Oil Production




*Source: EIA Annual Energy Outlook 2016*

## Figure 6: WTI Price History



## CITATIONS


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

2 http://instituteforenergyresearch.org/analysis/the-significance-of-spare-oil-capacity/

3 http://news.bbc.co.uk/2/hi/business/7786456.stm

4 http://money.cnn.com/2011/02/24/markets/oil/index.htm

5 http://uk.reuters.com/article/2014/11/27/uk-opec-meeting-idUKKCN0JB0M420141127

6 http://www.bloomberg.com/news/videos/2015-03-05/why-cheap-oil-doesn-t-stop-the-drilling

CHAPTER 2

# A FUTURE WITHOUT HYDRAULIC FRACTURING: IMPACTS ON U.S. ENERGY SECURITY

A ban on hydraulic fracturing would be economically devastating to the United States, and would negatively impact almost every sector of its economy. From upstream (oil and gas production) to downstream (industrial, commercial, and residential), a ban would touch the lives of all Americans in one way or another.

A ban would also affect consumers of natural gas, transportation fuels, and electricity, as well as those who use products that rely on these low-cost inputs to operate their businesses. Basic necessities, such as food, medicine, and housing, rely on oil and natural gas – produced by fracking – for important components or ingredients and materials, including packaging, cooling, heating, and transportation.

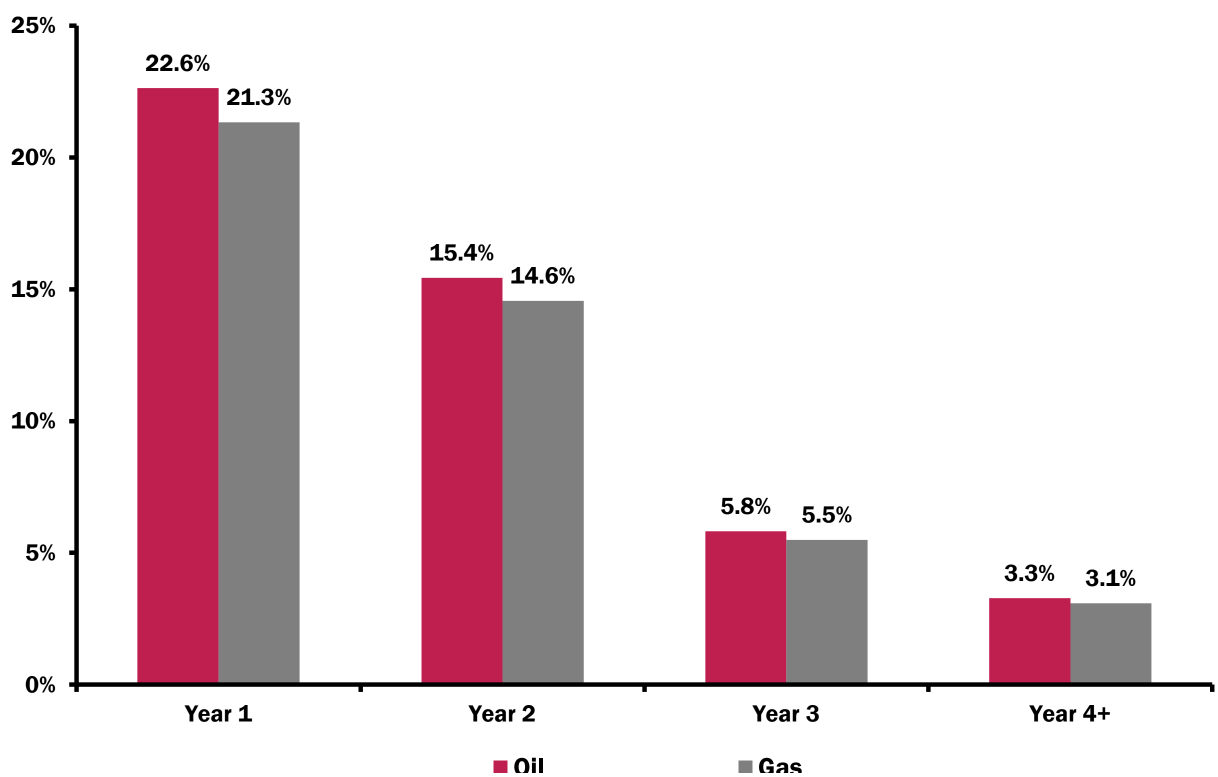
As noted earlier, in 2015, 69 percent of U.S. natural gas production and 52 percent of U.S. crude oil production came from wells that underwent fracture stimulation. Under a complete-ban scenario, the amount of oil and gas produced from these wells would naturally drop precipitously. This is due to the steep decline in production output in each subsequent year of production.

Figure 7 illustrates the typical field-level production decline rates experienced in both oil and gas-focused shale plays absent new development or the re-stimulation of existing wells (known in the industry as "re-fracs").

Using these field declines rates, and combining them with other key assumptions, the Institute developed a macroeconomic impact analysis around a future without hydraulic fracturing. This future was compared to a Business as Usual (BAU) future where fracking continues under the current set of laws and regulations. This BAU was based on the EIA's Annual Energy Outlook ("AEO") 2016 case entitled "High Oil and Gas Resource and Technology."



**Figure 7 – Typical Field Decline Rates for Oil & Gas Shale**



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As noted earlier, EIA's Reference case has historically underestimated the prospects for shale oil and gas production and its impact on energy prices, while the AEO's low price forecasts historically have been better predictors of future gas prices.

Key assumptions for the fracking ban future include the following:

### NATURAL GAS PRODUCTION, CONSUMPTION AND PRICE ASSUMPTIONS

- Conservatively assumed fracking is only applied to shale and tight oil and gas plays even though is used in other types of plays
- Applied recognized field decline rates for the Haynesville to represent what production from existing shale and tight oil and gas plays would be if no new wells were drilled. The Haynesville has experienced four years of decline with comparatively little new development activity.
- Re-adjusted future U.S. consumption of natural gas downward based on the summation of declining future production plus net pipeline imports plus net liquefied natural gas imports.
    - For net pipeline imports, assumed that natural gas exports to Mexico would drop to their historical average between 2004 and 2008 when natural gas prices were two to four times higher than today's prices.
    - Similarly, assumed that Canadian pipeline imports would rise to their historical average from 2004 to 2008.
    - Assumed that the U.S. would consume all excess LNG supply on the market such that LNG liquefaction facilities return to their historical average utilization of 82 percent.
- Used the price elasticity of natural gas demand implied in the AEO 2016 cases to determine the new Henry Hub gas price.

### U.S. CRUDE OIL PRODUCTION, CONSUMPTION, AND PRICE ASSUMPTIONS

- Conservatively assumed fracking is only applied to tight oil plays even though we know it is used in other types of plays.
- Applied the field decline rates shown in Figure 7 based on the Eagle Ford and Haynesville plays to represent what production from existing tight oil plays would be if no new wells were drilled. The Eagle Ford play has had one year of production decline with comparatively little new development activity. Production declines after the first year were based on proportional declines from the Haynesville shale gas play.
- Assumed in a world where supply is artificially limited that oil and natural gas prices would return to the tight relationship seen from 2006 to 2008, where the West Texas Intermediate ("WTI") crude oil price to Henry Hub gas price ratio averaged 11.
- Used the price elasticity of crude oil demand implied in the AEO 2016 cases to determine

the new U.S. crude oil consumption under higher prices.

## ELECTRICITY PRICES AND CONSUMPTION

*Prices*

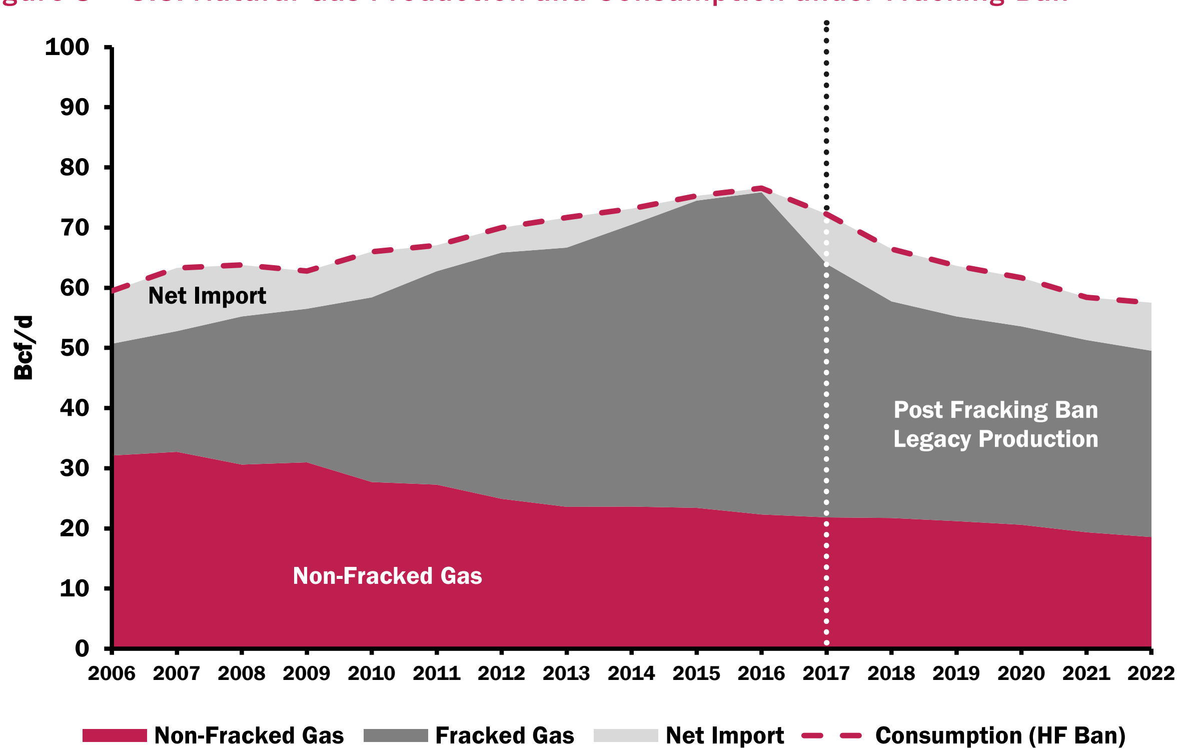
- Computed the average market heat rate (wholesale electricity price divided by Henry Hub gas price) from 2006–2015 using data from major competitive markets.
- Determined the variable fuel price component (average market heat rate multiplied by the natural gas price) of end-consumer (residential, commercial, and industrial) prices for 2006–2015.
- Calculated the fixed charge component of end-consumer prices from 2006–2015 by subtracting the variable fuel price component.
- Forecasted end-consumer prices by adding the average fixed charge component from 2010–2015 to the forecasted variable price component (projected Henry Hub price times the average market heat rate from 2010-2015).
- Consumption: used the price elasticity of electricity demand implied in the AEO 2016 cases to determine the change in electricity consumption under higher prices.

## NATURAL GAS PRICE IMPACTS

Hydraulic fracturing has made the U.S. more energy self-sufficient than could have been imagined just a decade ago. Forecasts show the United States becoming a net exporter of natural gas by 2018 and relying on minimal crude imports. If hydraulic fracturing were banned, the upshot would be an increased reliance on imported energy to meet domestic consumption, leaving the country more exposed to the whims and demands of foreign suppliers and to international price volatility.



Figure 8 – U.S. Natural Gas Production and Consumption under Fracking Ban



It is important to recognize that the price of natural gas in the U.S. was for many years closely linked to the price of crude oil, similar to how it is in other parts of the world. Because of hydraulic fracturing, however, this linkage has been severed, and natural gas prices respond more to supply and demand fundamentals of natural gas and not to crude oil. Should hydraulic fracturing be banned, it is likely that the linkage between oil and natural gas prices would be re-established.

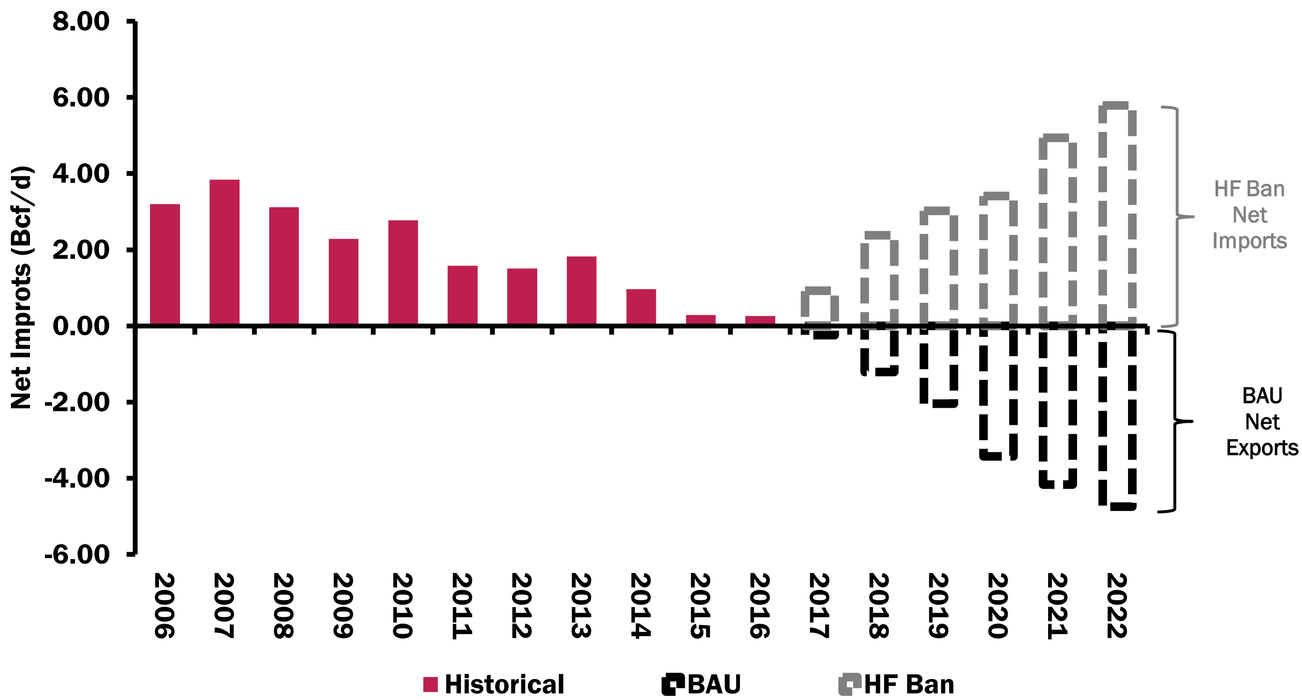
Shale gas production from existing wells has a steep decline rate (field declines rates are sizable but less dramatic due to legacy production and the asymptotic nature of shale production from individual wells), which under the scenario being analyzed will force the U.S. to import natural gas almost immediately.

Currently, shale production is about 37 Bcf/d or about half of U.S. production. With approximately a 20 to 30 percent annual shale gas field decline rates, production from existing sources would drop significantly. Similarly, natural gas production from tight gas formations would drop quickly as well since they rely on fracking to stimulate production. Figure 8 shows the combined impact of banning fracking and the resulting decline from shale and tight gas formations.

With more than 18 Bcf/d of LNG regasification capacity in the U.S. and more than 22 Bcf/d of capacity throughout North America, the United States would be forced to import additional LNG required to make up the difference between consumption and production plus net pipeline imports, as shown in Figure 9. Under this scenario, the U.S. would shift from becoming a projected natural gas exporter with complete natural gas independence to a natural gas



**Figure 9 – Projected Net Imports (Pipeline and LNG) under the BAU and No HF Scenarios**



In a future where fracking is banned, the systemic shocks to the global oil and gas markets would be immense. Oil and gas prices would be based on scarcity pricing as supply would be significantly reduced and demand would be fairly inelastic in the short-term.

To be conservative, however, the Institute developed its "no hydraulic fracturing" natural gas price forecast and consumption forecast by using the implied price elasticity of demand from the AEO cases. The result for the price forecast analysis is shown in Figure 10.

As we can see, by 2020 Henry Hub natural gas prices rise under the fracking-is-banned scenario to levels not experienced since 2008. Prices then rise further from there, to more than $12 per million Btu after 2020. These price points are similar to where international LNG prices were between 2010 and 2014 when supply was short and demand was growing rapidly.

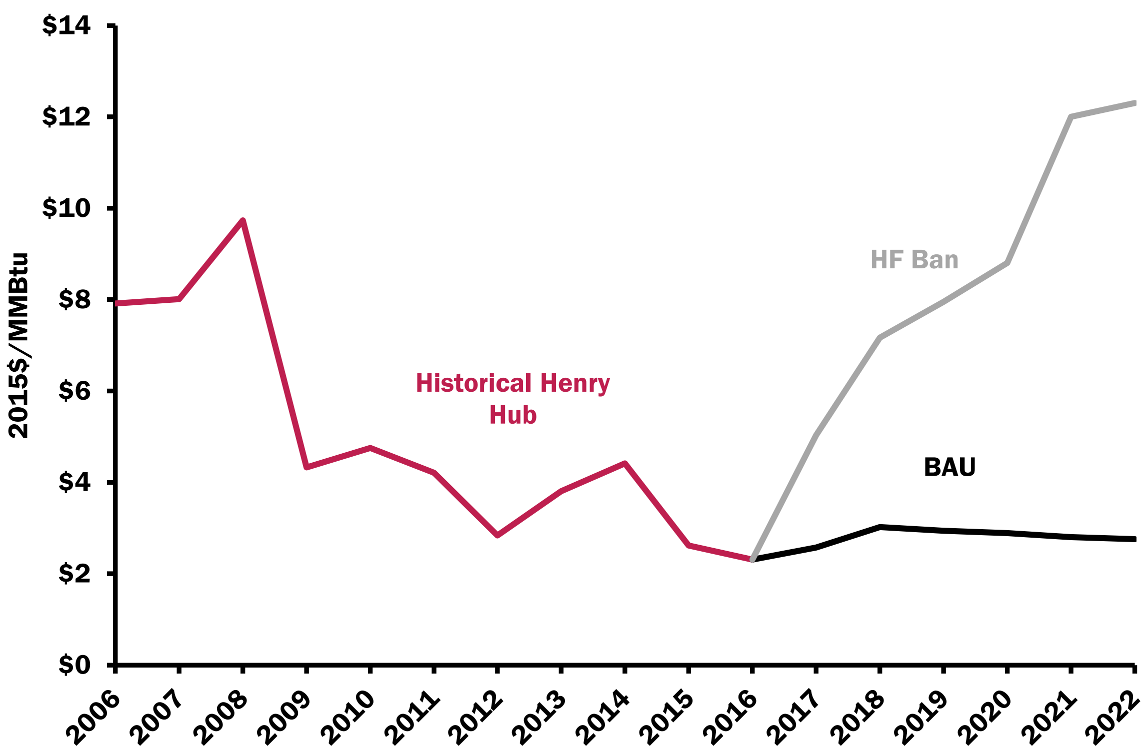
## CRUDE OIL PRICE IMPACT

The global crude market has been in an oversupply situation since 2014, when the growth in U.S. shale production became fully appreciated in and by the marketplace and when signs of global demand growth, particularly in China, became apparent. Figure 11 illustrates the global petroleum and supply demand imbalances since 2006 and indicates that the EIA expects the imbalance to collapse sometime in 2017.

Needless to say, the expected "soft landing" shown in Figure 11 for the current supply imbalance would become much less comfortable and controlled if fracking were banned. U.S. crude oil production from tight oil formations would decline by almost 23 percent, wiping out 1.1 million barrels per day (MM bbl/d) in tight oil production from 2016 to 2017.



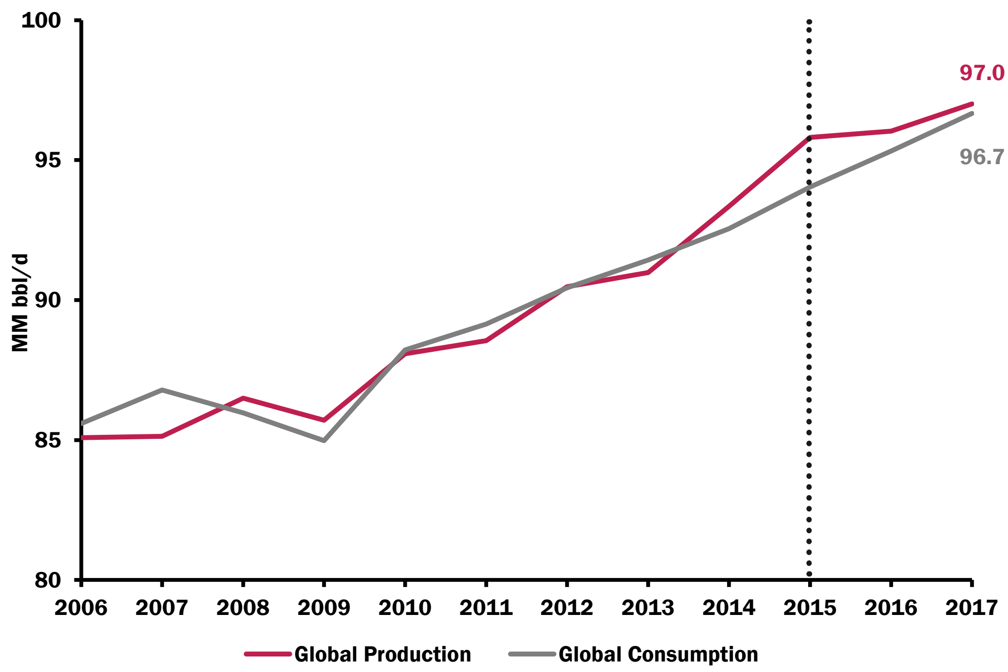
Figure 10 - Historical & Forecasted Henry Hub Natural Gas Prices



Given that the excess in global petroleum and products supply is expected to be less than 1 MM bbl/d in 2017, reducing U.S. tight oil production by 1.1 MM bbl/d plus another 0.65 MM bbl/d in declines expected would result in a total U.S. crude oil production decline of 1.75 MM bbl/d in 2017. This would create a global supply shortage, reversing current expectations for 2017.

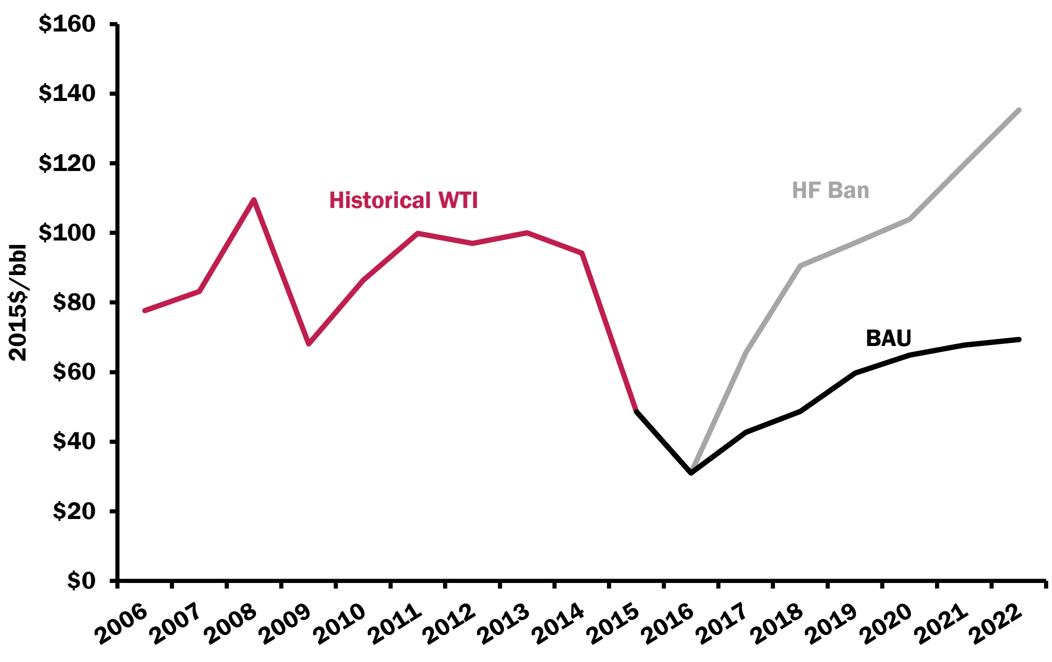
With a global supply shortage, we forecast crude prices between 2018 and 2020 to mirror prices

**Figure 11 - Global Petroleum & Liquids Supply Demand Balance**




Source: EIA Short Term Energy Outlook

**Figure 12 - Historical & Forecasted WTI Prices**



seen between 2010 and 2014 when supply generally trailed demand. After 2020, crude prices would rise to $120/bbl to reflect the historically tighter relationship seen between crude and natural gas prices (Figure 12).

Crude oil demand has shown to be inelastic, especially in the short term. Figure 13 shows the expected consumption and production under a future-ban scenario. The reduction in consumption between 2017 and 2022 is expected to average only -0.02 percent annually. The price elasticity of demand for crude oil is based on the implied relationship between AEO 2016 cases.

## ELECTRICITY PRICES

Over the past 10 years, average delivered electricity prices to all consumers – such as households, commercial entities, and industrials – have been kept in check. This is a direct result of hydraulic fracturing and the shale energy renaissance: Declining natural gas prices have been able to offset rising fixed costs that are imbedded within delivered electricity prices.

Figure 14 shows that delivered electricity prices would take a bad turn if there were a fracking ban, as natural gas prices would increase significantly. Natural gas currently fuels one-third of all electricity generation. With natural gas prices increasing by more than 400 percent by 2022, delivered electricity prices, in turn, would nearly double by 2022. Businesses would see a huge spike in operating costs and residents would see their monthly electricity budgets skyrocket.



Figure 13 – U.S. Crude Production under Fracking Ban

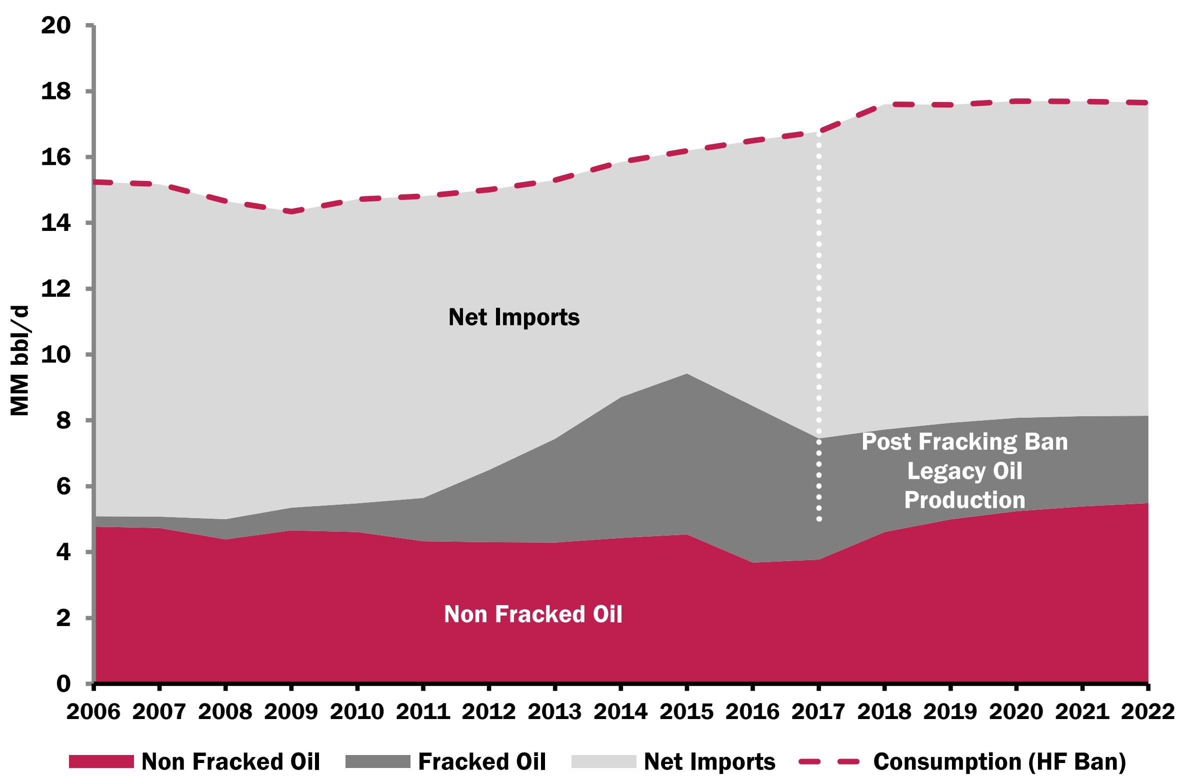
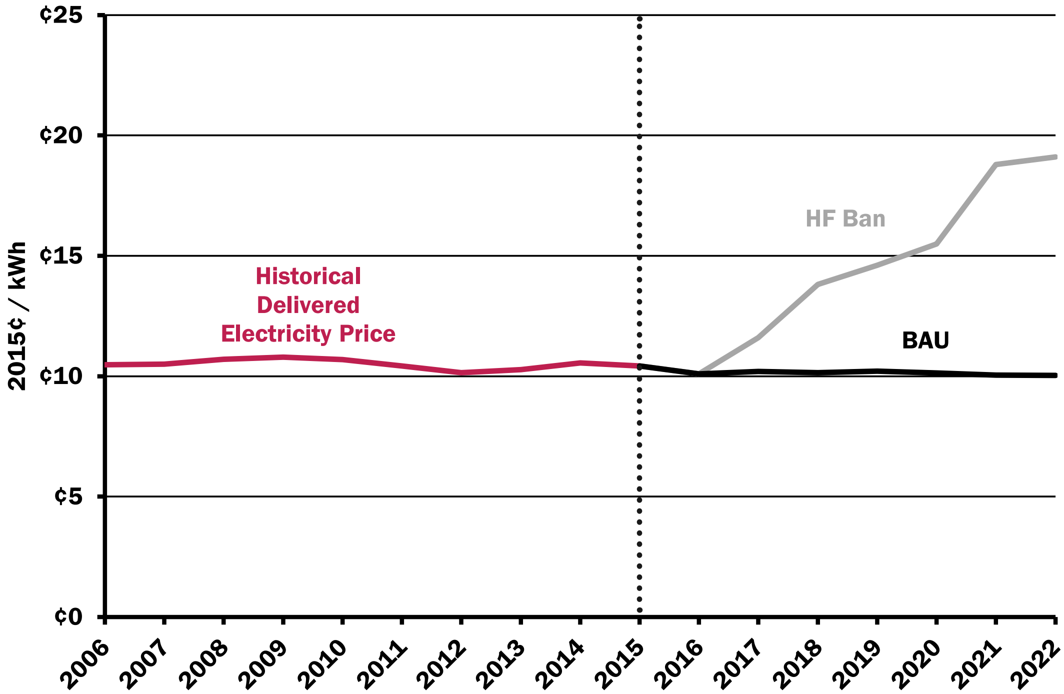


Figure 14 – Historical & Forecasted Average Delivered Electricity Prices



# CHAPTER 3

# A FUTURE WITHOUT HYDRAULIC FRACTURING: IMPACTS TO THE U.S. ECONOMY

This section describes the results of the macroeconomic "what if" scenario of banning the use of hydraulic fracturing in the United States, starting on January 1, 2017 and running through 2022. The public figures, politicians, and advocacy groups aiming to ban hydraulic fracturing might not initially consider the likely macroeconomic consequences of such a policy. This section helps quantify (for the first time ever, of which we are aware) the practical effects of those consequences.

## METHODOLOGY

For this analysis, we used the IMPLAN model, which is a well-known and widely used input-output model[1] that tracks monetary transactions within the economy between different industries, the government, and households.

For example, a change within IMPLAN to reduce the real income of households (from higher energy prices) will reduce their purchases of other items, such as prepared food, which, in turns, harms the restaurant industry, its wholesale suppliers, and the food processing and agriculture producers behind that.



The government experiences losses as well in the form of lost tax revenues associated with the labor, and lost capital income associated with a drop in economic activity along the way. These changes eventually add up to form the total changes for all industries and households, including the jobs available within the U.S. economy, the labor income, and the gross domestic product (GDP).

IMPLAN is a known as a static model, and while we modeled changes that could occur during the period of the next six years, we made a few small methodological assumptions to work around its static nature.

First, we only examined the question through 2022, rather than dealing with the obvious long-term implications a ban on hydraulic fracturing would have for the U.S. economy and energy industry throughout the late 2020s and into the 2030s. This predates an expected full implementation of the Clean Power Plan (CPP) starting in the mid-2020s, as well. By concentrating on the short-term, we also are able to discuss our impacts before any large, "structural" shifts in the production or consumption of energy in the U.S. different from the economy represented in the IMPLAN model.

For example, the mass adoption of electric cars or vast increases in renewable power generation would change the nature of the automotive and power generation sectors, and also affect their impact on the broader the economy.

Even under a scenario in which these significant structural changes were to happen, though, they would not happen quickly – certainly not with the myriad infrastructure, supply chain, regulatory, and technological challenges that would need to be addressed before any transition of this scale were to take place. Because of that, we believe that conducting our analysis within a six-year window via IMPLAN is an appropriate duration to consider before large structural shifts in the economy might occur (or might not).

## MODELING INPUTS AND ASSUMPTIONS

For the simulations conducted via IMPLAN, we included four types of changes. The numerical inputs for this section come from the price and market changes described in the previous section and elsewhere. This section describes these four, their basic functions, and the major assumptions behind their applications:

### CHANGES IN REAL LABOR INCOME

In the short-term, as energy prices rise, consumers will tend to shift more of their income into the purchase of energy commodities and away from their general consumption basket. This is because energy commodities are generally "inelastic" in the short term– where large changes in price generate only small fluctuations in demand.

We used the price elasticity of demand from the Annual Energy Outlook (AEO)[2] to determine how much income household consumers would reallocate toward higher natural gas, petroleum product, and electricity costs, and then removed that income from their general spending on other items. These commodities are inelastic in the AEO data (with consumption usually falling only a few percentage points despite the price changes in natural gas, petroleum products, and electricity reported in the previous section). This would tend to have the largest impact on consumer industries, such as real estate, retail, and entertainment, who now see more and more of their potential customers income funnel towards utility bills and prices at the pump.

### CHANGES IN ENERGY PRICES

To calculate energy price impacts, we used a similar approach to determine industry's response to higher energy prices. For the most part, they offered a similarly inelastic response where more and more income goes toward paying off energy bills, while less and less is available for investments, the purchase of inputs, or the hiring of workers.

We spread the impact of each price change across the industry sectors based on IMPLAN's internal calculations of demand for energy sectors by all other sectors. For instance, the largest consuming sector of "natural gas distribution," the utility industry for natural gas, in the U.S. IMPLAN model is petrochemical manufacturing followed by nitrogenous fertilizer manufacturing and junior colleges, colleges, universities, and professional schools.

The first two are large industries that consume natural gas at a very intense rate while the third, while not consuming natural gas as intensely as petrochemicals or fertilizer manufacturers, still requires natural gas for heating of large structures and campuses. Education is also one of the largest sectors of the U.S. economy, further increasing its importance as a consumer of natural gas. We repeated a similar process for petroleum products and electricity, though we exempted the air transportation industry from petroleum products as a separate category.

### CHANGES IN AIR TRANSPORTATION COSTS

One of the largest industrial consumers of petroleum products in the U.S. is air transportation. Thus, we created a separate category for jet fuel, based on the EIA share of jet fuel as a share of total petroleum consumption in the U.S., to have specific data on its share of consumption, rather than relying purely on the IMPLAN reckoning of the demand of air transportation for the output of the petroleum refining industry. For the remainder, we spread the impact across the other industries in the same fashion, with truck transportation, petrochemical manufacturing, local government transit, and construction being the largest consuming sectors.

### CHANGES IN ENERGY EXTRACTION JOBS

Without hydraulic fracturing available as a completions technology for industry, drilling and extraction activities would decline in the United

States. Using figures from the previous section, we estimated the number of direct jobs lost in both the drilling/exploration and in the extraction industries. We removed these from the economy in the IMPLAN model, allowing it to also remove the corresponding indirect suppliers and induced consumer spending from the economy overall as well.

## DISCUSSION AND IMPLICATIONS

The U.S. has been on a veritable roller coaster of prices and conditions in national and world energy markets over the past decade. U.S. benchmark prices once crested above $130 per barrel in 2008 before crashing to around $50, stabilized in the $80 to $100 range for five years, and then plunged again to under $35 at one point.[3]



Gasoline prices have fluctuated between $2 per gallon and $4 per gallon for the national average consumer from 2005 and the present, up from $1.50 in 2000 and under $1.00 a few years before.[4] The Henry Hub price for natural gas has seen even more volatility – from over $12 per MMBtu in 2005, 2006, and 2008 to around $3 now.[5]

All of this begs an important question: If the U.S. can survive these past shocks without major macroeconomic upsets or, at least, macroeconomic upsets related not to the energy economy but rather technology, finance, and real estate, why can't it again? The answer is that a specific policy like instituting a ban on fracking has the effect of eliminating some of the self-correcting features of the U.S. economy that spring into action to soften the blow of high prices on households..

For example: A standard news story when gasoline prices fall is the potential windfall that will be reaped by American consumers and the economy in general. That story is correct but incomplete. With the rise of petroleum and natural gas production in the U.S., low prices that once benefited mostly the general American household or businesses also harm U.S. energy development and manufacturing activities. This was always the case to some degree, but the energy renaissance has created an equivalency situation to where low prices help consumers but hurt the energy industry to the point where they actually offset. According to Christiane Baumeister and Lutz Kilian of the Brookings Institute:

*Our analysis suggests that this decline produced a stimulus of about 0.7 percentage points of real GDP growth by raising private real consumption and an additional stimulus of 0.04 percentage points reflecting a shrinking petroleum trade deficit. This stimulating effect, however, has been largely offset by a reduction in real investment by the oil sector more than twice as large as that following the 1986 oil price decline. Hence, the net stimulus since June 2014 has been effectively zero.*[6]

As energy prices fall, the consumer and industrial economies rise while the energy extraction, processing, and distribution industries suffer. Conversely, in a time of higher prices, the consumer and industrial economy may suffer while investments in oil and gas exploration, extraction, and distribution increase, cushioning or even negating the macroeconomic shock felt by the other side of the ledger.

This unique position of the U.S. as both a large consumer and producer of energy resources provides built-in stability against macroeconomic shocks caused by the energy industry, which means the business cycle generally turns on other factors.

There is not an even distribution of costs and benefits among U.S. states, as energy-consuming regions of the U.S., such as the Northeast Corridor, the Great Lakes states, much of the Southeast, and the major cities on the West Coast are likely to benefit from lower energy prices.[7] Appalachia, the Southwest, the Mountain West, and Alaska are more likely to benefit from higher ones, on the other hand,[8] even if the net effect at the national level is close to zero. These distributional issues are also true between different industry sectors.[9]

Removing hydraulic fracturing from the equation would greatly shrink the size of the U.S. energy industry and reduce its ability to cushion the economy against large swings in energy prices. In essence, a prohibition against fracking would be the worst of both worlds – with energy supply constrained, prices would rise, greatly burdening U.S. households and industry with higher prices, as well.

Under normal circumstances, absent this policy, much of this downturn would alleviate itself as energy producers increase their investments and activities, keeping the capital and labor in the U.S. utilized and helping to prevent the economy from slipping into a recession.

Without fracking, on the other hand, the energy industry would be unable to do that, creating a macroeconomic "double whammy" of high prices with a greatly diminished energy sector. These concurrent changes, both negative, instead of always one positive and one negative in an equal but opposite manner, could easily tip the U.S. economy out of its recovery since the Great Recession. That would undo much of the growth since the crisis or even cause a serious recession on par with the eight million jobs lost from 2007 to 2009.

Furthermore, without hydraulic fracturing available for use, the U.S. economy would be forced to become a large net importer of fossil energy once again. This would send trillions of dollars in value to oil exporting nations, either directly or by increasing the world price of petroleum to the advantage of producing nations and exporters. The largest oil exporters in the world include Saudi Arabia, Kuwait, Iran, Iraq, Nigeria, the United Arab Emirates, Angola, and Venezuela,[10] a list featuring many regimes openly hostile to the United States and its interests.

Banning fracking would shift this value away from American producers and their employees and to those controlling the oil revenues for these regimes. It would also likely only have limited impacts on world GHG emissions, as the extraction still takes place overseas and the consumption of the imported fuel much the same as before.



Additionally, if the U.S. were a large net importer of crude petroleum again, its macroeconomic situation would become much more vulnerable to price fluctuations in world markets, as what happened in the 1970s and the 1980s during the oil shocks when the U.S. economy last had its cycles turn directly on energy prices.

## MODELING RESULTS

### UPSTREAM IMPACTS

To better understand the influence that a ban on hydraulic fracturing would have on the economy, we first estimated the number of jobs that would be lost in the upstream oil and gas industry over a six-year period, focusing both on our four target states (Ohio, Pennsylvania, Colorado and Texas) and the U.S. economy writ large.

As shown in Table 1, although the hemorrhaging of jobs would begin relatively slowly in 2017, the pace of losses picks up considerably as we approach 2020 and beyond, culminating in more than a half million jobs lost just in the upstream oil and gas sector by 2022.

## MACROECONOMIC IMPACTS

Although a ban on hydraulic fracturing would be devastating to oil and natural gas workers, the harm this policy could inflict on the larger U.S. economy – even in states where no discernable fracturing activity takes place at all – is actually much greater.

Restricted access to oil and natural gas would mean higher energy costs for American families, who would have less disposable income to spend – which in turn inflicts harm on local businesses. Higher energy costs for businesses means not only fewer jobs created, but also fewer resources to support existing employees. Service industries and suppliers would also contract, causing even more jobs to be lost.

Table 2 captures and quantifies the jobs our modeling indicates would be lost under a ban-fracking scenario. Adding up the higher energy costs that residential consumers and businesses are likely to experience under such a circumstance, and including in this analysis the jobs that will be destroyed in the upstream energy sector, our analysis indicates that more than 14.7 million American jobs in total would be lost by 2022.

Of course, any time an implemented policy has the effect of wiping out significant numbers of existing jobs, it also tends to have a measurable impact on GDP. In the case of instituting a nationwide ban on hydraulic fracturing



**Table 1: U.S. Oil and Natural Gas Sector Jobs Lost (thousands)**

| Region | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| **U.S.** | **-170** | **-277** | **-346** | **-410** | **-466** | **-509** |
| Ohio | -5 | -8 | -10 | -11 | -13 | -14 |
| Pennsylvania | -4 | -7 | -9 | -10 | -12 | -13 |
| Colorado | -7 | -12 | -15 | -18 | -20 | -22 |
| Texas | -64 | -104 | -130 | -154 | -175 | -191 |
| Other states | -90 | -146 | -182 | -216 | -246 | -268 |

**Table 2: U.S. Jobs Lost From Hydraulic Fracturing Ban (thousands)**

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -1,138 | -2,060 | -2,091 | -2,328 | -3,617 | -4,094 |
| Higher business energy costs | -2,111 | -3,791 | -4,159 | -4,804 | -7,945 | -8,750 |
| Upstream production losses | -637 | -1,036 | -1,295 | -1,536 | -1,744 | -1,905 |
| **Total U.S. employment** | **-3,886** | **-6,887** | **-7,545** | **-8,668** | **-13,305** | **-14,749** |

### Table 3: U.S. GDP Lost From Hydraulic Fracturing Ban (2016 $billions)

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -$102 | -$186 | -$188 | -$210 | -$326 | -$369 |
| Higher business energy costs | -$218 | -$392 | -$426 | -$489 | -$799 | -$884 |
| Upstream production losses | -$122 | -$199 | -$249 | -$295 | -$335 | -$366 |
| **Total U.S. GDP** | **-$442** | **-$777** | **-$863** | **-$994** | **-$1,459** | **-$1,619** |

### Table 4: U.S. Household Income Lost From Hydraulic Fracturing Ban (2016 $billions)

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -$58 | -$105 | -$107 | -$119 | -$185 | -$209 |
| Higher business energy costs | -$120 | -$217 | -$236 | -$271 | -$442 | -$490 |
| Upstream production losses | -$58 | -$95 | -$118 | -$140 | -$159 | -$174 |
| **Total U.S. household income** | **-$237** | **-$417** | **-$461** | **-$530** | **-$787** | **-$873** |

technology, the impacts to economy-wide activity and growth would be immense.

As Table 3 shows below, our modeling indicates that the cumulative hit to U.S. GDP over the next six years could actually get into the trillions (more than $1.6 trillion, to be precise) when adding together both the economic penalties of higher residential and industrial energy prices and the direct hit that such a ban would have on the oil and gas industry.

When consumers and businesses are forced to spend more of their income to pay for energy, they naturally have less income available to spend in other sectors of the economy. This relationship is well understood. But as Table 4 shows, the volume of household income that has the potential to be displaced under a ban-fracking scenario is enormous, and might come as a surprise to those who reside in states where no or little shale development activity even takes place.

As our analysis shows, though, irrespective of where you happen to live, the higher energy prices generated by a lessening and then outright cessation of shale development under a ban-fracking scenario translate into the evaporation of literally hundreds of billions of dollars per year of household income for everyday American families.

The significant decrease in income that U.S. households would experience if hydraulic fracturing were banned is compounded by the higher cost-of-living expenses with which these consumers would have to deal, a function of the higher energy prices and rise in the cost of goods and services that correspond with a scenario in which inexpensive and reliable forms of energy are rendered less so in the future, thanks to a fracking ban.

As outlined in Table 5, residential consumers in the United States would be forced to pay nearly $4,000 per year, per person, over and above what they pay right now, just to be able to afford

## Table 5: Cost-of-Living Changes for Residential Consumers

| Region | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| **U.S.** | **$1,088** | **$1,969** | **$1,999** | **$2,226** | **$3,458** | **$3,914** |
| Ohio | $1,101 | $1,977 | $2,034 | $2,276 | $3,525 | $3,956 |
| Pennsylvania | $979 | $1,763 | $1,808 | $2,021 | $3,145 | $3,537 |
| Colorado | $991 | $1,790 | $1,819 | $2,023 | $3,080 | $3,486 |
| Texas | $1,279 | $2,328 | $2,344 | $2,604 | $4,072 | $4,632 |

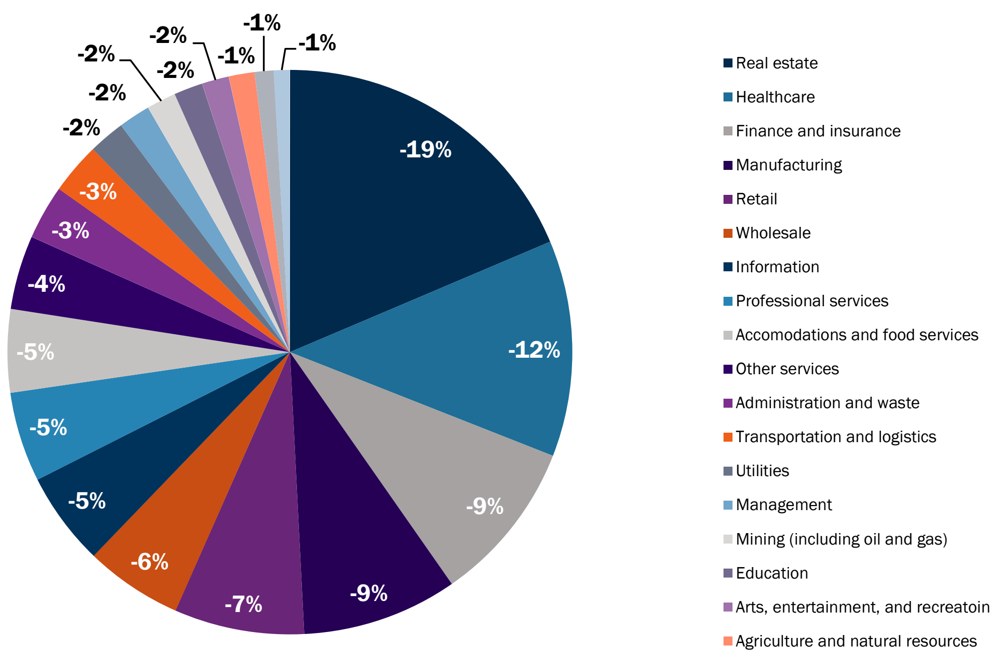
the volume and type of goods and services they consume right now.

As part of our analysis, we also took a closer look at which specific sectors of the broader U.S. economy stood to be impacted most severely by the implementation of a nationwide ban on fracturing technology. Figure 15 depicts the sectors placed under the greatest stress owing to the changes in residential energy costs engendered by a fracking ban, with real estate, finance and manufacturing accounting for nearly 50 percent of the total GDP impact across the entire economy.

As one might expect, the significant changes that would occur to natural gas commodity pricing under a scenario in which the primary technology used to produce that commodity in the United States is banned would be felt most severely by those who rely on that commodity the most. In this case, it's the U.S. manufacturing sector that would be projected to take the biggest hit owing to those higher natural gas prices; more than a quarter of the entire U.S. economy-wide impact would be born just by that sector, as shown in Figure 16.



## Figure 15: GDP Impacts to Top Sectors From Residential Energy Cost Changes



The manufacturing sector also suffers disproportionately from a cost-increase in the petroleum products brought on by a hydraulic fracturing ban, but in Figure 17 we see those impacts spread out a bit more evenly among the construction and mining sectors as well relative to where they were for natural gas, mostly a function of those sectors' heavy reliance on and large cost outlay for transportation fuels for their equipment.

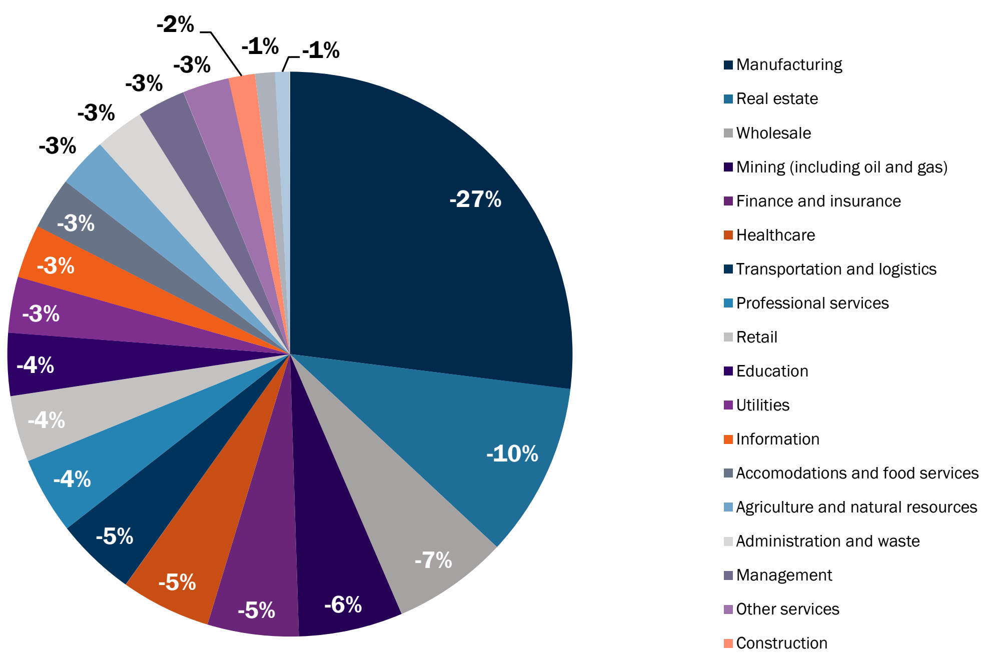
Figure 18 highlights the impacts associated with a scenario in which electricity prices were to increase significantly, which is precisely the outcome identified under our modeling. Here, we see for the first time the emergence of the retail and wholesale sectors of the economy as ones that happen to be particularly exposed to swings in electricity costs, at least relative to increases in price among other forms of energy.

As one would expect, the sector that stands to be hardest hit by a cessation of oil and gas development activities necessitated by a fracking ban is the mining sector, which includes the oil and gas industry.

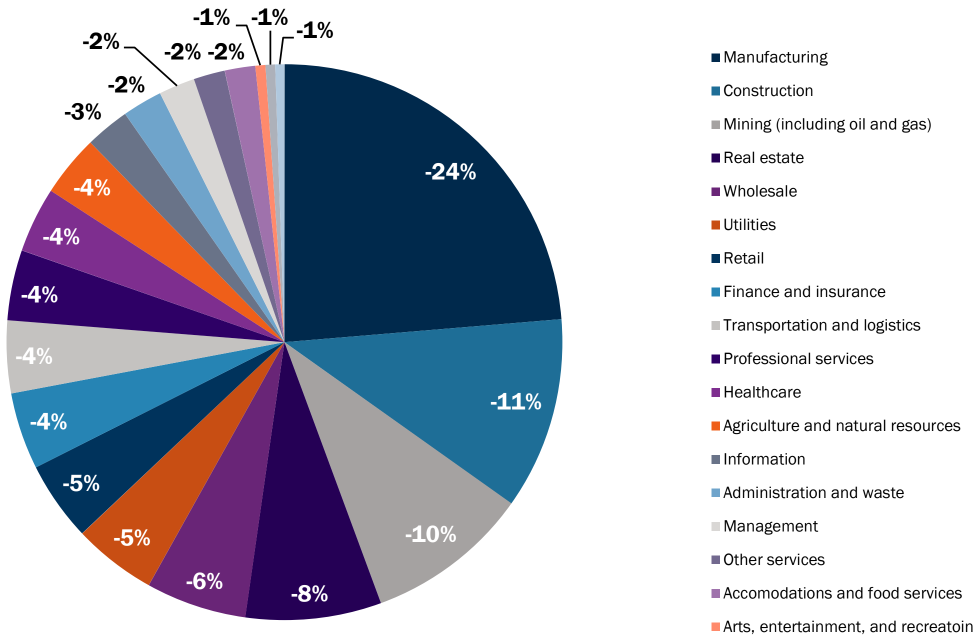
But as Figure 19 shows, 17 other economic sectors – few of which having anything to do, at least directly, with oil and gas development – would also experience hardship as part of this category. And those burdens come in addition to all the other impacts they would likely experience from higher energy prices and lower household income.



**Figure 16: GDP Impacts to Top Sectors From Natural Gas Cost Changes**

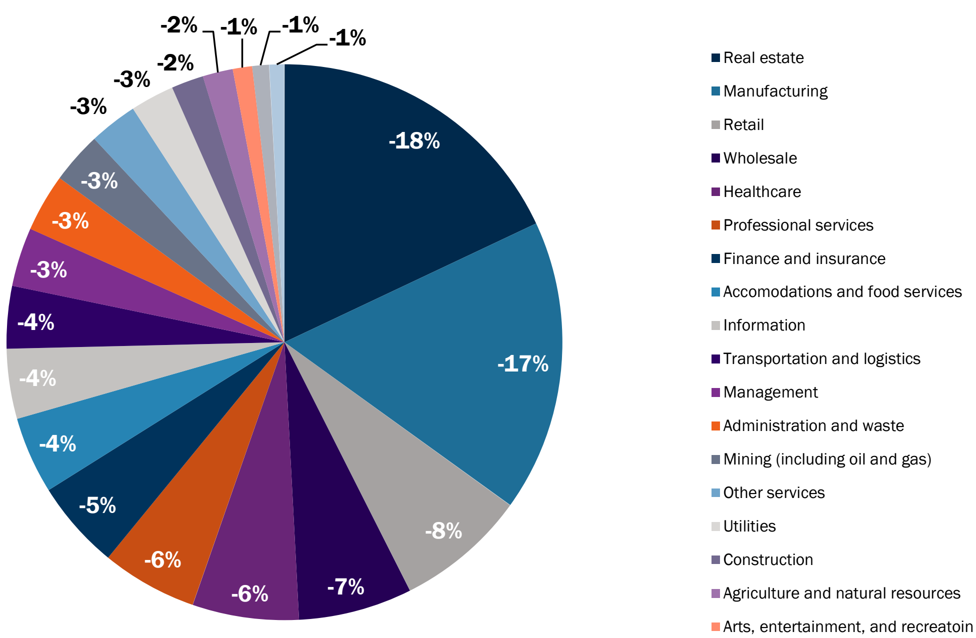


## Figure 17: GDP Impacts to Top Sectors From Petroleum Product Cost Changes

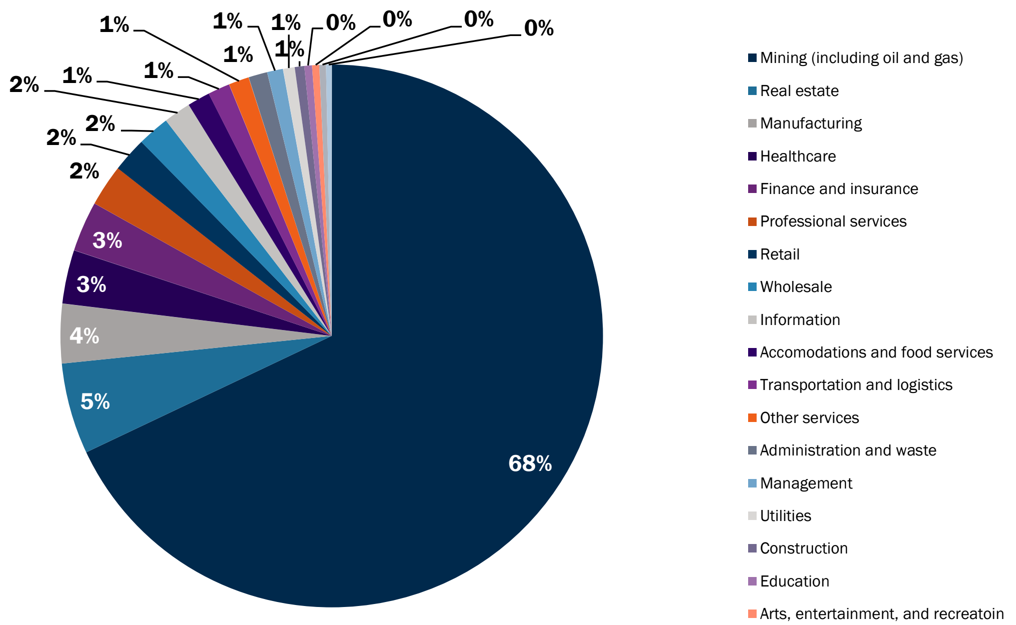





## Figure 18: GDP Impacts to Top Sectors From Electricity Cost Changes



### Figure 19: GDP Impacts to Top Sectors From Oil and Natural Gas Extraction Losses



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# CHAPTER 5

# STATE-LEVEL IMPACTS (OH, PA, CO, TX)

According to EPA, hydraulic fracturing technology was utilized in “at least” 25 separate U.S. states between 1990 and 2013.[1] But as we have seen over the past several years, not all states are created equal when it comes to the opportunity and prospectivity that are available within their borders with respect to hydrocarbon development.

As part of our analysis, we wanted to get a better sense of what the practical implications of a nationwide ban on hydraulic fracturing would be for the states that in recent years saw the greatest volume of activity associated with the development of oil and natural gas from shale.

The four states we chose to study – Colorado, Ohio, Pennsylvania and Texas – all rank within the top six U.S. states in terms of either oil or natural gas production (or, in Texas’s case, both).[2] The exception is Ohio, which is a top-10 natural gas producing state today but which has seen a significant uptick in production in recent years owing to the opportunities made available by the Utica and Point Pleasant shale formations primarily in the eastern portion of the state. Several credible projections suggest that Ohio could become a top-five energy producing state within the next five years, largely on the basis of increased contributions from the Utica.

But those projections will not be realized under a scenario in which well completion technologies such hydraulic fracturing are restricted or banned. And much more significantly, millions of jobs that would otherwise exist in the future based on the trajectory we’re currently would also be destroyed.

Among the four states we studied, we found that more than 2.6 million jobs would be lost by 2022 if hydraulic fracturing were banned starting next year. More than 1.6 million of those jobs would be lost in the state of Texas, the nation’s leading oil and gas producer. But Pennsylvania would also be projected to lose a half million jobs; Ohio another 371,000 jobs, and 210,000 jobs would leave the employment rolls in Colorado. State GDP would also decline precipitously in each state we studied, with Texas’s state GDP dropping by more than $200 billion; Pennsylvania’s by nearly $50 billion; Ohio’s by more than $30 billion; and Colorado’s by $25 billion.

Those are all big numbers, of course, but the impacts of a nationwide fracking ban on these states become especially pronounced when analyzed on the per-household and per-capital levels. Our analysis finds that household incomes would decrease in these states by literally billions of dollars per year, leading to a situation in which every man, woman and child experiences a significant drop in annual income relative to what they would have otherwise had available, combined with a cost-of-living increase ranging from $3,500 to $4,600 per household for the states we studied. Table 6 summarizes these and other impacts.



**Table 6: State-Level Impact Summary (2022)**

| Type of Economic Shock | Colorado | Ohio | Pennsylvania | Texas |
|---|---|---|---|---|
| Employment (thousands) | -215 | -397 | -466 | -1,499 |
| State GDP (2016 $billions) | -$26 | -$33 | -$45 | -$196 |
| Household income (2016 $billions) | -$14 | -$21 | -$27 | -$101 |
| Income loss per capita (2016 $) | -$1,400 | -$1,600 | -$1,400 | -$1,600 |
| Cost-of-living increase per household (2016 $) | $3,500 | $4,000 | $3,500 | $4,600 |

In addition to modeling the direct economic impacts associated with the imposition of a nationwide hydraulic fracturing ban, our analysis also 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.[3]

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 would be at risk of idling, moving or shutting down entirely under a scenario in which they were forced to endure higher input prices caused by a drop in available energy supply.

While we cannot say with certainty that all of these jobs, all of this GDP and all of this household income would be lost as a direct result of a fracking ban (which is precisely what is being said in Figure 17, for instance), we can say that these jobs, revenues and income streams would be placed under significant stress, and in combination with other factors, could easily be lost under the scenario being highlighted in this report.

Table 7 summarizes our findings with respect to economic outputs placed "at risk" of being lost under a ban-fracking scenario.

Ohio is a major manufacturing state, with that sector alone responsible for 17 percent of Ohio's GDP, more than 660,000 jobs, and $36 billion in labor income.[4] Ohio generated $608 billion in GDP in 2015[5], had 5.4 million people employed and had an unemployment rate of 4.9 percent, lower than the national average of 5.3 percent.[6]



**Table 7: State-Level Economic Value At-Risk**

| Type of Economic Shock | Colorado | Ohio | Pennsylvania | Texas |
|---|---|---|---|---|
| Employment (thousands) | 109 | 289 | 278 | 735 |
| State GDP (2016 $ billions) | $28 | $71 | $61 | $189 |
| Household income (2016 $ billions) | $7 | $16 | $18 | $46 |
| Income loss per capita (2016 $) | $1,300 | $1,400 | $1,400 | $1,700 |

# Ohio

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.[7] But the entire economy has received a boost from lower energy prices as a result of the energy renaissance taking place in both Ohio and nationally.

Of the 25.6 million barrels of oil produced in Ohio in 2015, 86 percent came from horizontal wells. Of the 1,007 billion cubic feet of natural gas produced in 2015, nearly 95 percent was attributable to horizontal wells. Compared to a decade ago Ohio is enjoying more than five times the production in oil and 12.75 times the production in natural gas almost entirely due to hydraulically fractured wells.[8] The Utica formation is considered a "liquids" play in that it holds large amounts of crude oil as well as wet natural gas, which can be processed to extract ethane, propane and other petrochemicals.[9]

The shale renaissance has already delivered plenty of jobs, revenue and opportunity to Ohio residents. But because unconventional development began in earnest in the state several years after similar activities commenced in Pennsylvania (and Texas), producers in Ohio had a much smaller window within which to operate before the 2014 commodity price drop forced many producers to institute a pause in activity.

In that way, Ohio is a special case: a state that has already benefited from the shale renaissance and the utilization of hydraulic fracturing, but one whose potential to benefit even more in the future is arguably greater than any other state outside of Texas. A big reason for this is due to rich liquid play, which provides the feedstock to power a manufacturing rebirth.

Our analysis helps quantify the size and scale of some of the impacts that Ohio residents would endure if hydraulic fracturing were banned. Table 8 summarizes the volume of jobs that would be lost as a result of this policy, accounting both for the jobs that would be destroyed as a result of higher energy costs, as well as those associated with the decline of the upstream oil and gas industry in the state. All told, we find that nearly 400,000 jobs would be lost in Ohio by 2022.

A ban on hydraulic fracturing would result in Ohio losing 400,000 jobs, with union jobs comprising a significant portion of this total. Recognizing the significance of this industry to the state economy, leading Republicans, Democrats, union officials, and business leaders have come together to support continued development, pushing away attempts to impose policies via referenda that seek to restrict the use of hydraulic fracturing.

**Table 8: Ohio Jobs Lost From Hydraulic Fracturing Ban (thousands)**

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Due to higher residential energy costs | -29 | -51 | -54 | -61 | -97 | -107 |
| Due to higher business energy costs | -54 | -95 | -109 | -129 | -221 | -238 |
| Upstream production losses | -17 | -28 | -35 | -42 | -47 | -52 |
| **Total Ohio employment** | **-100** | **-174** | **-199** | **-232** | **-365** | **-397** |

To date, 83 percent of local ballot measures seeking to restrict fracturing technology have been rejected by voters or ruled invalid by courts.[10] As U.S. Rep. Tim Ryan (D) recently said, speaking of Utica Shale development, "these are opportunities for all those steel workers and auto workers who lost jobs over generations to have the opportunity to figure out how to go to work. We don't get these opportunities very often."[11]

If there was a ban on hydraulic fracturing jobs like the ones discussed here would cease to exist and significant impacts to the state's GDP output will be inevitable. Our modeling indicates that $33 billion in state GDP in Ohio would be lost, with the majority of those losses attributed to the higher costs for energy that Ohio businesses would be forced to pay. Table 9 summaries the impacts that would be felt starting next year, and going on through 2022.

All of these losses in state GDP translate into lost income for Ohio households, with residents losing more of their hard-earned money as each year passes with the national hydraulic fracturing ban in place. If such a ban were implemented next year, our analysis finds that Ohio households would experience a **$6 billion reduction** in income in that calendar year. But as Table 10 shows, that household income hit increases by a staggering 250 percent (to $21 billion per year) by 2022, mostly driven by higher input and energy costs for businesses and consumers.



**Table 9: Ohio GDP Lost From Hydraulic Fracturing Ban (2016 $billions)**

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Due to higher residential energy costs | -$2 | -$4 | -$4 | -$5 | -$8 | -$8 |
| Due to higher business energy costs | -$5 | -$8 | -$9 | -$11 | -$19 | -$20 |
| Upstream production losses | -$1 | -$2 | -$3 | -$3 | -$4 | -$4 |
| **Total Ohio GDP** | **-$8** | **-$15** | **-$17** | **-$19** | **-$30** | **-$33** |

**Table 10: Ohio Household Income Lost From Hydraulic Fracturing Ban (2016 $billions)**

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Due to higher residential energy costs | -$1 | -$2 | -$2 | -$3 | -$4 | -$5 |
| Due to higher business energy costs | -$3 | -$5 | -$5 | -$6 | -$11 | -$12 |
| Upstream production losses | -$2 | -$2 | -$3 | -$4 | -$4 | -$5 |
| **Total Ohio household income** | **-$6** | **-$10** | **-$11** | **-$13** | **-$19** | **-$21** |

# Pennsylvania

In 2015, Pennsylvania generated $689 billion in GDP[12], had nearly 6.1 million people in the workforce[13] and had an unemployment rate of 5.1 percent, which is below the national average of 5.3 percent.[14] Pennsylvania is among the leading natural gas producing states in the country.[15]

Pennsylvania households have seen an increase in disposable income due to the lower energy bills that have been made possible by the energy renaissance. State GDP has increased by $5.8 billion and 69,400 people have found jobs as a result of increased consumer spending over the past five years.

Pennsylvania's natural gas production was more than eight times larger in 2015 than in 2010 because of development of the Marcellus. Gross natural gas production exceeded 4.7 trillion cubic feet in 2015 and made the state the second largest natural gas producer in the nation, after Texas. Pennsylvania is also second only to Texas in estimates of proved natural gas reserves, which quadrupled from 2010 to 2014.[16]

The Marcellus (especially in southwestern Pennsylvania) is also rich in natural gas liquids (NGLs), including ethane, propane and butane. Pennsylvania has seen a five-fold increase in natural gas processing from 2010 to 2014[17] with additional processing and fractionation plants as well as pipeline infrastructure being built to support continued NGLs development, marketing and end-use.[18]

The commonwealth's positive economic progress, driven in large part increased hydrocarbon production and the broad-based associated benefits, cannot continue under a scenario in which fracturing technology is banned.

Our analysis finds that such a scenario would have the effect of displacing hundreds of thousands of jobs – impacts that would occur



### Table 11: Pennsylvania Jobs Lost From Hydraulic Fracturing Ban (thousands)

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -59 | -111 | -106 | -115 | -166 | -197 |
| Higher business energy costs | -53 | -95 | -107 | -124 | -208 | -227 |
| Upstream production losses | -14 | -23 | -29 | -34 | -39 | -42 |
| **Total Pennsylvania employment** | **-127** | **-229** | **-242** | **-273** | **-413** | **-466** |

### Table 12: Pennsylvania GDP Lost From Hydraulic Fracturing Ban (2016 $billions)

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -$5 | -$9 | -$9 | -$10 | -$14 | -$17 |
| Higher business energy costs | -$5 | -$9 | -$10 | -$12 | -$19 | -$21 |
| Upstream production losses | -$3 | -$4 | -$5 | -$6 | -$7 | -$8 |
| **Total Pennsylvania GDP** | **-$13** | **-$22** | **-$24** | **-$27** | **-$40** | **-$45** |

almost immediately, and only compound from there. Table 11 summarizes these severe impacts, which culminate in 2022 with the loss of nearly half a million jobs that would otherwise exist absent a ban on fracturing.

Higher energy costs begotten by a reduction in available energy supply – itself, a natural consequence of a national hydraulic fracturing ban – not only cost the Pennsylvania economy jobs, but they also take a significant bite out of the state's GDP figures. As Table 12 shows, the commonwealth would be projected to lose **$45 billion in state economic output** in 2022 if unconventionals development comes to an end as a result of a national fracking ban.

Similar to the situation we saw in Ohio – but more severe – is the blanket ban's impact on household income, driven primarily by the additional energy costs with which consumers and businesses will be saddled. As shown in Table 13, we project that households in Pennsylvania will experience a collective **loss in income of $27 billion** by 2022, with more than $23 billion of that total attributable to the higher energy bills they will be forced to pay.

**Table 13: Pennsylvania Household Income Lost From Hydraulic Fracturing Ban (2016 $billions)**

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -$3 | -$6 | -$5 | -$6 | -$8 | -$10 |
| Higher business energy costs | -$3 | -$5 | -$6 | -$7 | -$12 | -$13 |
| Upstream production losses | -$1 | -$2 | -$3 | -$3 | -$4 | -$4 |
| **Total Pennsylvania household income** | **-$7** | **-$13** | **-$14** | **-$16** | **-$24** | **-$27** |

# Colorado

Colorado is one of the top energy-producing states in the country, ranking sixth in natural gas and seventh in oil.[19] Oil and gas production has been a mainstay of the state's economy for decades, supporting overall growth and the economy's diversification into other sectors. In 2015, Colorado generated $315 billion in GDP[20], had 2.7 million people in the workforce[21] and an unemployment rate of 3.9 percent, which is well below the national average of 5.3 percent.[22]

Colorado is home to a number of prolific shale basins, including the Niobrara, with resource estimates running as high as two billion barrels of oil. [23] From 2004 to 2014, crude oil production in Colorado more than quadrupled; in the same period, marketed natural gas production rose 51 percent. With oil production from the Niobrara Shale increasing at a steady pace, more pipelines are being built or repurposed to move Colorado crude to refineries out of state, [24] since demand for refined petroleum products in Colorado exceeds refining capacity.[25]

Among all the states we analyzed, Colorado has been under the most significant pressure over the past several years to restrict or outright block the application of fracturing technology. Several cities along the state's Front Range were targeted by environmental groups and passed a series of real and de facto bans bans on oil and gas development. Colorado courts later determined these bans to be unlawful. In a related development, the same environmental groups have twice attempted – in 2014 and 2016 – to put anti-oil and gas measures on the statewide ballot.

These measures have failed so far because they would effectively drive oil and gas development, a vital economic sector in Colorado, out of the state.[26] However, the groups behind these measures continue to campaign for a nationwide ban on hydraulic fracturing. [27]

Based on our analysis, we find that hundreds of thousands of jobs would be displaced under a scenario in which a nationwide ban was imposed. Table 14 summarizes these findings, which project a total **job loss figure for Colorado of 215,000.**

Similar to what we've seen in other states, the upward pressure on energy prices spurred on by the imposition of a fracking ban manifests itself in the form of lower economic output across all major economic sectors in the state. In the case of Colorado, our modeling, outlined in Table 15, finds that banning hydraulic fracturing would deprive Colorado's economy of **$26 billion in state GDP** by 2022, with half of that total coming directly from the upstream oil and gas segment itself.

**Table 14: Colorado Jobs Lost From Hydraulic Fracturing Ban (thousands)**

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -11 | -19 | -20 | -22 | -34 | -38 |
| Higher business energy costs | -23 | -41 | -47 | -54 | -91 | -99 |
| Upstream production losses | -26 | -42 | -53 | -63 | -71 | -78 |
| **Total Colorado employment** | **-60** | **-103** | **-119** | **-139** | **-196** | **-215** |

As we continue to see, all of these major macroeconomic trends that run in the wrong direction under a ban-fracking scenario end up translating into significant cost increases for everyday families, which themselves contribute to lower household incomes.

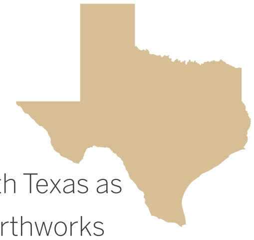
Adding together the higher costs that residential consumers and businesses will have to pay under this set of circumstances, along with the direct income hit that comes when folks in the upstream sector lose their jobs, our analysis finds that Colorado household income would **decline by $14 billion** in 2022 – $14 billion that Colorado families would otherwise be able to spend and save (Table 16).

### Table 15: Colorado GDP Lost From Hydraulic Fracturing Ban (2016 $billions)

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -$1 | -$2 | -$2 | -$2 | -$3 | -$3 |
| Higher business energy costs | -$2 | -$4 | -$4 | -$5 | -$8 | -$9 |
| Upstream production losses | -$4 | -$7 | -$9 | -$11 | -$12 | -$13 |
| **Total Colorado GDP** | **-$8** | **-$13** | **-$15** | **-$18** | **-$24** | **-$26** |

### Table 16: Colorado Household Income Lost From Hydraulic Fracturing Ban (2016 $billions)

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | $0 | -$1 | -$1 | -$1 | -$2 | -$2 |
| Higher business energy costs | -$1 | -$2 | -$2 | -$3 | -$5 | -$5 |
| Upstream production losses | -$3 | -$4 | -$5 | -$6 | -$7 | -$8 |
| **Total Colorado household income** | **-$4** | **-$7** | **-$8** | **-$10** | **-$13** | **-$14** |



# Texas

In Texas, most of the power produced and consumed in the state (over 81 percent)[28] comes from low-cost sources such as coal and natural gas. In 2015, Texas generated $1.59 trillion in GDP[29], had 12.5 million people in the workforce[30], and had an unemployment rate of 4.5 percent, which is below the national average of 5.3 percent.[31] 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 (and world) – the Barnett, Eagle Ford and Permian.[32]

Thanks to the lower energy prices made possible by the energy renaissance, Texas households have benefited from major economic gains over the past five years. GDP has increased by $13.2 billion and created 156,700 jobs as a result of increased consumer spending.

Dr. Thomas Tunstall, research director for the University of Texas at San Antonio's Institute for Economic Development, wrote recently that "Texas benefits economically from all aspects of oil and gas production," adding that "recent oil and gas activity in Texas benefits residents in ways other states can only imagine."[33]

These massive and large-scale benefits, however, have not stopped anti-fracking activists from trying to stop economic growth. The Sierra Club recently announced a $5 million expansion of its campaign against natural gas, with Texas as one of the target states. Groups like Earthworks have expanded their state presence to include organizers in both North and South Texas. Environmental groups from across the country, including the San Francisco-based Rainforest Action Network, are campaigning against liquefied natural gas export projects that are being built or currently under consideration in Texas. All along the supply chain in the Lone Star State, the environmental community is doing whatever it to delay, re-route, or – ultimately – "keep it in the ground."

Despite these efforts, Texas leads the nation in both crude oil and natural gas production. But natural gas production in the state had been in decline from its peak in 1972 of 8.6 trillion cubic feet (tcf) to around 6 tcf in the mid-1980s.

The advances in hydraulic fracturing and horizontal drilling in the 1990s (in conjunction with a rebound in prices) led to an increase in production in the early 2000s, and by 2014 production levels had jumped to 7.95 tcf.[34] Most of the increase in natural gas production has occurred in the Barnett, Eagle Ford and Haynesville-Bossier formations. While the Barnett and Haynesville/Bossier formations produce mostly dry gas, the Eagle Ford Shale produces a substantial amount of petroleum and NGLs.[35]

**Table 17: Texas Jobs Lost From Hydraulic Fracturing Ban (thousands)**

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -38 | -67 | -74 | -86 | -148 | -158 |
| Higher business energy costs | -237 | -437 | -448 | -502 | -788 | -899 |
| Upstream production losses | -147 | -240 | -300 | -356 | -404 | -441 |
| **Total Texas employment** | **-423** | **-743** | **-822** | **-944** | **-1,339** | **-1,499** |

If Texas were its own country, it would be among the top-10 oil and gas producing nations in the world.[36] Little wonder, then, that a scenario in which hydraulic fracturing technology is banned across the country would have a disproportionately negative impact on the place where it used with the greatest frequency. As Table 17 shows, the state of Texas would face the possibility of losing **nearly 1.5 million jobs** by the time we reached 2022, after shedding **more than 420,000 jobs** in the first year of the ban's implementation alone.

Although banning fracking in Texas may sound about as likely as deep sea diving in Nebraska, recent history shows that the state is not immune from anti-fracking campaigns. Denton County is the tenth largest natural gas producing county in Texas, and yet in 2014, its principal city – Denton, Texas – voted to ban fracking following a years-long campaign from local and out-of-state activists.

Although the ban in Denton was widely thought to be illegal, and has since been repealed, it showed that restricting fracking is possible even in the most iconic oil and natural gas producing state. Other drilling restrictions in the Barnett Shale region of North Texas, including large setbacks in Dallas, Southlake, and Flower Mound, have been dubbed "de facto" bans by industry and environmental activists alike.

The desire to score wins in Texas specifically has been a motivating factor for the environmental groups who want to ban fracking. As Bruce Baizel, the energy program director for Earthworks, told Reuters after Denton passed its fracking ban, "If this place in the heart of the oil and gas industry can't live with fracking, then who can?"[37]



### Table 18: Texas GDP Lost From Hydraulic Fracturing Ban (2016 $billions)

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -$3 | -$6 | -$6 | -$7 | -$13 | -$14 |
| Higher business energy costs | -$28 | -$53 | -$53 | -$59 | -$91 | -$105 |
| Upstream production losses | -$26 | -$42 | -$53 | -$62 | -$71 | -$77 |
| **Total Texas GDP** | **-$58** | **-$101** | **-$112** | **-$129** | **-$174** | **-$196** |

### Table 19: Texas Household Income Lost From Hydraulic Fracturing Ban (2016 $billions)

| Type of Economic Shock | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|
| Higher residential energy costs | -$2 | -$3 | -$4 | -$4 | -$7 | -$8 |
| Higher business energy costs | -$15 | -$27 | -$28 | -$31 | -$47 | -$54 |
| Upstream production losses | -$13 | -$21 | -$26 | -$31 | -$35 | -$39 |
| **Total Texas household income** | **-$30** | **-$52** | **-$57** | **-$66** | **-$90** | **-$101** |

Importantly, the idea that Texas residents could seamlessly transition to an economy without fracking is not supported by the data. If fracking were banned, our modeling points to a potential **state GDP loss of nearly $200 billion** in the year 2022. This total is driven in large part by the enormous cost increases that Texas businesses would be forced to endure to pay for the energy they consume. Table 18 summarizes these impacts.

That nearly $200 billion loss in state GDP manifests itself in a number of ways, including a decrease in household income for Texas residents that we estimate will be in **excess of $100 billion** by 2022 (Table 19).

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