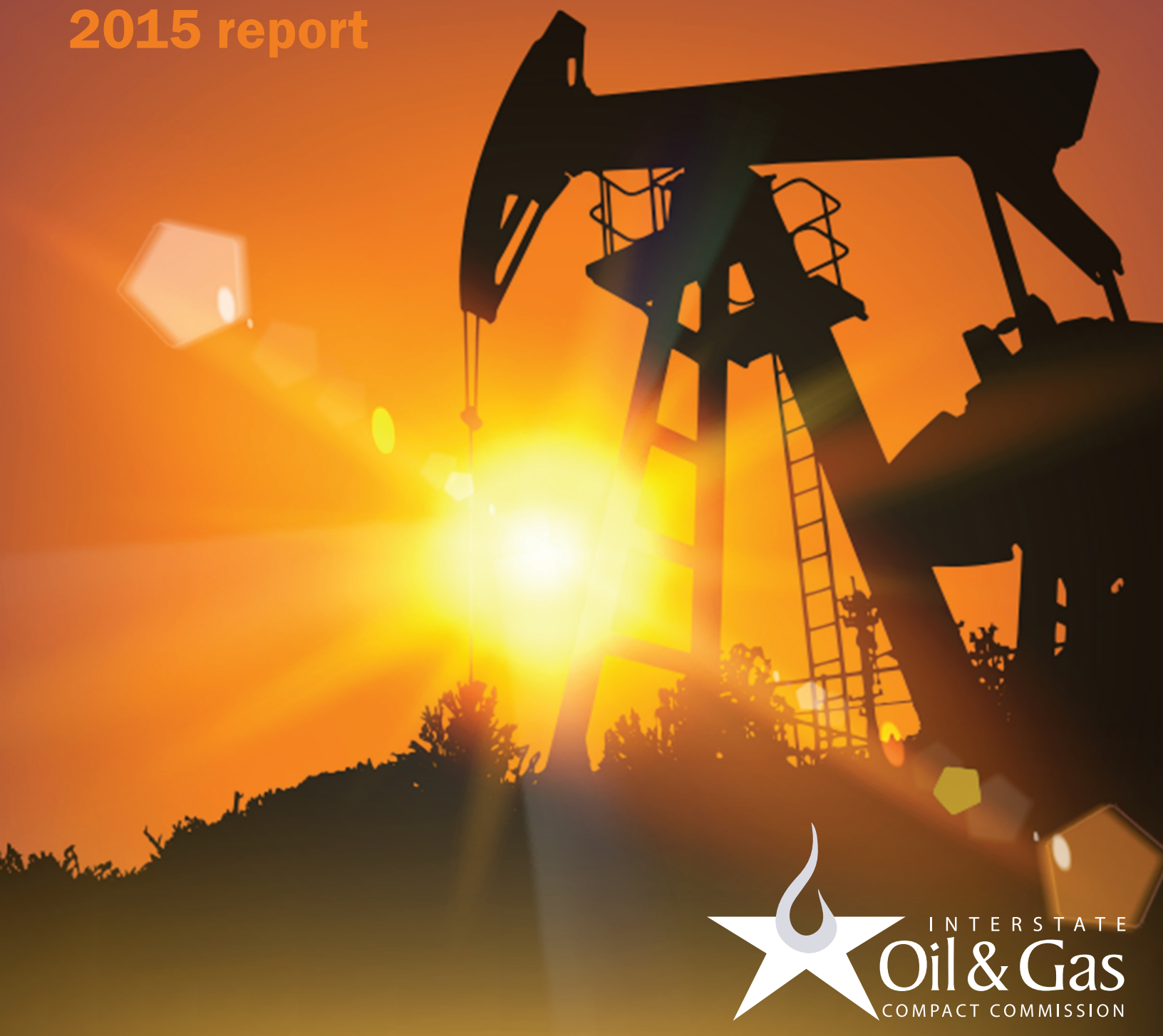


# **marginal wells:** fuel for economic growth

**2015 report**



# About the Interstate Oil and Gas Compact Commission

The Interstate Oil and Gas Compact Commission (IOGCC) is a multi-state quasi government agency that promotes the conservation and efficient recovery of our nation's oil and natural gas resources while protecting health, safety and the environment. The IOGCC consists of the governors of 38 states (30 members and eight associate states) that produce almost all of the oil and natural gas in the United States. Chartered by Congress in 1935, the organization is the oldest and largest interstate compact in the nation. The IOGCC assists states in balancing interests through sound regulatory practices. These interests include: maximizing domestic oil and natural gas production, minimizing the waste of irreplaceable natural resources and protecting human and environmental health. The IOGCC also provides an effective forum for government, industry, environmentalists and others to share information and viewpoints, allowing members to take a proactive approach to emerging technologies and environmental issues. For more information, visit [iogcc.ok.gov](http://iogcc.ok.gov) or call (405) 525-3556.

## Acknowledgements

The final report and analysis was partly funded by Sustaining Oklahoma's Energy Resources (SOER).

SOER was previously known as the Marginal Well Commission. SOER is now a committee under the authority of the Oklahoma Energy Resources Board (OERB). SOER was established to encourage new processes and technological advancements to sustain the oil and natural gas industry in the future for the benefit of the citizens of Oklahoma, and to advance activities to support marginally producing oil and natural gas wells. Although the name has changed, the important programs of the former Marginal Well Commission have remained the same. Workshops, roundtables, the Digital Oilfield Conference and the successful Oklahoma Oil & Gas Expo have not changed.

Both SOER and the OERB are champions for, and are funded by, Oklahoma's oil and natural gas industry. By merging the two, the missions of both have been enhanced. SOER is a proud supporter of Oklahoma's oil and natural gas industry, and is looking forward to leveraging this merger into new opportunities for Oklahoma's oil and natural gas producers and royalty owners.

For more information on SOER, please visit [soerok.com](http://soerok.com) or call 405-601-2190.

The IOGCC would also like to recognize and thank Mark C. Snead for analyzing the data and composing the valuable assessment for this report. Mr. Snead is a regional economist and president of RegionTrack, Inc. ([regiontrack.com](http://regiontrack.com)), an Oklahoma City-based economic research firm specializing in regional economic forecasting and analysis.

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# Introduction

The Interstate Oil and Gas Compact Commission (IOGCC) champions the preservation of this country's low-volume, marginally economic wells. The IOGCC recognizes that it goes to the heart of conservation values to do all that is possible to productively recover the scarce oil and natural gas resources marginal wells produce.

The IOGCC defines a marginal well as a well that produces 10 barrels of oil or 60 Mcf of natural gas per day or less. Generally, these wells started their productive life producing much greater volumes using natural pressure. Over time, the pressure decreases and production drops. That is not to say that the reservoirs which feed the wells are necessarily depleted. It has been estimated that in many cases marginal wells may be accessing a reservoir that stills holds two-thirds of its potential value.

However, because these resources are not always easily or economically accessible, many of the marginal wells in the United States are at risk of being prematurely abandoned, leaving large quantities of oil or gas behind.

In addition to supplying much-needed energy, marginal wells are important to communities across the country, providing jobs and driving economic activity. Today, as the nation ponders the solution to its energy challenges, the commission continues to tell the story of how low-volume producing wells can collectively contribute to a sound energy and economic future.

# Definitions used in this report

**Marginal Well.** A producing well that requires a higher price per Mcf or per barrel of oil to be worth producing, due to low production rates and/ or high production costs from its location (e.g. far offshore; in deep waters; onshore far from good roads for oil pickup and no pipeline) and/or its high co-production of substances that must be separated out and disposed of (e.g. saline water, non-burnable gasses mixed with the natural gas). A Marginal Well becomes unprofitable to produce whenever oil and/or gas prices drop below its crucial profit point. On land, this is often but not always a stripper well.

**Stripper Well.** An oil well whose maximum daily average oil production does not exceed 10 bbls oil per day during any consecutive 12 month period. Often used interchangeably with the term “Marginal Well”, although they are not the same.

**Temporary Abandonment.** “Cessation of work on a well pending determination of whether it should be completed as a producer or permanently abandoned.” (Williams & Meyers)

**Idle Well.** (1) A well that is not producing or injecting, and has received state approval to remain idle or (2) a well that is not producing or injecting, has not received state approval to remain idle, and for which the operator is known or solvent. (IOGCC)

**Plugged and Abandoned.** Wells that have had plugging operations during the calendar year. Does not include wells that have been plugged back up-hole in order to kick the well, etc. This category does not necessarily exclude those with site restoration remaining to be completed.

## Abbreviations

### Oil

bbls = barrels

Mbbls = one thousand barrels (1,000 barrels)

MMbbls = one million barrels (1,000,000 barrels)

BOPD = barrels of oil per day

BOEPD = barrels of oil equivalent per day

MMBOE = million barrels of oil equivalent (1,000,000 barrels of oil equivalent)

### Natural Gas

Mcf = one thousand cubic feet (1,000 cubic feet)

Bcf = one billion cubic feet (1,000,000,000 cubic feet)

MCFD = one thousand cubic feet per day (1,000 cubic feet per day)

MMCF = one million cubic feet (1,000,000 cubic feet)

MMCFD = one million cubic feet per day (1,000,000 cubic feet per day)

Source: Langenkamp, Robert D., ed. The Illustrated Petroleum Reference Dictionary. 4th ed. PennWell Books: Tulsa, 1994.



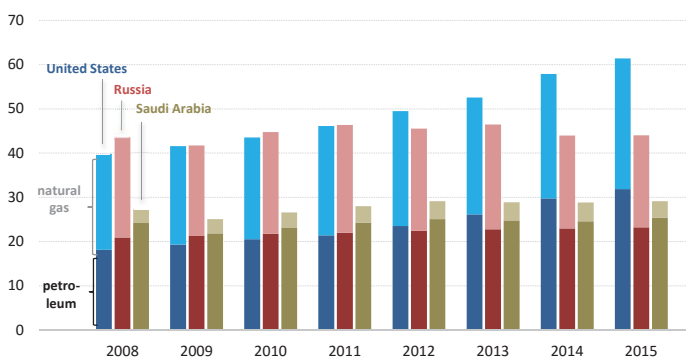
# U.S. Oil and Natural Gas Production Amidst Increasing Global Supply

The United States continues to extend its lead as the world's top producer of petroleum and natural gas hydrocarbons (see Figure 1).<sup>1</sup> After taking the top spot in overall production from Russia in 2012, the gap has widened considerably, with the U.S. now the largest producer of both petroleum and natural gas.

In petroleum output, the U.S. passed Russia in 2012 and Saudi Arabia the following year. U.S. petroleum production is now 25 percent higher than Saudi Arabia and 37 percent higher than Russia.

The U.S. lead is even larger on the natural gas side where U.S. production in 2015 is 42 percent above second-ranked Russia's output and roughly five times the output of Canada, the third-largest natural gas producer.

**Figure 1. Total Hydrocarbon Production** (quadrillion British thermal units)



Source: U.S. EIA and RegionTrack

## Rising Domestic Oil and Natural Gas Output

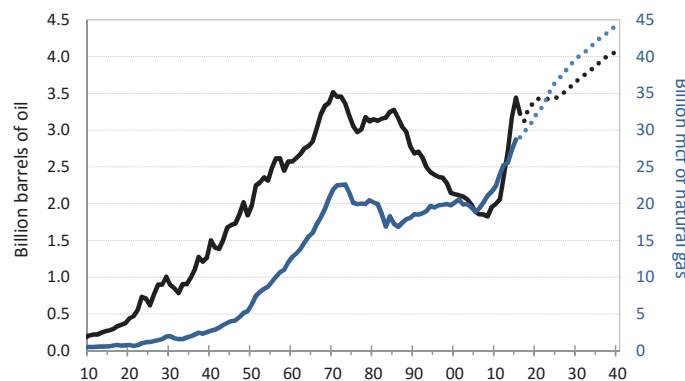
The sharp rebound in U.S. oil and natural gas output in recent years is traced to both the industry's rapid transition to unconventional methods of hydrocarbon production and increased efficiencies from the widespread deployment of new drilling technologies and techniques.

Along with opening new fields, the shift to unconventional production and modern drilling techniques

has revitalized many of the nation's legacy oil and natural gas fields written off long ago as economically marginal. Recent U.S. Energy Information Administration (EIA) estimates indicate that domestic crude oil production reached 3.44 billion barrels in 2015, a near doubling from the recent bottom in output in 2008 (see Figure 2). Annual U.S. oil production has increased by more than 1.6 billion barrels (88 percent) since 2008 and is now only slightly below the all-time high of 3.52 billion barrels set in 1970. Natural gas output has similarly risen by more than 50 percent since the recent bottom in 2005 to 28.8 billion Mcf in 2015, an all-time high in domestic gas production.

EIA forecasts suggest that these recent supply trends are likely to persist for many years as U.S. production of both oil and natural gas climb well above current levels (see Figure 2). Current projections suggest that domestic oil production will drop slightly in 2016 to 3.22 billion barrels pressured by weak crude oil prices before rising a projected 27 percent to more than 4 billion barrels annually by 2040. U.S. natural gas production is expected to rise more than 50 percent by 2040 to 44.5 billion Mcf per year. The underlying annualized growth rates suggest that crude oil output will rise 1 percent, and natural gas 1.8 percent, annually in the period.

**Figure 2. U.S. Oil & Natural Gas Production Outlook**



Source: U.S. EIA

## A Step Closer to U.S. Energy Independence

The strong rebound in domestic oil production has reduced the reliance of the U.S. economy on imported oil by almost one-third (see Figure 3). In early 2014, domestically-produced oil exceeded imports for the first time in two decades and now accounts for 56 percent of total U.S. supply. Since 2008, the 1.6-billion-barrel increase in domestic oil production allowed the U.S. to offset 1.1 billion barrels of oil imports annually. Despite recent reductions in imports, more than 2.5 billion barrels of imported oil remain that could potentially be offset by further increases in domestic production.

Buoyed by surging oil production, exports of U.S. petroleum products remain on the rise as well (see Figure 4). Petroleum exports have increased four-fold since 2005, from 425 million barrels annually to approximately 1.73 billion barrels in 2015. Most of these products are first refined and then exported, primarily in the form of natural gas liquids and distillate fuel oil (diesel fuel). Rising petroleum exports have played a major role in the resurgence of the U.S. as the world leader in total hydrocarbon production.

Natural gas remains largely a regional market, with the U.S. fully able to produce the majority of the supply needed domestically. Total U.S. exports and imports of natural gas remain modest. In 2015, the U.S. imported 7.5 billion cubic feet per day of natural gas (slightly less than 10 percent of total supply), with nearly all imports coming from Canada by pipeline, while exporting 4.8 billion cubic feet per day, mostly to Mexico by pipeline.

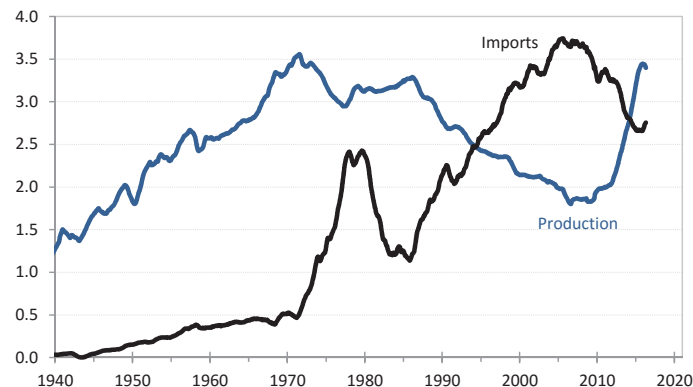
Liquefied natural gas (LNG) exports remained modest through the end of 2015 as the initial authorized export shipment of LNG was made in February 2016 from the newly opened Sabine Pass LNG terminal in Louisiana. LNG is viewed as a strong potential source of future natural gas exports.

## International Crude Oil Supply Continues to Rise

The substantial rebound in U.S. production has played a pivotal role in the energy market volatility experience the past few years, particularly in the crude oil market.

**Figure 3. U.S. Oil Production & Imports**

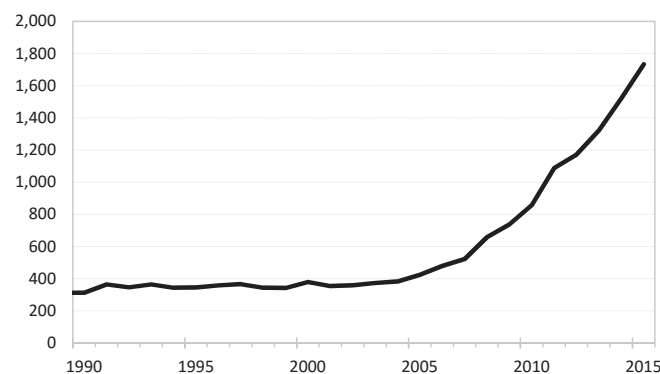
(billions of barrels, 12-month rolling total)



Source: U.S. EIA

**Figure 4. U.S. Exports of Crude Oil & Petroleum Products**

(millions of barrels annually)



Source: U.S. EIA

**Figure 5. World Crude Oil & Condensate Production**

(billions of barrels annually)



Source: U.S. EIA - International Energy Statistics

From 2010 to 2015, U.S. crude oil and condensate output increased 72 percent, adding 1.45 billion barrels to annual domestic output. This represents roughly 77 percent of the 1.87 billion net new barrels added to world production in the period (see Figure 5).



However, world petroleum markets remain highly dynamic, and the U.S. has not been the sole source of swings in supply. World oil production minus the U.S. increased by a net 320 million (6.9 percent) barrels annually from 2010 to 2015 to meet growing world-wide demand.

Many of the world's major oil producers have managed significant gains in annual crude oil and condensate output since 2010 including Iraq (+603 million barrels), Saudi Arabia (+443 million barrels), Canada (+327 million barrels), Russia (+178 million barrels), United Arab Emirates (+143 million barrels), and Brazil (+138 million barrels).<sup>2</sup> Three other countries – Kuwait (+101 million barrels), Columbia (+83 million barrels), and China (+72 million barrels) – increased crude oil output by more than 50 million barrels annually. Many of these producers are expected to continue to add to crude output in 2016 as U.S. output slows.

The production news is not positive for all major oil producers, however, with two countries suffering steep declines that resulted from factors other than market forces. Civil war-torn Libya experienced the steepest decline in production the past five years, falling by 452 million barrels annually (75 percent decline).

The next steepest is Iran's production pullback of 285 million barrels annually as a result of economic sanctions. While a reversal in Libyan output is unlikely in the near term, expectations are that Iran will quickly recover to pre-sanction output levels now that international oil sales have resumed.

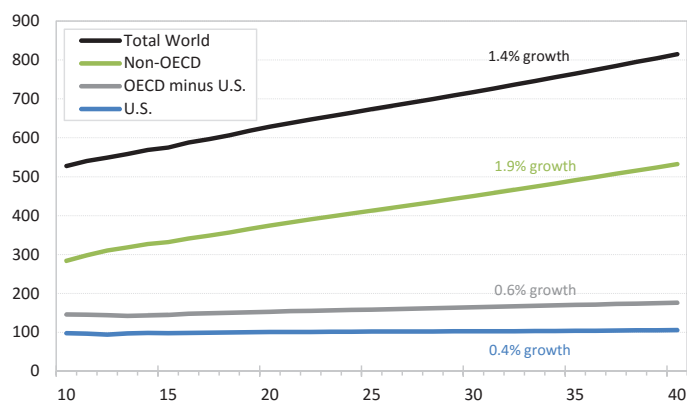
Many other smaller oil-producing countries continue to battle long-run oil production declines. Ten countries have experienced a decline in production of more than 50 million barrels annually since 2010 including Syria (-127 million barrels), United Kingdom (-126 million barrels), Mexico (-117 million barrels), Norway (-95 million barrels), Yemen (-85 million barrels), Sudan and South Sudan (-84 million barrels), Azerbaijan (-62 million barrels), Algeria (-62 million barrels), Australia (-58 million barrels), and Indonesia (-57 million barrels).

## Rising Energy Demand

While the U.S. has played the major role in offsetting petroleum supply declines around the world, the recent oil glut and subsequent collapse in oil prices suggests that a further rise in world energy demand is needed to support further expansion of the revitalized U.S. oil and natural gas industry.

EIA forecasts suggest that future growth in energy demand is likely to be strongest outside the United States (see Figure 6), particularly in the non-OECD (Organisation for Economic Co-operation and Development) countries.

**Figure 6. World Total Primary Energy Consumption** (quadrillion British thermal units)



Source: U.S. EIA - International Energy Statistics

Through 2040, total U.S. energy demand is projected to grow at only 0.4 percent annually versus 1.4 percent worldwide. Non-OECD countries are expected to have the greatest demand for energy with 1.9 percent growth, more than three times the 0.6 percent pace projected for OECD countries other than the U.S. This suggests that any future gains in domestic crude oil and natural gas production may initially be used to offset additional imports into the U.S. but will eventually have to be directed toward meeting demand growth outside the country through exports. This only underscores the importance of the recent removal of restrictions on crude oil exports and the opening of additional liquid natural gas (LNG) export terminals in supporting the future growth of the U.S. energy sector.

# Marginal Oil

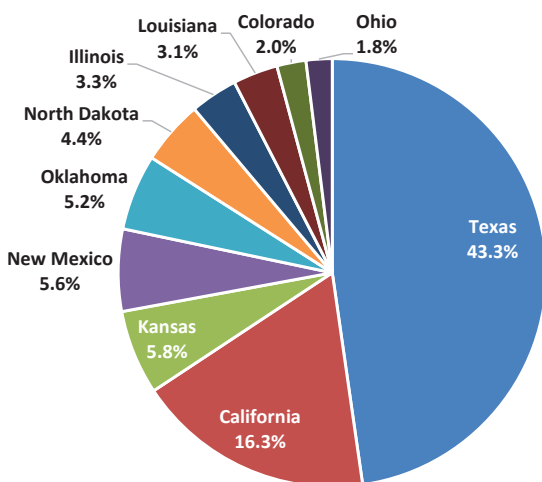
**Table 3. National Marginal Oil Well Survey (2015)**

State	Number of Marginal Oil Wells	Production from Marginal Wells (Bbls)	Average Daily Production per Well (Bbls)	Total Oil Production (Bbls)	Marginal Share of Total Production
Alabama	638	734,617	3.2	9,737,363	7.5%
Alaska	-	-	-	176,240,630	0.0%
Arizona	21	19,528	2.5	39,888	49.0%
Arkansas	4,658	3,315,331	1.9	6,161,781	53.8%
California	37,262	47,702,697	3.5	201,733,162	23.6%
Colorado	9,992	5,829,735	1.6	126,035,935	4.6%
Illinois	29,386	9,521,000	0.9	9,521,000	100.0%
Indiana	4,320	1,996,902	1.3	2,218,780	90.0%
Kansas	18,375	16,954,840	2.5	44,618,000	38.0%
Kentucky	26,192	2,289,229	0.2	2,854,400	80.2%
Louisiana	20,576	8,996,596	1.2	62,861,269	14.3%
Maryland	-	-	-	-	-
Michigan	2,305	3,624,877	4.3	6,590,686	55.0%
Mississippi	992	1,170,601	3.2	23,659,104	4.9%
Missouri	426	138,000	0.9	138,000	100.0%
Montana	2,880	2,047,732	1.9	28,232,121	7.3%
Nebraska	1,697	1,596,393	2.6	2,697,022	59.2%
Nevada	43	69,285	4.4	281,382	24.6%
New Mexico	17,263	16,462,950	2.6	145,236,621	11.3%
New York	3,629	283,089	0.2	283,089	100.0%
North Dakota	3,087	12,834,028	11.4	432,278,474	3.0%
Ohio	13,213	5,473,187	1.1	25,584,163	21.4%
Oklahoma	28,351	15,188,479	1.5	157,770,000	9.6%
Pennsylvania	21,284	1,423,504	0.2	7,369,000	19.3%
South Dakota	29	47,194	4.5	1,666,177	2.8%
Texas	152,376	126,659,423	2.3	1,008,711,161	12.6%
Utah	2,710	4,019,088	4.1	36,980,385	10.9%
Virginia	3	958	0.9	10,897	8.8%
West Virginia	3,641	838,731	0.6	7,969,729	10.5%
Wyoming	3,141	3,291,306	2.9	86,008,769	3.8%
Survey States	408,490	292,529,299	2.0	2,613,488,988	11.2%

## State Rankings - Marginal Crude Oil (2015)

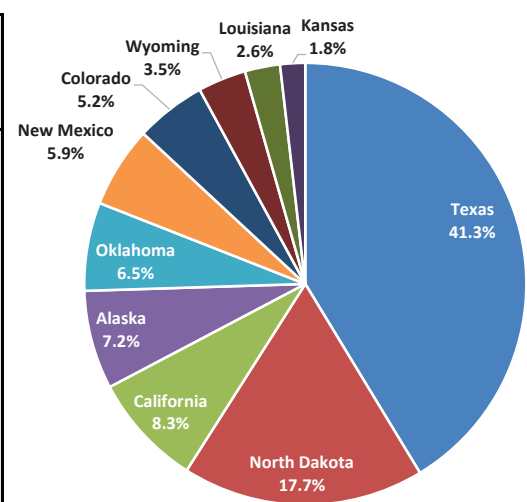
State	Number of Marginal Oil Wells	State	Production from Marginal Wells (Bbls)	State	Marginal Share of Total Production	State	Average Daily Production per Well (Bbls)
Texas	152,376	Texas	126,659,423	Illinois	100.0%	North Dakota	11.39
California	37,262	California	47,702,697	Missouri	100.0%	South Dakota	4.46
Illinois	29,386	Kansas	16,954,840	New York	100.0%	Nevada	4.41
Oklahoma	28,351	New Mexico	16,462,950	Indiana	90.0%	Michigan	4.31
Kentucky	26,192	Oklahoma	15,188,479	Kentucky	80.2%	Utah	4.06
Pennsylvania	21,284	North Dakota	12,834,028	Nebraska	59.2%	California	3.51
Louisiana	20,576	Illinois	9,521,000	Michigan	55.0%	Mississippi	3.23
Kansas	18,375	Louisiana	8,996,596	Arkansas	53.8%	Alabama	3.15
New Mexico	17,263	Colorado	5,829,735	Arizona	49.0%	Wyoming	2.87
Ohio	13,213	Ohio	5,473,187	Kansas	38.0%	New Mexico	2.61
Colorado	9,992	Utah	4,019,088	Nevada	24.6%	Nebraska	2.58
Arkansas	4,658	Michigan	3,624,877	California	23.6%	Arizona	2.55
Indiana	4,320	Arkansas	3,315,331	Ohio	21.4%	Kansas	2.53
West Virginia	3,641	Wyoming	3,291,306	Pennsylvania	19.3%	Texas	2.28
New York	3,629	Kentucky	2,289,229	Louisiana	14.3%	Arkansas	1.95
Wyoming	3,141	Montana	2,047,732	Texas	12.6%	Montana	1.95
North Dakota	3,087	Indiana	1,996,902	New Mexico	11.3%	Colorado	1.60
Montana	2,880	Nebraska	1,596,393	Utah	10.9%	Oklahoma	1.47
Utah	2,710	Pennsylvania	1,423,504	West Virginia	10.5%	Indiana	1.27
Michigan	2,305	Mississippi	1,170,601	Oklahoma	9.6%	Louisiana	1.20
Nebraska	1,697	West Virginia	838,731	Virginia	8.8%	Ohio	1.13
Mississippi	992	Alabama	734,617	Alabama	7.5%	Illinois	0.89
Alabama	638	New York	283,089	Montana	7.3%	Missouri	0.89
Missouri	426	Missouri	138,000	Mississippi	4.9%	Virginia	0.87
Nevada	43	Nevada	69,285	Colorado	4.6%	West Virginia	0.63
South Dakota	29	South Dakota	47,194	Wyoming	3.8%	Kentucky	0.24
Arizona	21	Arizona	19,528	North Dakota	3.0%	New York	0.21
Virginia	3	Virginia	958	South Dakota	2.8%	Pennsylvania	0.18
Maryland	-	Maryland	-	Maryland	-	Maryland	-
Survey States	408,490	Survey States	292,529,299	Survey States	12.0%	Survey States	1.96

**Top 10 in Marginal Oil Production**



State	Total Oil Production (Bbls)
Texas	1,008,711,161
North Dakota	432,278,474
California	201,733,162
Alaska	176,240,630
Oklahoma	157,770,000
New Mexico	145,236,621
Colorado	126,035,935
Wyoming	86,008,769
Louisiana	62,861,269
Kansas	44,618,000

**Top 10 in Total Oil Production**



## Comparative number of marginal oil wells and marginal oil well production 2011 - 2015

State	2011		2012		Number of Marginal Oil Wells
	Number of Marginal Oil Wells	Production from Marginal Wells (Bbls)	Number of Marginal Oil Wells	Production from Marginal Wells (Bbls)	
Alabama	678	876,930	701	897,436	616
Arizona	16	16,943	16	18,617	20
Arkansas	4,393	3,127,385	4,387	3,123,544	4,411
California	33,150	43,167,278	34,006	41,652,890	36,524
Colorado	9,692	9,878,343	10,405	10,039,715	10,685
Illinois	25,903	9,158,000	27,479	8,908,000	29,441
Indiana	4,408	1,887,281	4,323	2,115,032	4,351
Kansas	19,068	16,265,900	19,068	16,265,900	16,537
Kentucky	26,120	1,967,708	26,424	2,705,474	26,505
Louisiana	19,274	20,977,684	16,679	9,851,323	20,273
Maryland	-	-	-	-	-
Michigan	2,386	3,020,100	2,375	3,100,000	2,463
Mississippi	1,030	1,348,460	1,000	1,366,348	974
Missouri	439	112,508	425	175,000	614
Montana	2,745	2,077,397	2,788	2,192,351	2,839
Nebraska	1,516	1,596,257	1,553	1,545,886	1,617
Nevada	35	57,189	36	58,230	37
New Mexico	15,945	15,274,557	15,914	15,816,600	16,630
New York	3,568	374,363	3,386	347,780	3,694
North Dakota	1,580	2,219,319	2,587	11,215,102	3,080
Ohio	29,334	4,135,696	28,204	3,885,815	14,791
Oklahoma	29,439	16,408,474	29,167	16,103,475	28,895
Pennsylvania	22,562	2,217,506	20,498	1,982,529	20,150
South Dakota	30	48,673	28	45,090	38
Texas	139,737	110,814,436	142,726	114,190,108	148,363
Utah	2,142	3,343,297	2,352	3,485,740	2,437
Virginia	3	626	3	517	3
West Virginia	3,779	753,366	4,386	829,013	4,224
Wyoming	3,856	4,048,670	4,244	4,384,106	3,962
Survey States	402,828	275,174,346	405,161	276,301,621	404,175

2013	2014		2015	
Production from Marginal Wells (Bbls)	Number of Marginal Oil Wells	Production from Marginal Wells (Bbls)	Number of Marginal Oil Wells	Production from Marginal Wells (Bbls)
864,230	629	887,571	638	734,617
34,377	21	28,357	21	19,528
3,140,632	4,546	3,235,615	4,658	3,315,331
46,911,641	37,342	48,392,763	37,262	47,702,697
8,289,694	10,626	8,339,626	9,992	5,829,735
9,539,000	29,466	9,547,000	29,386	9,521,000
2,158,967	4,360	2,255,918	4,320	1,996,902
17,800,067	17,963	18,803,199	18,375	16,954,840
2,319,876	26,329	3,270,565	26,192	2,289,229
9,289,627	20,246	9,191,087	20,576	8,996,596
-	-	-	-	-
4,150,000	2,365	3,470,000	2,305	3,624,877
1,325,045	1,024	1,337,570	992	1,170,601
199,000	605	196,000	426	138,000
2,122,406	2,834	2,173,566	2,880	2,047,732
1,544,109	1,678	1,577,747	1,697	1,596,393
39,312	42	62,580	43	69,285
16,518,096	17,085	17,128,865	17,263	16,462,950
366,262	4,028	355,505	3,629	283,089
17,334,985	3,093	15,111,113	3,087	12,834,028
4,469,085	14,349	5,208,690	13,213	5,473,187
15,798,476	28,623	15,493,477	28,351	15,188,479
1,747,552	24,833	2,050,989	21,284	1,423,504
56,506	34	60,582	29	47,194
118,172,917	151,691	125,217,363	152,376	126,659,423
3,533,456	2,559	3,743,706	2,710	4,019,088
305	3	1,321	3	958
1,132,282	4,141	762,398	3,641	838,731
4,073,931	3,905	3,995,200	3,141	3,291,306
292,931,837	414,420	301,898,374	408,490	292,529,299

# Marginal Gas

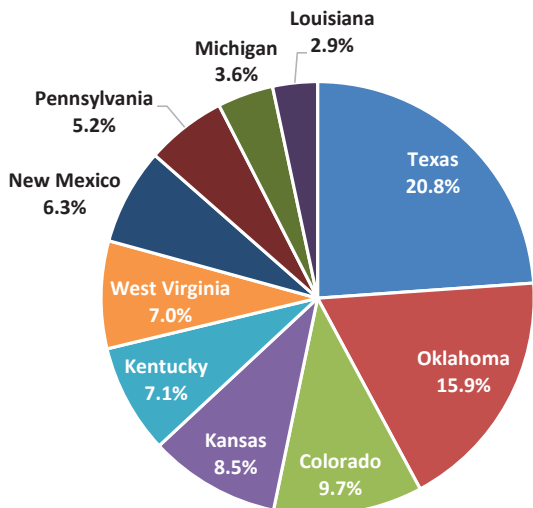
**Table 4. National Marginal Gas Well Survey (2015)**

State	Number of Marginal Gas Wells	Production from Marginal Wells (Mcf)	Average Daily Production per Well (Mcf)	Total Gas Production (Mcf)	Marginal Share of Total Production
Alabama	5,416	51,417,194	26.0	169,114,373	30.4%
Alaska	-	-	-	104,786,730	0.0%
Arizona	3	53,728	49.1	98,964	54.3%
Arkansas	3,878	29,843,423	21.1	1,015,231,830	2.9%
California	819	7,288,955	24.4	223,181,908	3.3%
Colorado	18,915	189,207,817	27.4	1,707,125,982	11.1%
Illinois	640	427,987	1.8	3,423,898	12.5%
Indiana	1,059	6,525,005	16.9	7,250,005	90.0%
Kansas	16,932	166,696,500	27.0	292,450,000	57.0%
Kentucky	19,439	139,090,703	19.6	139,090,703	100.0%
Louisiana	15,449	56,865,395	10.1	1,754,317,208	3.2%
Maryland	7	43,295	16.9	43,295	100.0%
Michigan	7,886	71,072,012	24.7	107,594,838	66.1%
Mississippi	1,475	1,335,810	2.5	55,166,000	2.4%
Missouri	4	9,000	6.2	9,000	100.0%
Montana	5,393	26,219,406	13.3	30,661,149	85.5%
Nebraska	141	375,328	7.3	375,328	100.0%
Nevada	-	-	-	4,103	0.0%
New Mexico	14,292	122,454,849	23.5	1,263,295,582	9.7%
New York	6,699	9,202,778	3.8	17,725,342	51.9%
North Dakota	155	797,909	14.1	584,958,638	0.1%
Ohio	32,154	55,311,561	4.7	1,011,054,764	5.5%
Oklahoma	45,340	310,610,973	18.8	2,499,599,000	12.4%
Pennsylvania	65,755	102,196,082	4.3	4,784,767,144	2.1%
South Dakota	66	225,240	9.3	14,609,976	1.5%
Texas	56,561	406,325,755	19.7	8,348,144,763	4.9%
Utah	2,905	30,135,108	28.4	423,185,726	7.1%
Virginia	1,731	14,480,577	22.9	132,301,992	10.9%
West Virginia	52,684	136,611,541	7.1	1,290,758,001	10.6%
Wyoming	2,180	20,468,449	25.7	1,943,950,821	1.1%
Survey States	377,977	1,955,292,380	14.2	27,924,277,063	7.0%

## State Rankings - Marginal Gas (2015)

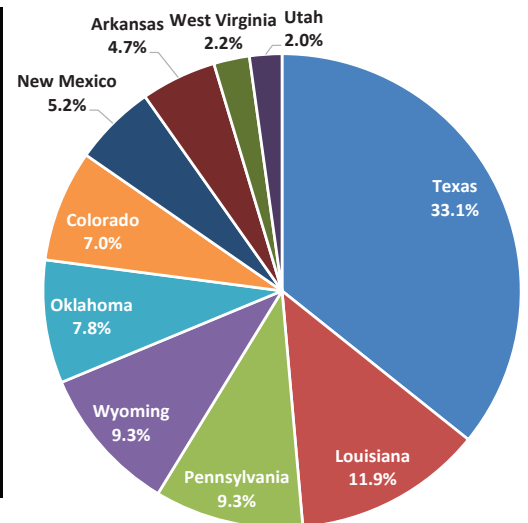
State	Number of Marginal Gas Wells	State	Production from Marginal Gas Wells (Mcf)	State	Marginal Share of Total Gas Production	State	Average Daily Production per Well (Mcf)
Pennsylvania	65,755	Texas	406,325,755	Kentucky	100.0%	Arizona	49.1
Texas	56,561	Oklahoma	310,610,973	Maryland	100.0%	Utah	28.4
West Virginia	52,684	Colorado	189,207,817	Missouri	100.0%	Colorado	27.4
Oklahoma	45,340	Kansas	166,696,500	Nebraska	100.0%	Kansas	27.0
Ohio	32,154	Kentucky	139,090,703	Indiana	90.0%	Alabama	26.0
Kentucky	19,439	West Virginia	136,611,541	Montana	85.5%	Wyoming	25.7
Colorado	18,915	New Mexico	122,454,849	Michigan	66.1%	Michigan	24.7
Kansas	16,932	Pennsylvania	102,196,082	Kansas	57.0%	California	24.4
Louisiana	15,449	Michigan	71,072,012	Arizona	54.3%	New Mexico	23.5
New Mexico	14,292	Louisiana	56,865,395	New York	51.9%	Virginia	22.9
Michigan	7,886	Ohio	55,311,561	Alabama	30.4%	Arkansas	21.1
New York	6,699	Alabama	51,417,194	Illinois	12.5%	Texas	19.7
Alabama	5,416	Utah	30,135,108	Oklahoma	12.4%	Kentucky	19.6
Montana	5,393	Arkansas	29,843,423	Colorado	11.1%	Oklahoma	18.8
Arkansas	3,878	Montana	26,219,406	Virginia	10.9%	Maryland	16.9
Utah	2,905	Wyoming	20,468,449	West Virginia	10.6%	Indiana	16.9
Wyoming	2,180	Virginia	14,480,577	New Mexico	9.7%	North Dakota	14.1
Virginia	1,731	New York	9,202,778	Utah	7.1%	Montana	13.3
Mississippi	1,475	California	7,288,955	Ohio	5.5%	Louisiana	10.1
Indiana	1,059	Indiana	6,525,005	Texas	4.9%	South Dakota	9.3
California	819	Mississippi	1,335,810	California	3.3%	Nebraska	7.3
Illinois	640	North Dakota	797,909	Louisiana	3.2%	West Virginia	7.1
North Dakota	155	Illinois	427,987	Arkansas	2.9%	Missouri	6.2
Nebraska	141	Nebraska	375,328	Mississippi	2.4%	Ohio	4.7
South Dakota	66	South Dakota	225,240	Pennsylvania	2.1%	Pennsylvania	4.3
Maryland	7	Arizona	53,728	South Dakota	1.5%	New York	3.8
Missouri	4	Maryland	43,295	Wyoming	1.1%	Mississippi	2.5
Arizona	3	Missouri	9,000	North Dakota	0.1%	Illinois	1.8
Nevada	0	Nevada	0	Nevada	0.0%	Nevada	-
Survey States	377,977	Survey States	1,955,292,380	Survey States	7.0%	Survey States	14.2

**Top 10 in Marginal Gas Production**



State	Total Gas Production (Mcf)
Texas	8,024,741,449
Louisiana	2,876,819,270
Pennsylvania	2,259,769,718
Wyoming	2,245,230,966
Oklahoma	1,883,204,000
Colorado	1,707,125,982
New Mexico	1,251,237,600
Arkansas	1,146,168,000
West Virginia	541,570,080
Utah	490,691,929

**Top 10 in Total Gas Production**



## Comparative number of marginal gas wells and marginal gas well production 2011 - 2015

State	2011		2012		Number of Marginal Gas Wells
	Number of Marginal Gas Wells	Production from Marginal Wells (Mcf)	Number of Marginal Gas Wells	Production from Marginal Wells (Mcf)	
Alabama	4,672	49,102,574	4,582	51,296,788	5,150
Arizona	2	21,958	2	17,471	3
Arkansas	2,292	25,818,362	3,681	26,447,304	3,578
California	677	5,682,312	741	5,999,884	770
Colorado	15,803	178,850,282	17,277	186,585,869	18,195
Illinois	1,052	264,574	1,054	265,073	539
Indiana	525	8,167,631	560	7,932,487	885
Kansas	18,066	178,745,912	17,598	170,458,990	17,437
Kentucky	18,310	157,636,826	18,355	179,419,019	19,335
Louisiana	10,702	89,735,563	15,118	59,808,791	8,647
Maryland	7	41,198	7	31,186	7
Michigan	8,114	89,407,474	7,967	80,200,240	7,985
Mississippi	1,591	1,132,420	1,567	1,158,549	1,537
Missouri	4	32,342	4	9,000	4
Montana	5,844	37,096,563	5,822	32,845,974	5,452
Nebraska	297	1,859,439	291	1,220,867	222
Nevada	-	-	-	-	-
New Mexico	13,655	117,256,498	13,867	117,374,597	13,876
New York	6,707	12,213,746	6,963	11,257,580	7,027
North Dakota	163	1,477,345	164	870,513	146
Ohio	34,601	58,521,936	32,360	61,941,296	36,341
Oklahoma	39,106	274,283,188	40,665	283,365,134	42,223
Pennsylvania	64,320	145,179,862	53,636	137,685,084	66,077
South Dakota	89	465,941	85	361,999	67
Texas	53,149	415,370,422	54,651	419,502,886	55,483
Utah	2,252	23,081,201	2,422	25,438,799	2,599
Virginia	1,499	11,891,264	1,582	12,411,043	1,652
West Virginia	51,544	164,134,457	51,678	166,595,970	54,794
Wyoming	6,010	43,863,788	4,955	38,878,967	4,549
Survey States	361,053	2,091,335,077	357,654	2,079,381,360	374,580



2013	2014		2015	
Production from Marginal Wells (Mcf)	Number of Marginal Gas Wells	Production from Marginal Wells (Mcf)	Number of Marginal Gas Wells	Production from Marginal Wells (Mcf)
51,945,319	5,317	52,719,751	5,416	51,417,194
23,737	3	27,597	3	53,728
28,164,306	3,785	29,701,325	3,878	29,843,423
6,984,346	774	7,301,350	819	7,288,955
189,563,613	18,685	193,167,104	18,915	189,207,817
360,875	491	328,250	640	427,987
7,143,941	1,021	5,954,794	1,059	6,525,005
168,154,160	17,250	164,216,400	16,932	166,696,500
223,651,597	19,418	185,715,994	19,439	139,090,703
54,374,585	14,114	56,826,213	15,449	56,865,395
37,298	7	58,591	7	43,295
75,804,752	8,049	72,158,442	7,886	71,072,012
1,175,746	1,505	1,244,342	1,475	1,335,810
9,000	4	9,000	4	9,000
30,455,822	5,349	35,241,168	5,393	26,219,406
868,248	102	337,222	141	375,328
-	-	-	-	-
118,227,596	14,193	124,007,910	14,292	122,454,849
10,820,908	7,108	10,655,712	6,699	9,202,778
896,497	158	989,699	155	797,909
59,751,149	35,753	55,041,545	32,154	55,311,561
292,447,080	43,781	301,529,027	45,340	310,610,973
130,190,306	71,521	124,220,419	65,755	102,196,082
308,097	68	247,953	66	225,240
417,256,855	56,045	418,245,862	56,561	406,325,755
26,387,347	2,706	28,408,439	2,905	30,135,108
12,680,229	1,689	12,586,543	1,731	14,480,577
157,783,446	54,763	153,958,229	52,684	136,611,541
36,166,110	4,403	35,009,180	2,180	20,468,449
2,101,632,966	388,062	2,069,908,061	377,977	1,955,292,380



# Measuring the Contribution of Marginal Wells

The shift toward searching for new sources of domestic oil and natural gas in recent years has not diminished the critical role played by marginal production in the overall U.S. energy production framework. Marginal wells continue to provide a significant share of domestic oil and natural gas output. Over the past decade, marginal wells have contributed more than \$300 billion of production in the form of 2.85 billion barrels of oil and 19.9 billion Mcf of natural gas.

Extending the life of mature U.S. oil and natural gas fields continues to play an important transition role in exploration and development by keeping them active and available for further exploration. Marginal production requires the ongoing use of existing surface roads for servicing access and the maintenance of local pipelines for distribution. The wide, national footprint of marginal well activity has helped ease the path for new unconventional drilling and exploration activity in most existing fields across the country.

## Marginal Well Survey

In order to quantify the ongoing economic contribution of marginal wells in the U.S., the IOGCC periodically surveys its member states to acquire data related to marginal well production. The survey results have served as the basis for a long-standing series of reports documenting marginal well activity and the economic contribution of marginal production in the U.S.<sup>3</sup>

The current report is based on data collected in the latest IOGCC marginal well survey covering production activity in calendar years 2013, 2014, and 2015. This was a period of extreme price volatility and dramatic shifts in exploration and production activity for the domestic energy industry.

The survey questionnaire is extensive and collects a range of information on the behavior of marginal oil and natural gas operators across the responding states. The primary data items used in this report include the

number of producing marginal and total wells, type of wells, amounts of marginal and total production, and the number of plugged and abandoned wells.

Twenty-nine states are included in the current marginal wells report as producers of either marginal oil or natural gas, or both. Twenty-eight states submitted extensive responses to the current IOGCC survey, while data for the remaining state (Oklahoma) is estimated from alternative sources. A few states that produced very small amounts of marginal oil or natural gas production in the period are not included in the report. Even after excluding these very small producers, the 29 states included in the report are believed to represent substantially all of the marginal oil and natural gas produced within the U.S.

While each state receives the same survey questionnaire, the methodology used by the states in defining a marginal well and its associated production can differ. Similarly, the reporting entity within a state and the methods used by a state to derive estimates may also vary over time. Because of the inherent variability in reporting, every effort is made to place all reported data on comparable terms in order to facilitate valid state-to-state and year-to-year comparisons where possible. Where a state's reporting is incomplete, estimates are obtained from reliable alternative sources or formed using statistical-based methods. Most estimates are derived from data published by the U.S. Energy Information Administration (EIA). Appendix A provides a detailed description of the survey responses, alternative data sources, and any estimates used in the report.

**Table 1. National Marginal Oil Well Survey from 1992 - 2015**

Year	Number of Marginal Oil Wells	Production from Marginal Oil Wells (Bbls)	Price of Oil (\$/Bbl)	Value of Marginal Oil Production (\$)	Average Daily Production per Well (Bbls)
1992	453,277	368,132,000	15.99	5,886,430,680	2.23
1993	452,248	355,961,000	14.25	5,072,444,250	2.16
1994	442,500	339,930,000	13.19	4,483,676,700	2.10
1995	433,048	332,288,089	14.62	4,858,051,861	2.10
1996	428,842	323,468,274	18.46	5,971,224,338	2.06
1997	420,674	323,487,914	17.23	5,573,696,758	2.11
1998	406,380	316,870,286	10.87	3,444,380,009	2.14
1999	410,680	315,514,283	15.56	4,909,402,243	2.10
2000	411,629	325,947,181	26.72	8,709,308,676	2.16
2001	403,459	316,099,192	21.84	6,903,606,353	2.15
2002	402,072	323,776,606	22.51	7,288,211,401	2.21
2003	393,463	313,748,001	27.56	8,646,894,908	2.18
2004	397,362	310,922,122	36.77	11,432,606,426	2.14
2005	401,072	321,761,570	50.28	16,178,171,740	2.20
2006	422,381	324,496,483	59.69	19,369,195,070	2.10
2007	396,537	291,067,592	66.52	19,361,816,220	2.01
2008	379,405	266,389,079	94.04	25,051,228,977	1.92
2009	390,480	262,978,307	56.35	14,818,827,577	1.85
2010	395,467	267,764,103	74.97	20,073,194,781	1.86
2011	402,828	275,174,346	93.73	25,791,937,817	1.87
2012	405,161	276,301,621	92.82	25,646,832,133	1.87
2013	404,175	292,931,837	95.58	27,999,382,857	1.99
2014	414,420	301,898,374	87.31	26,359,781,503	2.00
2015	408,490	292,529,299	44.40	12,987,817,985	1.96

Value of Annual Marginal Production Per Well (\$)	Oil Wells Plugged/ Abandoned	Total Oil Production (Bbls)	Value of Total Oil Production (\$)	Marginal Share of Total Production
12,986	16,211	2,624,632,000	41,967,865,680	14.0%
11,216	16,914	2,499,033,000	35,611,220,250	14.2%
10,133	17,896	2,431,476,000	32,071,168,440	14.0%
11,218	16,389	2,394,268,000	35,004,198,160	13.9%
13,924	16,674	2,366,017,000	43,676,673,820	13.7%
13,249	15,172	2,354,831,000	40,573,738,130	13.7%
8,476	13,912	2,281,919,000	24,804,459,530	13.9%
11,954	11,227	2,146,732,000	33,403,149,920	14.7%
21,158	10,718	2,130,707,000	56,932,491,040	15.3%
17,111	12,234	2,117,511,000	46,246,440,240	14.9%
18,127	13,635	2,096,588,000	47,194,195,880	15.4%
21,976	14,300	2,061,995,000	56,828,582,200	15.2%
28,771	11,977	1,991,394,000	73,223,557,380	15.6%
40,337	11,058	1,892,095,000	95,134,536,600	17.0%
45,857	11,738	1,856,606,000	110,820,812,140	17.5%
48,827	11,296	1,853,243,000	123,277,724,360	15.7%
66,028	10,328	1,830,416,000	172,132,320,640	14.6%
37,950	10,070	1,954,241,000	110,121,480,350	13.5%
50,758	10,483	1,998,554,000	149,823,532,334	13.4%
64,027	10,698	2,058,916,000	192,981,047,379	13.4%
63,300	12,839	2,372,312,000	220,202,427,566	11.6%
69,275	11,571	2,715,220,000	259,529,606,153	10.8%
63,606	11,387	3,178,306,000	277,508,787,573	9.5%
31,795	13,161	3,442,205,000	152,828,219,897	8.5%

**Table 2. National Marginal Gas Well Survey from 1992 - 2015**

Year	Number of Marginal Gas Wells	Production from Marginal Gas Wells (Mcf)	Price of Natural Gas (\$/Mcf)	Value of Marginal Gas Production(\$)	Value of Annual Marginal Production per Well (\$)
1992	130,432	670,202,323	1.74	1,166,152,043	8,941
1993	142,100	759,410,105	2.04	1,549,196,615	10,902
1994	159,369	940,421,000	1.85	1,739,778,850	10,917
1995	159,669	925,563,034	1.55	1,434,622,703	8,985
1996	168,702	986,676,219	2.17	2,141,087,395	12,692
1997	189,756	1,042,153,002	2.32	2,417,794,965	12,742
1998	199,745	1,104,683,975	1.96	2,165,180,591	10,840
1999	207,766	1,138,979,506	2.19	2,494,365,118	12,006
2000	223,222	1,258,726,664	3.68	4,632,114,124	20,751
2001	234,507	1,353,516,378	4.00	5,414,065,512	23,087
2002	245,961	1,418,273,779	2.95	4,183,907,648	17,010
2003	260,563	1,478,105,524	4.88	7,213,154,957	27,683
2004	271,856	1,539,960,495	5.46	8,408,184,303	30,929
2005	288,898	1,760,063,552	7.33	12,901,265,836	44,657
2006	304,000	1,716,319,702	6.39	10,967,282,896	36,077
2007	322,160	1,763,592,746	6.25	11,022,454,663	34,214
2008	326,242	1,831,573,892	7.97	14,597,643,920	44,745
2009	331,474	2,152,462,929	3.67	7,899,538,950	23,832
2010	353,490	2,171,645,538	4.47	9,713,211,951	27,478
2011	361,053	2,091,335,077	3.94	8,239,026,685	22,819
2012	357,654	2,079,381,360	2.66	5,528,031,064	15,456
2013	374,580	2,101,632,966	3.73	7,840,411,518	20,931
2014	388,062	2,069,908,061	4.37	9,050,200,896	23,322
2015	377,977	1,955,292,380	2.62	5,131,618,630	13,577

Average Daily Production per Well (Mcf)	Gas Wells Plugged/ Abandoned	Total Gas Production (Mcf)	Value of Total Gas Production (\$)	Marginal Share of Total Production
14.1	3,161	18,711,808,000	32,558,545,920	3.6%
14.6	3,162	18,981,915,000	38,723,106,600	4.0%
16.2	3,163	19,709,525,000	36,462,621,250	4.8%
15.9	3,189	19,506,474,000	30,235,034,700	4.7%
16.0	4,671	19,812,241,000	42,992,562,970	5.0%
15.0	4,661	19,866,093,000	46,089,335,760	5.2%
15.2	4,203	19,961,348,000	39,124,242,080	5.5%
15.3	3,546	19,804,848,000	43,372,617,120	5.8%
15.4	3,534	20,197,511,000	74,326,840,480	6.2%
15.8	3,600	20,570,295,000	82,281,180,000	6.6%
15.8	3,870	19,884,780,000	58,660,101,000	7.1%
15.5	3,883	19,974,360,000	97,474,876,800	7.4%
15.5	4,129	19,517,491,000	106,565,500,860	7.9%
16.7	4,517	18,927,095,000	138,735,606,350	9.3%
15.5	4,463	19,409,674,000	124,027,816,860	8.8%
15.0	5,155	20,196,346,000	126,227,162,500	8.7%
15.4	5,075	21,112,053,000	168,263,062,410	8.7%
17.8	5,381	21,647,936,000	79,447,925,120	9.9%
16.8	6,333	22,381,873,000	100,108,361,384	9.7%
15.9	6,803	24,036,352,000	94,693,647,000	8.7%
15.9	9,119	25,283,278,000	67,215,542,498	8.2%
15.4	7,541	25,562,232,000	95,363,187,336	8.2%
14.6	8,266	27,336,644,000	119,523,241,002	7.6%
14.2	7,301	28,751,579,000	75,457,839,431	6.8%

# U.S. Marginal Well Count & Production Trends

Year-to-year changes in the number and production of marginal oil and gas wells can be traced to many factors. These include trends in oil and gas exploration, the aging of producing wells, tax treatment of marginal production, crude oil and natural gas prices, and other factors.

In the current survey period, two key market forces were at work to reduce the role played by marginal well activity. First, the dramatic rise in U.S. production from readily available reserves has shifted some of the focus away from maintaining long-run production from marginal wells. Second, the collapse in oil prices in 2015 and early 2016 placed the economic viability of many more marginal wells in jeopardy.

Despite these current challenges, marginal wells remain in widespread operation across the country and continue to reliably produce a meaningful share of total domestic oil and natural gas output.

## Continued growth in the number of marginal wells

Tables 1 and 2 provide detailed statistics on annual U.S. marginal oil and natural gas production, respectively, derived from IOGCC marginal well surveys administered for production years 1992 to 2015. An estimated 786,000 marginally-producing wells (408,000 oil wells and 378,000 natural gas wells) contributed to U.S. oil and gas production in 2015 (see Figure 7).

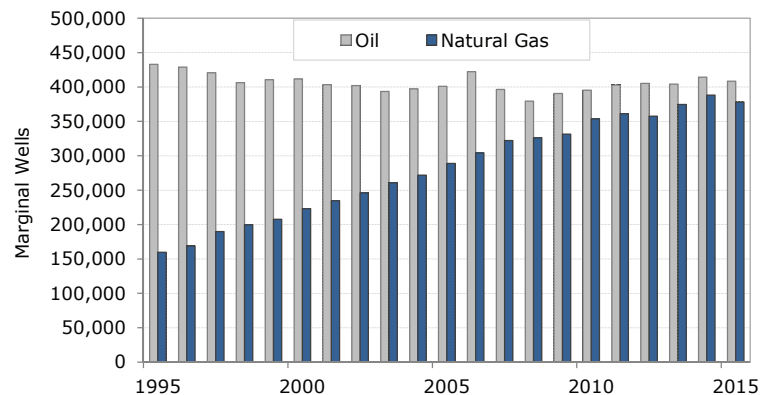
The total number of producing marginal wells increased by nearly 24,000 (3.1 percent) since the prior survey in 2012. Over the past two decades, almost 200,000 additional wells have been deemed marginal producers, a one-third increase in the total.

The share of all operating wells in the U.S. that are marginal producers remains quite high (see Figure 8). In fact, most wells in the U.S. are marginal based on

their rate of production. The nation's 408,000 marginal oil wells comprise an estimated 69.1 percent of all operating oil wells in the U.S. in 2015. The 378,000 reported marginal gas wells comprise an even larger share, 75.9 percent, of all operating natural gas wells. Overall, 72.2 percent of all operating wells in the U.S. in 2015 are marginal producers.

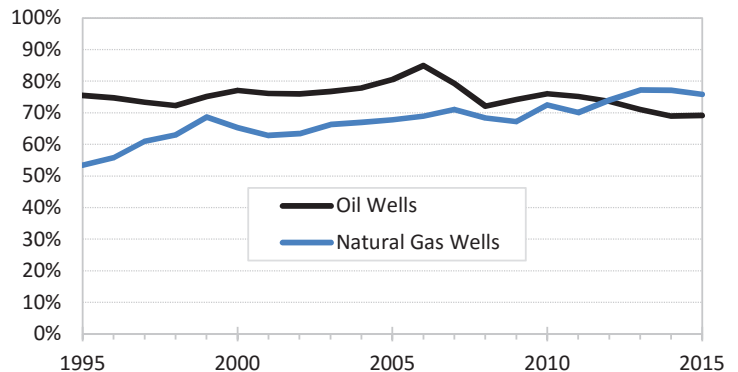
Most of the increase in the marginal well count the past two decades has been on the natural gas side. The steady rise in domestic natural gas drilling activity since 2001 continues to produce steady growth in the number of marginal gas wells. The count increased by 20,300 gas wells since the 2012 survey to 377,977, a 5.7 percent increase. Other than a modest slowing in both

**Figure 7. Number of Marginal Oil and Natural Gas Wells**



Source: IOGCC Marginal Well Survey and RegionTrack

**Figure 8. Marginal Share of Total Oil and Natural Gas Wells**



Source: U.S. EIA, World Oil, and RegionTrack



2012 and 2015 under pressure from very low natural gas prices, the number of marginal natural gas wells in the U.S. has increased steadily the past two decades.

On the oil side, the sharp rise in oil prices beginning in 2008 has increased oil drilling activity and once again led to a rising number of marginal oil wells. More than 29,000 oil wells (7.7 percent increase) have become marginal since 2008, pushing the total to 408,490 in the 2015 survey. The current uptrend reverses a nearly two-decade slide in the number of marginal oil wells that was driven largely by weak oil prices.

### Marginal production trends

Despite a continued rise in the number of marginal wells since the 2012 survey, marginal oil production increased only moderately and marginal natural gas production declined slightly in the period (see Figure 9).

Marginal oil production has remained in a slow, steady uptrend since 2008 and is consistent with the slowly rising number of marginal oil wells. Since the 2012 survey, marginal oil production has increased 5.9 percent, from 276.3 million barrels to 292.5 million barrels in 2015. The weakness in 2015 marginal oil production relative to 2013 and 2014 is due primarily to the collapse in oil prices and is consistent with the pullback in the number of marginal oil wells in 2015.

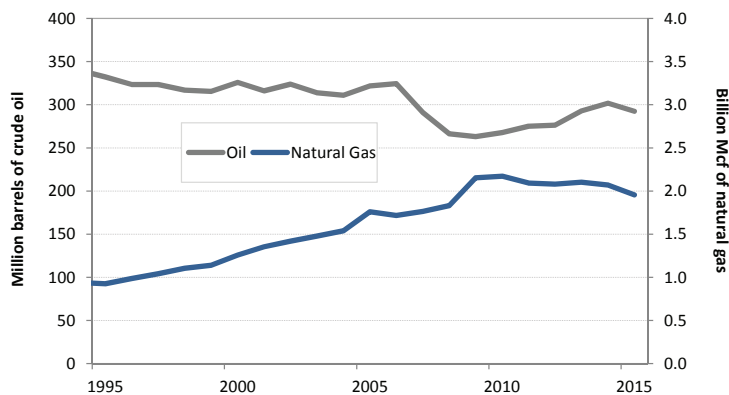
Conversely, the steady long-run increase in marginal natural gas production in place for several decades reversed course beginning in 2010 and remains in a moderate downtrend. Marginal natural gas production fell 6.0 percent since the 2012 survey, despite rising numbers of marginal gas wells. Total production from the nation's 378,000 marginal natural gas wells in 2015 fell to 1.96 billion Mcf, 10.0 percent below the all-time peak of 2.17 billion Mcf reached in 2010.

Figure 10 illustrates the sharp drop in the estimated market value of both marginal oil and marginal natural gas production since the 2012 survey.<sup>4</sup> The combined market value of marginal oil and natural gas fell to only \$18.1 billion in 2015, the lowest market valuation for total marginal production since 2003.

The collapse in crude oil prices played the largest role in reducing the value of marginal output between the 2012 and 2015 survey periods (see Figure 10). Marginal

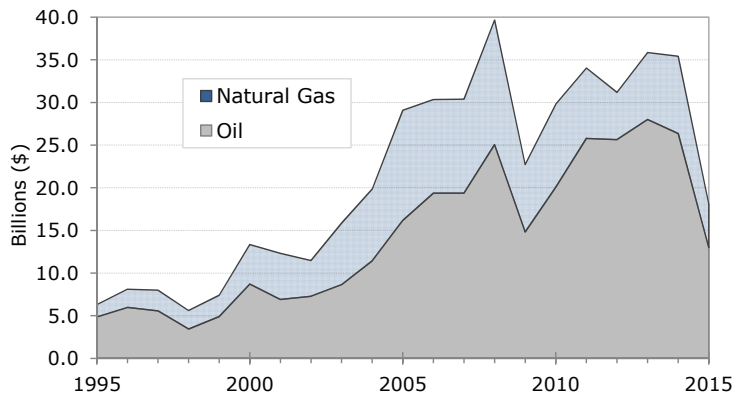
oil typically provides at least two-thirds of the total market value of marginal production and can more readily sway the overall valuation. In 2015, the estimated market value of the 292.5 million barrels of marginal oil were valued at only \$13.0 billion based on an average price of only \$44.40 per barrel. This is less than half the market value of marginal oil production each year from 2011 to 2014 when the total value averaged \$26.7 billion annually.

**Figure 9. Marginal Oil and Natural Gas Production**



Source: IOGCC Marginal Well Survey, U.S. EIA, and RegionTrack

**Figure 10. Market Value of Marginal Production**



Source: IOGCC Marginal Well Survey, U.S. EIA, and RegionTrack

The value of marginal natural gas production benefited since the last survey from a rise in natural gas prices to \$3.73 per Mcf in 2013 and to \$4.37 per Mcf in 2014. However, the sharp pullback to an average price of only \$2.62 per Mcf in 2015 sharply reduced the value to only \$5.1 billion. This represents the lowest annual valuation for marginal natural gas since 2002 and is only about one-third the \$14.6 billion produced in 2008 at the recent peak in natural gas prices.

## Marginal production remains a substantial share of U.S. oil and gas

The ongoing boom in U.S. oil and natural gas output has slowly lowered the share of total U.S. production derived from marginal wells. Despite the reduction in share, marginal wells remain a critical contributor to total U.S. production.

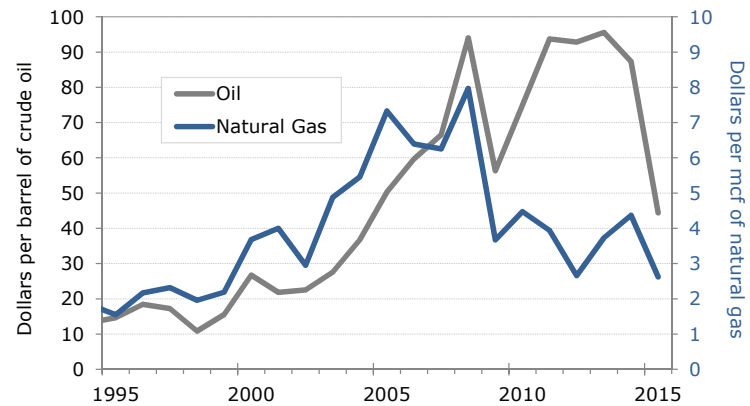
Figure 12 illustrates the share of total U.S. oil and natural gas produced from marginal wells the past two decades. While the quantity of oil produced from marginal wells has increased modestly since 2008, the share of total U.S. oil production from marginal wells has dropped steadily from a peak of 17.5 percent in 2006 (see Figure 12) as unconventional oil production has boosted total production levels. In 2015, the 292.5 million barrels of marginal oil produced represent 8.5 percent of total domestic oil production of 3.44 billion barrels. For comparison, total U.S. oil production increased by more than 1.1 billion barrels (45 percent) between 2012 and 2015, while marginal oil output increased only 16.2 million barrels (5.9 percent) in the period.

The marginal share of total U.S. oil production is more notable when viewed alongside the production levels of the major oil-producing states. Despite the rapid rise in non-marginal oil production, the volume of marginal oil produced in the U.S. in 2015 still exceeds the total oil production of every producing state except Texas (1.0 billion barrels) and North Dakota (432.3 million barrels). Third-place California produced only 201.7 million barrels of oil in 2015, nearly one-third less than total marginal oil output.

The marginal share of total U.S. natural gas production increased steadily much of the past two decades before peaking at an all-time high of 9.9 percent in 2009 (see Figure 12). The marginal share of U.S. production has since retreated slowly to 7.0 percent in 2015 as total domestic gas production increased and marginal gas production softened.

The current volume of 1.96 billion Mcf of marginal natural gas exceeds the production of all but four natural gas-producing states - Texas (8.02 billion Mcf), Louisiana (2.88 billion Mcf), Pennsylvania (2.26 billion Mcf), and Wyoming (2.25 billion Mcf). U.S. marginal

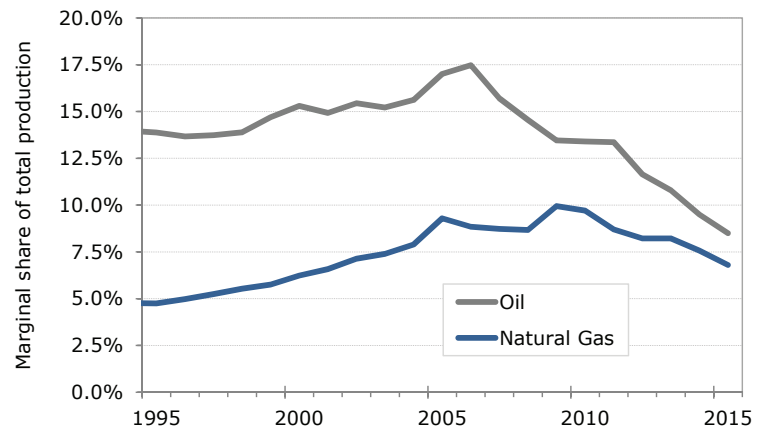
**Figure 11. Oil and Natural Gas Prices**



Source: U.S. EIA and RegionTrack

Note: Prices are annual averages. Oil price is West Texas Intermediate. Natural gas price is Henry Hub spot.

**Figure 12. Marginal Share of Total U.S. Production**



Source: IOGCC Marginal Well Survey, U.S. EIA, and RegionTrack

gas output slightly exceeds the total natural gas output of top-tier gas producing states such as Oklahoma (1.88 billion Mcf) and Colorado (1.71 billion Mcf).

Measured across both oil and natural gas, the estimated \$18.1 billion in marginal oil and natural gas production in 2015 represents 7.9 percent of the value of all oil and natural gas produced domestically in the U.S. This share is five percentage points below the 12.9 percent all-time peak share of total production established in 2006, and is only 45 percent of the peak value of \$39.6 billion reached in 2008 when energy markets were driven by historically high prices for both oil and natural gas (see Figure 11).

## Marginal well productivity

Tables 1 and 2 also contain a summary of the productivity characteristics of marginal oil and natural gas wells, respectively, from 1992 to 2015. A typical marginal oil well in the U.S. produced about 716 barrels of oil annually, or 1.96 barrels per day, in 2015. After dipping well below 2 barrels per day from 2009 to 2012, average production has since moved closer to 2 barrels per day, averaging 1.98 barrels from 2013 to 2015.

The market value of oil produced per marginal oil well collapsed along with crude oil prices in 2015, falling to only \$31,800 annually at an average oil price of \$44.40 per barrel. This is less than half the \$65,700 in production from a typical marginal oil well between 2011 and 2014.

The average marginal natural gas well in the U.S. produced 14.2 Mcf of natural gas per day, or 5,170 Mcf annually, in 2015. The average daily output is down steadily from an all-time high of 17.8 Mcf as recently as 2009, a decline of 20 percent in the period.

The value of production from the average marginal natural gas well in the survey was only \$13,550 in 2015 at a relatively low average price of \$2.62 per Mcf of natural gas. This value is less than one-third the \$44,745 in gas value produced at the recent natural gas price peak in 2008.

# State - Level Trends

## Marginal Production

Marginal oil and natural gas is currently produced in roughly two-thirds of the U.S. states. Many of the large, traditional oil- and gas-producing states generally have both the largest number of producing marginal wells and highest amount of marginal production. Tables 3 and 4 provide state-level well counts and production data from the IOGCC survey of marginal oil and natural gas production for 2015.

### Marginal Oil Production

*Marginal oil is produced from wells that operate on the lower edge of profitability. Generally speaking, low-volume “stripper” wells – defined by the IOGCC as those wells producing 10 barrels of oil per day or less – fall into this category.*

The top 10 marginal oil-producing states in 2015 include the traditional oil patch states of Texas, Oklahoma, Kansas, and Louisiana as well as a diverse group of other producing states including New Mexico, California, North Dakota, Colorado, Ohio, and Illinois. Jointly, their 364,278 marginal oil wells produced 265.6 million barrels of marginal oil, or more than 90 percent of total U.S. marginal oil production, in 2015.

Texas and California alone produced 60 percent of the 292.3 million barrels of total marginal oil output in 2015. A second tier of six states – Kansas, New Mexico, Oklahoma, North Dakota, Illinois, and Louisiana – produced between 9 million and 17 million barrels of marginal oil each in 2015 and jointly produced a total of 80.0 million barrels (27.4 percent of total marginal oil). Overall, 20 of the 29 survey states produced more than 1 million barrels of oil from marginal wells in 2015.

The U.S. added 3,330 net new marginal oil wells since the 2012 survey, as a majority of the survey states experienced an increase. States with the largest gains include Texas (+9,650 wells), Louisiana (+3,897 wells), California (+3,256 wells), Illinois (+1,906 wells), New

Mexico (+1,349 wells), Pennsylvania (+786 wells), and North Dakota (+500 wells).

Eleven states reported a declining number of marginal oil wells in the period, with the largest decline of 14,991 wells reported in Ohio. Other states with a significant reduction in the number of marginal oil wells include Wyoming (-1,103 wells), Oklahoma (-816 wells), West Virginia (-745 wells), Kansas (-693 wells), Colorado (-413 wells), and Kentucky (-232 wells).

Texas and California now account for more than 45 percent of all producing marginal oil wells, with 152,376 wells and 37,262 wells, respectively. Other states with more than 15,000 producing marginal oil wells include Illinois, Kansas, Kentucky, Louisiana, New Mexico, Ohio, Oklahoma, and Pennsylvania.

The total amount of marginal oil produced in the U.S. increased 5.9 percent (16.2 million barrels) between the 2012 and 2015 surveys, as well as in most reporting states. Texas and California posted the largest increases in annual marginal oil production with gains of 12.5 million barrels and 6.0 million barrels, respectively, in the period. States with gains in marginal oil production exceeding 500,000 barrels in the period include North Dakota (+1.6 million barrels), Ohio (+1.6 million barrels), Illinois (+613,000 barrels), Kansas (+689,000 barrels), New Mexico (+646,000 barrels), Utah (+533,000 barrels), and Michigan (+525,000 barrels).

Six large marginal oil-producing states posted declines in marginal oil production since the 2012 survey. Among these, Colorado marginal oil output declined by 4.2 million barrels and accounts for roughly half of all lost marginal oil output across the survey states. Marginal oil production also fell by an estimated 1.1 million barrels in Wyoming, 914,000 barrels in Oklahoma, 855,000 barrels in Louisiana, 559,000 barrels in Pennsylvania, and 416,000 barrels in Kentucky. These six states all produce at least 1.4 million barrels of oil annually from marginal wells. All other states that

experienced a decline in output were either very small marginal oil producers or suffered relatively small percentage declines.

The average daily production rate for marginal oil wells has remained at or slightly below 2 barrels per day for several years but continues to vary widely across the states. Average daily oil production is highest in North Dakota (11.4 Bbls), South Dakota (4.5 Bbls), Nevada (4.4 Bbls), Michigan (4.3 Bbls), and Utah (4.1 Bbls), all states where the rate is more than twice the overall average across all marginally producing states. Seven states have especially low volume marginal wells (less than 1 barrel per day), including Pennsylvania (0.18 Bbls), New York (0.21 Bbls), Kentucky (0.24 Bbls), West Virginia (0.63 Bbls), Virginia (0.87 Bbls), Missouri (0.89 Bbls), and Illinois (0.89 Bbls).

While the average share of total U.S. oil production from marginal wells is 8.5 percent, the contribution of marginal oil to total state oil production remains highly variable across the survey states. Three states – Illinois, Missouri, and New York – produce essentially all of their oil from marginal wells. A second group of five states including Indiana, Kentucky, Nebraska, Michigan, and Arkansas produce between 50 percent and 90 percent of total state oil output from marginal wells.

The majority of the major marginal oil-producing states generate one-third or less of total state oil output from marginal wells. Eight of the ten largest marginal oil-producing states – Louisiana (14.3 percent), Texas (12.6 percent), New Mexico (11.3 percent), Utah (10.9 percent), Oklahoma (9.6 percent), Colorado (4.6 percent), Wyoming (3.8 percent), and North Dakota (3.0 percent) – derive less than 15 percent of total state oil production from marginal wells.

## Marginal Natural Gas Production

*Marginal natural gas wells are defined by the IOGCC as those wells producing 60 Mcf of natural gas per day or less.*

Eight states – Texas, Oklahoma, Colorado, Kansas, Kentucky, West Virginia, New Mexico, and Pennsylvania – remain the clear leaders in marginal natural gas production. Each produced more than 100 million Mcf of natural gas from marginal wells in 2015. Jointly they accounted for 1.57 billion Mcf, or 81 percent of

total U.S. marginal production, in 2015. This represents a 5.4 percent decline in output for the group of eight states relative to the 1.66 Mcf reported in 2012. Texas and Oklahoma are the largest among the leaders and combined to produce 37 percent of total U.S. marginal natural gas output in 2015, the same share reported in the 2012 survey.

A second tier of four states including Michigan, Louisiana, Ohio, and Alabama produced between 50 million and 100 million Mcf of marginal natural gas each in 2015 and jointly accounted for an additional 234.7 million Mcf of production. The top 12 states produced more than 92 percent of all marginal natural gas output. Overall, 20 of the 28 states reporting marginal gas production in the survey produced more than 5 million Mcf of natural gas from marginal wells in 2015.

More than 20,300 net new marginal natural gas wells were added between the 2012 and 2015 surveys. Consistent with the rise in the number of marginal natural gas wells at the national level, 18 of the 28 states that produced marginal natural gas in 2015 posted an increase in wells between 2012 and 2015. States adding more than 1,000 marginal gas wells include Pennsylvania (+12,119 wells), Oklahoma (+4,675 wells), Texas (+1,910 wells), Colorado (+1,638 wells), Kentucky (+1,084 wells), and West Virginia (+1,006 wells). Of the ten states reporting a decline since 2012, Wyoming's decline of 2,775 marginal gas wells in the period represents more than half of the declining well count. Other states with a decline of more than 100 marginal gas wells include Kansas (-666 wells), Montana (-429 wells), Illinois (-414 wells), New York (-264 wells), Ohio (-206), and Nebraska (-150 wells).

By total number of marginal gas wells, Pennsylvania, Texas, West Virginia, Oklahoma, and Ohio are the largest, with each having more than 30,000 marginal natural gas wells. These five states jointly account for two-thirds (252,500) of all marginal natural gas wells in the U.S. in 2015. A second tier of states with more than 15,000 marginal natural gas wells includes Kentucky, Colorado, Kansas, Louisiana, and New Mexico.

The survey states posted an aggregate 6.0 percent decline (-124.1 million Mcf) in total marginal natural gas output between the survey years of 2012 and 2015. Fourteen of the 28 states producing marginal gas reported a decline in the period. Ten of the 14 declining

states reported a decline of ten percent or more. Six of the 14 states with falling production reported an increase in the number of marginal gas wells in the period, a sign of declining productivity for the average marginal gas well in those states.

There is also tremendous variability in the production trend among the top marginal gas-producing states. Among the eight states that produced more than 100 million Mcf of marginal natural gas, only three – Colorado, New Mexico, and Oklahoma – saw an increase in output averaging 5.1 percent since the 2012 survey. The remaining five top producing states – Kansas, Kentucky, Pennsylvania, Texas, and West Virginia – suffered a decline averaging 14.3 percent in the period. Texas, the largest marginal gas producing state, posted a 3.1 percent decline.

The daily production rate for all marginal natural gas wells has averaged 15.6 Mcf across the past two decades but fell to only 14.2 Mcf in 2015. This reflects a 20 percent decline in marginal well productivity from the recent peak production rate 17.8 Mcf per day reported in 2009. Daily production rates vary greatly across the producing states, with average rates above 25 Mcf in Arizona (49.1 Mcf), Utah (28.4 Mcf), Colorado (27.4 Mcf), Kansas (27.0 Mcf), Alabama (26.0 Mcf), and Wyoming (25.7 Mcf). States with especially low volume marginal gas wells (less than 10 mcf per day) include Illinois (1.8 Mcf), Mississippi (2.5 Mcf), New York (3.8 Mcf), Ohio (4.7 Mcf), Pennsylvania (4.3 Mcf), Missouri (6.2 Mcf), West Virginia (7.1 Mcf), Nebraska (7.3 Mcf), and South Dakota (9.3 Mcf).

Similar to oil, marginal natural gas production as a share total state natural gas output remains highly variable across the survey states. Four states currently produce substantially all of their natural gas from marginal wells – Kentucky, Maryland, Missouri, and Nebraska. Six additional states – Indiana, Montana, Michigan, Kansas, Arizona, and New York – produce between 50 percent and 90 percent of total state natural gas output from marginal wells. In contrast, the eight largest natural gas-producing states measured by total volume averaged only 5.9 percent of total state natural gas output from marginal wells in 2015. This is slightly below the overall average of 7.0 percent across all survey states and reflects in part the attractive environment for the development of new gas wells in these states.

# Economic Spillover Effects from Marginal Production

While marginal oil and gas production is a relatively small segment of the broader U.S. energy complex, it nonetheless remains a sizeable business sector. In 2015, marginal wells were used to produce oil and natural gas valued at \$18.1 billion.

This business activity is driven largely by thousands of small well operators who focus on the less visible production side of the industry rather than drilling and exploration.<sup>5</sup> The combined activity of marginal well operators exerts a range of substantial direct economic impacts. This activity, in turn, induces spillover economic activity in other areas of the broader economy of each producing state.

In order to assess the economic contribution of marginal oil and natural gas production, two industry scenarios are examined. The first is the hypothetical case where all marginal oil and natural gas production is eliminated. A second scenario assesses the economic impact of the recent collapse in oil prices on marginal producers between the 2012 and 2015 survey years.

Estimates of the size of the spillover effects to the broader economy are formed for each survey state. The economic impacts are estimated at the individual state level in order to capture differing degrees of economic linkages between the oil and natural gas sector and other industry sectors within each survey state. The state-level estimates are then aggregated to assess the total expected effect across the nation.

## Spillover effects from marginal production

Keeping a marginal well in active production extends the life of a large and long-lived stream of payments to a range of recipients. An operating marginal well provides a multi-year stream of revenue for marginal well operators, earnings to employees, income to servicing firms, payments to royalty owners, and tax revenue to federal, state, and local governments.

Marginal production also produces indirect, or spillover, economic impacts as producers purchase goods and services from firms in other sectors of the economy. Marginal wells must be monitored, maintained, and serviced on a continual basis by local servicing firms. The daily production of marginal oil and natural gas requires ongoing expenditures for electricity and other fuels, truck transportation, and storage. Well work-overs and stimulation are frequently used to extend the life of existing wells. Manufactured goods are needed to support a well's operation until final shut-in.

Marginal well activity also feeds downstream relationships with pipelines and refineries. And like all oil and gas activity, marginal production requires the ongoing use of significant legal, financial, and other business services. In short, nearly every major industry sector in every producing state benefits from some level of direct or indirect purchases from the operation of marginal wells.

## Measuring economic impact

Estimates of the economic spillover effects from marginal oil and gas production are formed for each state using Regional Input-Output Modeling System (RIMS II) multipliers from the U.S. Bureau of Economic Analysis (BEA).<sup>6</sup> RIMS II multipliers provide model-based estimates of the impact that a local demand shock has on total gross output, value added, earnings, and employment within a region.<sup>7</sup> In other words, multipliers provide a convenient method for estimating the effects that a change in *output*, *employment*, or *earnings* within an industry sector may have on broader state economic activity. The use of RIMS II multipliers also maintains consistency with the approach used in marginal well reports in prior years.

The demand shock in the two scenarios evaluated is a change in marginal oil and natural gas production. Estimates of the spillover effects are formed using

Type-2 state-level multipliers derived for NAICS industry sector 211000 (Oil and Gas Extraction).<sup>8</sup> For the marginal oil and natural gas sector, *output* multipliers provide an estimate of the change in output in the broader state economy per dollar of output (or revenue) added or lost in the form of changing marginal oil and natural gas production. *Employment* multipliers provide an estimate of the number of jobs generated in the broader state economy as marginal production changes. Similarly, *earnings* multipliers provide an estimate of the amount of additional earnings received by households in the broader state economy as marginal production changes.

It is important to note that the RIMS multipliers represent estimates of *gross* economic effects and do not account for any public or private costs associated with oil and gas production. And while the estimated spillover effects are calculated for each of the 29 states in the survey and then aggregated, they represent only an approximation of the total national impact.

Many of the traditional energy-producing states such as California, Colorado, Kansas, Louisiana, Oklahoma, Texas, and Wyoming have a large and highly diverse industry mix that has developed over time to support oil and natural gas activity. The smaller producing states generally have smaller support sectors located within the state and must import significant quantities of both goods and services from outside the state to support oil and natural gas activity. The larger and more developed these linkages to other industries within a given state, the greater the resulting multiplier tends to be on average.

### Economic contribution of marginal oil

Table 5a provides an assessment of the overall economic contribution of marginal oil production in 2015. Again, the estimates are based upon a hypothetical elimination of all marginal oil production in each of the producing states.<sup>10</sup>

**Table 5a. Economic Impact of Hypothetical Elimination of Marginal Oil Production**

State	Direct Impact			Multipliers			Total Impact		
	Lost Output (\$)	Earnings Loss (\$)	Employment Loss	Output	Earnings	Employment	Lost Output (\$)	Earnings Loss (\$)	Employment Loss
Texas	5,693,341,064	1,473,436,667	15,983	1.72	2.12	3.70	9,787,991,957	3,127,074,639	59,203
California	2,176,674,064	517,177,758	5,518	1.53	1.85	2.86	3,323,128,294	956,623,698	15,804
Kansas	731,770,894	167,721,889	3,131	1.48	1.72	1.96	1,083,386,809	288,951,270	6,131
Oklahoma	682,873,995	172,220,821	1,908	1.57	1.90	3.24	1,072,521,896	326,410,123	6,178
New Mexico	730,954,980	162,929,865	2,245	1.45	1.72	2.40	1,056,814,710	280,060,145	5,390
North Dakota	531,585,440	123,168,346	1,575	1.45	1.66	2.20	771,755,741	205,001,396	3,463
Louisiana	435,705,144	107,227,036	1,234	1.57	1.92	3.07	684,623,493	205,897,355	3,788
Illinois	418,638,370	94,779,727	2,119	1.50	1.83	1.79	628,752,968	173,257,341	3,787
Colorado	236,162,554	60,552,079	656	1.66	2.07	3.66	391,014,341	125,439,687	2,402
Ohio	210,170,381	47,204,268	978	1.48	1.81	1.87	311,388,436	85,326,434	1,827
Utah	163,536,691	40,622,514	524	1.59	1.96	3.15	260,334,058	79,571,380	1,651
Michigan	164,496,918	37,275,002	853	1.42	1.72	1.74	233,519,825	64,045,908	1,486
Arkansas	142,691,846	32,419,587	596	1.46	1.77	2.02	208,544,133	57,453,993	1,206
Wyoming	133,758,676	30,764,495	322	1.40	1.61	2.47	187,890,812	49,500,073	795
Kentucky	103,885,192	22,532,698	526	1.42	1.68	1.72	147,735,132	37,751,282	907
Indiana	88,882,108	18,523,031	244	1.40	1.67	2.44	124,257,187	30,916,792	594
Montana	82,687,418	17,752,989	258	1.43	1.74	2.42	118,267,814	30,852,919	624
Pennsylvania	55,488,186	12,790,027	138	1.56	1.94	3.17	86,311,873	24,807,536	438
Nebraska	64,015,359	13,974,553	323	1.34	1.58	1.60	85,716,566	22,033,678	517
Mississippi	54,795,833	12,438,654	163	1.45	1.72	2.53	79,552,590	21,389,510	412
Alabama	32,727,187	7,379,981	172	1.42	1.67	1.74	46,410,424	12,354,088	300
West Virginia	28,282,009	6,377,593	148	1.47	1.70	1.72	41,540,615	10,839,995	255
New York	12,566,321	2,610,025	31	1.36	1.57	2.09	17,049,984	4,104,264	65
Missouri	6,125,820	1,313,376	30	1.42	1.68	1.71	8,710,916	2,204,895	52
Nevada	3,075,561	680,622	16	1.36	1.63	1.63	4,188,914	1,107,167	26
South Dakota	2,016,600	420,864	10	1.30	1.51	1.57	2,614,521	634,074	16
Arizona	866,848	185,159	4	1.39	1.68	1.73	1,203,098	311,789	7
Virginia	42,526	8,684	0	1.37	1.63	1.64	58,064	14,184	0
Maryland	-	-	-	-	-	-	-	-	-
Survey States	12,987,817,985	3,184,488,310	39,706	1.60	1.95	2.95	20,765,285,174	6,223,935,614	117,323



The value of lost marginal oil output totaling \$12.99 billion in 2015 is used to estimate both the employment required to produce the output and the earnings that would be lost if production were eliminated. Using ratios of output to employment and output to earnings derived from RIMS multipliers for each state, the shuttering of marginal oil production (NACIS sector 211000) would produce an estimated decline in direct employment of 39,706 workers and a reduction in direct earnings of \$3.18 billion across the states reporting marginal oil production in 2015.

More than 60 percent of the direct economic loss is concentrated in the key oil producing states of Texas and California. The direct impact to the oil and gas industry in these two states totals \$7.87 billion in lost output, 21,502 lost jobs, and \$2.0 billion in lost earnings. Four additional states – Kansas, Oklahoma, New Mexico, and North Dakota – all suffer direct reductions in output in the oil and gas sector of more than \$500 million. Nine additional states – Arkansas, Colorado, Illinois, Kentucky, Louisiana, Michigan, Ohio, Utah, and Wyoming – suffer an estimated loss in direct output in the oil and gas sector of at least \$100 million with the elimination of marginal oil production.

RIMS II multipliers provide an estimate of the spillover effects to the broader economy of the survey states as a result of eliminating marginal oil production. In addition to the overall direct loss of \$12.99 billion in oil and gas output, the weighted average of the output multipliers in Table 5a suggest that each dollar of reduced marginal oil output reduces the total output of goods and services in the marginally producing states by an additional 60 cents (1.60-1.0) through spillover effects. Based on the overall employment multiplier, each direct job lost as a result of eliminating marginal oil production will reduce total employment in these states by an additional 1.95 jobs (2.95-1.00). Similarly, based on the earnings multiplier, cutting marginal oil production by one dollar reduces total earnings in the marginal producing states by an additional \$0.95 (1.95-1.0).

Accounting for both direct and spillover effects, lost output from a hypothetical shuttering of marginal oil production would total an estimated \$20.8 billion in 2015. This consists of a loss of \$13.0 billion in direct oil production and \$7.8 billion in lost production in other areas of the economy through spillover effects. Total employment losses reach an estimated 117,323 full-

and part-time jobs, consisting of a direct loss of 39,706 energy sector jobs and an additional loss of 77,617 jobs through spillover effects. The total earnings decline to households is estimated at \$6.2 billion, with roughly half (\$3.04 billion) resulting from spillover earnings losses in other sectors of the survey states.

Including spillover losses, the overall impact of shuttering marginal oil production is heavily concentrated in 8 states. The total output loss is again greatest in Texas (-\$9.8 billion) and California (-\$3.3 billion). The estimated share of total jobs lost in the scenario originating from these two states alone is 64 percent (75,007 jobs). Three additional states – Kansas, Oklahoma, and New Mexico – are expected to suffer a total output loss in excess of \$1 billion from eliminating marginal oil production. Three more states – North Dakota, Louisiana, and Illinois – suffer a total decline in the output of goods and services of more than \$500 million. The top eight states measured by lost output are expected to suffer combined total job losses ranging between 3,788 (Louisiana) and 59,203 (Texas) workers, as well as earnings declines ranging from \$173 million (Illinois) to \$3.1 billion (Texas). Jointly, these eight states account for more than 89 percent of total lost output, 89 percent of total lost earnings, and 87 percent of total lost employment.

### Economic contribution of marginal gas

Table 5b provides estimates of the expected impact of eliminating marginal natural gas output totaling \$5.13 billion in 2015. Using RIMS multipliers for each state in the survey, the shuttering of marginal natural gas production produces an estimated decline in direct oil and gas employment of 17,854 workers, less than half the estimated number of direct jobs lost under the scenario of ending marginal oil production. Direct earnings lost total an estimated \$1.23 billion across the 28 states reporting marginal natural gas production in 2015.

Twelve states would suffer a loss in direct output of natural gas of more than \$100 million. Texas suffers the greatest loss at \$1.1 billion, or nearly 22 percent of the total reduction in marginal gas across all states. Oklahoma (\$855.6 million) suffers the second largest output loss, and when combined with Texas accounts for approximately 38 percent (\$1.97 billion) of the total direct loss to the marginal oil and gas sector. Texas would experience an earnings loss of \$289 million

versus \$216 million in Oklahoma, along with a direct employment loss of 3,135 jobs in Texas versus 2,391 jobs in Oklahoma.

Six additional key marginal gas producing states – Colorado, Kansas, New Mexico, West Virginia, Kentucky, and Pennsylvania – would suffer direct reductions in oil and gas industry output of at least \$250 million if marginal gas production ceased. Four more states – Michigan, Louisiana, Ohio, and Alabama – would suffer estimated direct reductions in output in the oil and gas sector of more than \$100 million.

RIMS II multipliers provide an estimate of the spillover economic loss in each of the survey states as a result of eliminating marginal natural gas production. Using

weighted average results across all 29 states, the output multipliers in Table 5b suggest that each dollar reduction in marginal gas output reduces total economic activity in the survey states through spillover effects by an additional 56 cents (1.56-1.0). Each direct job lost as a result of eliminating marginal natural gas production will reduce total employment by an additional 1.61 jobs (2.61-1.00). Similarly, reducing household earnings from marginal oil production by one dollar will reduce total household earnings in the survey states by an additional \$0.89 (1.89-1.0).

Including multiplier effects, lost output from a hypothetical shuttering of marginal natural gas production totals an estimated \$8.0 billion in 2015. This is about 40 percent the size of the loss expected from shuttering marginal oil production. The \$8.0 billion loss comprises

**Table 5b. Economic Impact of Hypothetical Elimination of Marginal Natural Gas Production**

State	Direct Impact			Multipliers			Total Impact		
	Lost Output (\$)	Earnings Loss (\$)	Employment Loss	Output	Earnings	Employment	Lost Output (\$)	Earnings Loss (\$)	Employment Loss
Alabama	134,111,651	30,242,177	706	1.42	1.67	1.74	190,183,732	50,625,405	1,229
Arizona	129,141	27,585	0.6	1.39	1.68	1.73	179,235	46,450	1.1
Arkansas	67,019,801	15,226,899	280	1.46	1.77	2.02	97,949,440	26,985,110	566
California	20,759,530	4,932,464	53	1.53	1.85	2.86	31,693,574	9,123,579	151
Colorado	438,185,033	112,350,642	1,218	1.66	2.07	3.66	725,502,959	232,745,591	4,457
Illinois	1,121,327	253,868	6	1.50	1.83	1.79	1,684,120	464,071	10
Indiana	15,759,926	3,284,369	43	1.40	1.67	2.44	22,032,377	5,481,940	105
Kansas	412,372,909	94,515,871	1,765	1.48	1.72	1.96	610,518,091	162,831,942	3,455
Kentucky	363,604,209	78,865,753	1,840	1.42	1.68	1.72	517,081,545	132,131,682	3,174
Louisiana	140,673,310	34,619,701	398	1.57	1.92	3.07	221,039,971	66,476,751	1,223
Maryland	113,433	22,222	0.5	1.34	1.60	1.58	152,000	35,554	0.8
Michigan	157,529,211	35,696,119	817	1.42	1.72	1.74	223,628,468	61,333,072	1,423
Mississippi	3,257,647	739,486	10	1.45	1.72	2.53	4,729,452	1,271,620	24
Missouri	23,580	5,056	0.1	1.42	1.68	1.71	33,531	8,487	0.2
Montana	55,814,561	11,983,386	174	1.43	1.74	2.42	79,831,566	20,825,927	421
Nebraska	873,609	190,709	4	1.34	1.58	1.60	1,169,763	300,691	7
Nevada	-	-	-	-	-	-	-	-	-
New Mexico	380,987,649	84,922,147	1,170	1.45	1.72	2.40	550,831,943	145,972,678	2,809
New York	25,026,215	5,197,945	62	1.36	1.57	2.09	33,955,569	8,173,768	129
North Dakota	1,829,206	423,827	5	1.45	1.66	2.20	2,655,642	705,418	12
Ohio	149,768,398	33,637,982	697	1.48	1.81	1.87	221,896,858	60,804,017	1,302
Oklahoma	855,580,697	215,777,452	2,391	1.57	1.90	3.24	1,343,775,043	408,963,005	7,740
Pennsylvania	267,753,735	61,717,236	666	1.56	1.94	3.17	416,490,935	119,706,751	2,112
South Dakota	590,129	123,160	2.9	1.30	1.51	1.57	765,102	185,553	4.6
Texas	1,116,851,640	289,041,204	3,135	1.72	2.12	3.70	1,920,091,339	613,432,148	11,614
Utah	74,548,069	18,517,740	239	1.59	1.96	3.15	118,673,071	36,272,550	753
Virginia	37,939,112	7,747,167	177	1.37	1.63	1.64	51,802,063	12,654,222	290
West Virginia	357,922,237	80,711,465	1,870	1.47	1.70	1.72	525,716,182	137,185,276	3,221
Wyoming	51,472,667	11,838,713	124	1.40	1.61	2.47	72,303,655	19,048,490	306
Survey States	5,131,618,630	1,232,612,344	17,854	1.56	1.89	2.61	7,986,367,226	2,333,791,747	46,541

a \$5.1 billion loss in direct energy industry output plus \$2.9 billion in lost output in other industry sectors through spillover effects. Total employment losses reach an estimated 46,541 full- and part-time jobs, consisting of a direct loss of 17,854 energy sector jobs and an additional loss of 28,687 jobs in other sectors through spillover effects. Total household earnings decline by an estimated \$2.3 billion, with \$1.1 billion of the loss attributed to spillover wage losses in other industry sectors.

Total lost output remains greatest in Texas (-\$1.92 billion) and Oklahoma (-\$1.34 billion), the two largest marginal natural gas-producing states. This represents 41 percent of total lost economic output and 42 percent of total jobs lost. Five states – Colorado, Kansas, New Mexico, West Virginia, and Kentucky – are expected to suffer a loss in total output of goods and services of more than \$500 million. Six more states – Pennsylvania, Michigan, Ohio, Louisiana, Alabama, and Utah – are expected to suffer a loss in total output of more than \$100 million. Across the 13 states with an expected total output loss of \$100 million or more, the projected loss in total employment averages 3,646 jobs and annual earnings of \$183 million as marginal natural gas production ends.

### Total impact of eliminating marginal oil and natural gas production

In total, the elimination of \$18.1 billion in production of both marginal oil and marginal natural gas in 2015 would trigger an estimated direct loss within the oil and gas sector of 57,560 jobs and \$4.4 billion in direct earnings within the survey states. Including spillover effects, total output of goods and services would fall by an estimated \$28.8 billion, 163,864 jobs would be lost, and household earnings would decline by an estimated \$8.6 billion.

Overall, Texas, California, and Oklahoma suffer the greatest losses in total output from eliminating all marginal oil and natural gas production. These three states suffer estimated declines in output of \$11.7 billion, \$3.4 billion, and \$2.4 billion, respectively. Total earnings (and total employment) lost in these three states is estimated at \$3.7 billion (70,817 jobs) in Texas, \$965 million (15,955 jobs) in California, and \$735 million (13,918 jobs) in Oklahoma.

Three additional states – Kansas, New Mexico, and Colorado – suffer estimated losses in total output of goods and services ranging from \$1.1 billion to \$1.7 billion. Total earnings lost in these three states from shuttering marginal oil and natural gas production ranges from \$358 million to \$451 million, while total employment losses range from 6,860 jobs to 9,586 jobs.

Fourteen states suffer estimated total output declines of between \$100 million and \$1 billion. These states include Alabama, Arkansas, Illinois, Indiana, Kentucky, Louisiana, Michigan, Montana, North Dakota, Ohio, Pennsylvania, Utah, West Virginia, and Wyoming.

Four states – Mississippi, Nebraska, New York and Virginia – have estimated lost output of between \$50 million and \$100 million from shuttering all marginal production.

Finally, the five smallest marginally-producing states – Arizona, Maryland, Missouri, Nevada, and South Dakota – experience less than \$10 million in lost direct and spillover output of goods and services. Across all 29 survey states, each million dollars of lost marginal production would reduce total economic output by an additional \$630,800 on average. Per million dollars of lost marginal production, total employment falls by 2.0 jobs and household earnings decline by \$153,800. The overall multiplier effects tend to be the highest in many of the traditional key energy producing states including Texas, Oklahoma, Colorado, Pennsylvania, Utah, Louisiana, and California.

# Economic Effects of Falling Crude Oil Prices

The second economic impact scenario examines the effect of the recent collapse in crude oil prices on U.S. marginal oil producers. Between the 2012 and 2015 survey periods, the weighted-average first purchase price for crude oil in the survey states dropped 52 percent, from \$92.82 to \$44.40 per barrel. The effect was to slash the value of U.S. marginal oil production by roughly half, from \$25.65 billion in 2012 to only \$12.98 billion in 2015. The price decline dominated the \$12.66 billion (49.4 percent) drop in the value of marginal oil output and far outweighed the 16.2 million barrel (5.9 percent) increase in marginal oil production in the period.

Table 6 provides state-level changes in both the quantity and value of marginal oil produced between survey years 2012 and 2015, as well as estimates of the spillover effects from the decline in oil value. While only 12 of 28 marginal oil producing states experienced a decline in oil production in the period, all 28 states reported a decline in the value of marginal oil produced. Texas, for example, added 12.5 million barrels of marginal oil in the period but saw the value of production fall by \$4.87 billion (46.1 percent) in the period. Similarly, California added 6.0 million barrels of marginal oil but saw the total value decline by \$2.16 billion (49.8 percent).

Following Texas and California, five additional states – Colorado, Kansas, Louisiana, New Mexico, and Oklahoma – suffered marginal oil losses valued at more than \$500 million as a result of the oil price decline. Colorado suffered the largest loss in percentage terms, falling 72.6 percent in the period. Colorado's loss was driven by a 4.2-million-barrel decline in marginal oil production coupled with a 52.8 percent decline in oil price.

Nine additional states – Arkansas, Illinois, Kentucky, Michigan, North Dakota, Ohio, Pennsylvania, Utah, and Wyoming – posted reductions in the value of marginal oil production ranging from \$100 million to \$500 million between survey periods.

Aggregated across all states in the survey, the \$12.66 billion drop in the value of marginal oil production produced an estimated decline in direct oil and gas industry employment of 38,476 workers and lost household earnings of \$3.1 billion.

Accounting for both direct and spillover effects, lost output from lower crude oil prices totaled an estimated \$20.2 billion. The loss consists of \$12.7 billion in direct oil production and \$7.5 billion in lost production in other areas of the economy through spillover effects. Total employment losses reach an estimated 113,597 full- and part-time jobs, consisting of a direct loss of 38,476 energy sector jobs and an additional loss of 75,121 jobs in other sectors through spillover effects. The total earnings decline to households is estimated at \$6.0 billion, with a little less than half (\$2.9 billion) resulting from spillover earnings losses in other industry sectors within the survey states.

Including spillover losses, the overall impact of the drop in crude oil prices on economic output is heavily concentrated in seven of the largest marginal oil producing states. These include Texas (-\$8.4 billion), California (-\$3.3 billion), Oklahoma (-\$1.2 billion), Colorado (-\$1.0 billion), Kansas (-\$1.0 billion), Louisiana (-\$956 million), and New Mexico (-\$956 million), all with declines in output of roughly \$1 billion or more. Two additional states – North Dakota and Illinois – suffered a total decline in the output of goods and services of more than \$500 million. Jointly, these top nine states account for 90 percent of the lost total output of goods and services, 90 percent of the total household earnings lost, and 89 percent of total full- and part-time employment lost as a result of the collapse in crude oil prices.

Table 6. Economic Impact of Oil Price Decline (2012 to 2015)

Well Type	Direct Impact			Multipliers			Total Impact		
	Lost Output (\$)	Earnings Loss (\$)	Employment Loss	Output	Earnings	Employment	Lost Output (\$)	Earnings Loss (\$)	Employment Loss
Texas	5,693,341,064	1,473,436,667	15,983	1.72	2.12	3.70	9,787,991,957	3,127,074,639	59,203
California	2,176,674,064	517,177,758	5,518	1.53	1.85	2.86	3,323,128,294	956,623,698	15,804
Kansas	731,770,894	167,721,889	3,131	1.48	1.72	1.96	1,083,386,809	288,951,270	6,131
Oklahoma	682,873,995	172,220,821	1,908	1.57	1.90	3.24	1,072,521,896	326,410,123	6,178
New Mexico	730,954,980	162,929,865	2,245	1.45	1.72	2.40	1,056,814,710	280,060,145	5,390
North Dakota	531,585,440	123,168,346	1,575	1.45	1.66	2.20	771,755,741	205,001,396	3,463
Louisiana	435,705,144	107,227,036	1,234	1.57	1.92	3.07	684,623,493	205,897,355	3,788
Illinois	418,638,370	94,779,727	2,119	1.50	1.83	1.79	628,752,968	173,257,341	3,787
Colorado	236,162,554	60,552,079	656	1.66	2.07	3.66	391,014,341	125,439,687	2,402
Ohio	210,170,381	47,204,268	978	1.48	1.81	1.87	311,388,436	85,326,434	1,827
Utah	163,536,691	40,622,514	524	1.59	1.96	3.15	260,334,058	79,571,380	1,651
Michigan	164,496,918	37,275,002	853	1.42	1.72	1.74	233,519,825	64,045,908	1,486
Arkansas	142,691,846	32,419,587	596	1.46	1.77	2.02	208,544,133	57,453,993	1,206
Wyoming	133,758,676	30,764,495	322	1.40	1.61	2.47	187,890,812	49,500,073	795
Kentucky	103,885,192	22,532,698	526	1.42	1.68	1.72	147,735,132	37,751,282	907
Indiana	88,882,108	18,523,031	244	1.40	1.67	2.44	124,257,187	30,916,792	594
Montana	82,687,418	17,752,989	258	1.43	1.74	2.42	118,267,814	30,852,919	624
Pennsylvania	55,488,186	12,790,027	138	1.56	1.94	3.17	86,311,873	24,807,536	438
Nebraska	64,015,359	13,974,553	323	1.34	1.58	1.60	85,716,566	22,033,678	517
Mississippi	54,795,833	12,438,654	163	1.45	1.72	2.53	79,552,590	21,389,510	412
Alabama	32,727,187	7,379,981	172	1.42	1.67	1.74	46,410,424	12,354,088	300
West Virginia	28,282,009	6,377,593	148	1.47	1.70	1.72	41,540,615	10,839,995	255
New York	12,566,321	2,610,025	31	1.36	1.57	2.09	17,049,984	4,104,264	65
Missouri	6,125,820	1,313,376	30	1.42	1.68	1.71	8,710,916	2,204,895	52
Nevada	3,075,561	680,622	16	1.36	1.63	1.63	4,188,914	1,107,167	26
South Dakota	2,016,600	420,864	10	1.30	1.51	1.57	2,614,521	634,074	16
Arizona	866,848	185,159	4	1.39	1.68	1.73	1,203,098	311,789	7
Virginia	42,526	8,684	0	1.37	1.63	1.64	58,064	14,184	0
Maryland	-	-	-	-	-	-	-	-	-
Survey States	12,987,817,985	3,184,488,310	39,706	1.60	1.95	2.95	20,765,285,174	6,223,935,614	117,323

# Economic Losses from Plugged and Abandoned Wells

Economically marginal wells represent lost future economic activity as they are plugged and abandoned. Once a marginal well is removed from production, a stream of economic benefits is forfeited going forward, potentially for many years into the future. While the decision to shut-in any individual well may seemingly have only a minor economic impact, when viewed cumulatively across the U.S. and over time they can have a large and significant impact on national and state-level oil and natural gas production. Concern over the potential impact of this lost economic activity has been heightened once again as the number of plugged and abandoned wells resumed growth in recent years following many years of decline.

## Reversal in the number of plugged and abandoned wells

Tables 7a and 7b provide historical estimates of the number of oil and natural gas wells plugged and abandoned annually in the U.S., including estimates of the amount and value of foregone production.<sup>11</sup> Results from the current IOGCC survey indicate that the upward trend in the number of plugged and abandoned wells beginning in 2009 remains intact, but that plugging activity now differs between oil and natural gas wells.

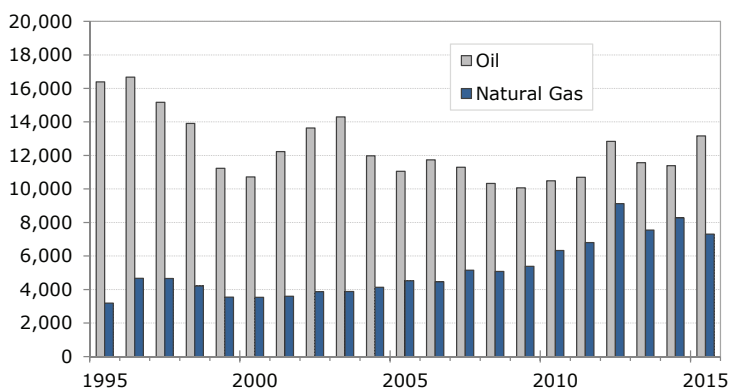
**Table 7a. National Plugged and Abandoned Oil Wells**

Year	Number of Marginal Oil Wells	Production from Marginal Oil Wells (Bbls)	Value of Marginal Oil Production	Average Daily Production per Well (Bbls)	Oil Wells Plugged/ Abandoned	Lost Oil Production (Bbls)	Price of Oil (\$/Bbl)	Lost Value of Oil Production (\$)
1992	453,277	368,132,000	5,886,430,680	2.23	16,211	13,165,874	15.99	210,522,325
1993	452,248	355,961,000	5,072,444,250	2.16	16,914	13,312,882	14.25	189,708,572
1994	442,500	339,930,000	4,483,676,700	2.10	17,896	13,747,768	13.19	181,333,058
1995	433,048	332,288,089	4,858,051,861	2.10	16,389	12,562,169	14.62	183,658,903
1996	428,842	323,468,274	5,971,224,338	2.06	16,674	12,537,181	18.46	231,436,354
1997	420,674	323,487,914	5,573,696,758	2.11	15,172	11,684,716	17.23	201,327,653
1998	406,380	316,870,286	3,444,380,009	2.14	13,912	10,866,663	10.87	118,120,629
1999	410,680	315,514,283	4,909,402,243	2.10	11,227	8,605,496	15.56	133,901,510
2000	411,629	325,947,181	8,709,308,676	2.16	10,718	8,450,071	26.72	225,785,902
2001	403,459	316,099,192	6,903,606,353	2.15	12,234	9,600,632	21.84	209,677,792
2002	402,072	323,776,606	7,288,211,401	2.21	13,635	10,998,673	22.51	247,580,124
2003	393,463	313,748,001	8,646,894,908	2.18	14,300	11,378,510	27.56	313,591,736
2004	397,362	310,922,122	11,432,606,426	2.14	11,977	9,355,235	36.77	343,991,980
2005	401,072	321,761,570	16,178,171,740	2.20	11,058	8,871,323	50.28	446,050,143
2006	422,381	324,496,483	19,369,195,070	2.10	11,738	9,017,782	59.69	538,271,399
2007	396,537	291,067,592	19,361,816,220	2.01	11,296	8,291,533	66.52	551,552,758
2008	379,405	266,389,079	25,051,228,977	1.92	10,328	7,251,523	94.04	681,933,222
2009	390,480	262,978,307	14,818,827,577	1.85	10,070	6,781,894	56.35	382,159,727
2010	395,467	267,764,103	20,073,194,781	1.86	10,483	7,097,870	74.97	530,281,836
2011	402,828	275,174,346	25,791,937,817	1.87	10,698	7,307,527	93.73	699,549,542
2012	405,161	276,301,621	25,646,832,133	1.87	12,839	8,755,627	92.82	827,581,862
2013	404,175	292,931,837	27,999,382,857	1.99	11,571	8,386,254	95.58	804,996,535
2014	414,420	301,898,374	26,359,781,503	2.00	11,387	8,295,248	87.31	724,921,703
2015	408,490	292,529,299	12,987,817,985	1.96	13,161	9,424,894	44.40	418,371,038

The total number of plugged and abandoned oil wells reached 20,462 in 2015, comprised of 13,161 oil wells and 7,301 natural gas wells. Other than the recent peak of 21,958 wells plugged in 2012, this is the highest number of plugged wells in the U.S. since 1996 (see Figure 13).

The number of oil wells plugged annually has fluctuated in a range between 10,000 and 15,000 much of the past two decades. Following the upturn in oil prices in 2008, the number of plugged oil wells surged from a little more than 10,000 wells in 2009 to nearly 13,000 wells by 2012. After easing in 2013 and 2014, the reported 13,161 oil wells plugged in 2015 represent the highest number since the prior peak in 2003. Although marginal oil wells have been much more profitable in the elevated oil price environment of recent years, they must also compete against the increased number of drilling and exploration opportunities available to producers across the country. More recently, the collapse in oil prices in 2015 is putting substantial added pressure on the viability of many marginal oil wells.

**Figure 13. Plugged and Abandoned Wells**



Source: IOGCC Marginal Well Survey and RegionTrack

The number of natural gas wells plugged and abandoned reached a bottom at only 3,534 wells in 2000 before entering a steady uptrend, eventually peaking at more than 9,100 wells in the 2012 survey. This rise coincides closely with rising natural gas prices beginning in 2001 and the resulting increase in domestic natural gas exploration. The number of plugged and abandoned natural gas wells eased somewhat to an average of 7,700 wells in the 2013 to 2015 period but remains well above historical plugging totals.

**Table 7b. National Plugged and Abandoned Natural Gas Wells**

Year	Number of Marginal Gas Wells	Production from Marginal Gas Wells (Mcf)	Value of Marginal Gas Production	Average Daily Production per Well (Mcf)	Gas Wells Plugged/Abandoned	Lost Gas Production (Mcf)	Price of Gas (\$/Mcf)	Value of Lost Gas Production (\$)
1992	130,432	670,202,323	1,166,152,043	14.1	3,161	16,242,253	1.74	28,261,520
1993	142,100	759,410,105	1,549,196,615	14.6	3,162	16,898,345	2.04	34,472,623
1994	159,369	940,421,000	1,739,778,850	16.2	3,163	18,664,556	1.85	34,529,429
1995	159,669	925,563,034	1,434,622,703	15.9	3,189	18,507,362	1.55	28,686,410
1996	168,702	986,676,219	2,141,087,395	16.0	4,671	27,278,640	2.17	59,194,649
1997	189,756	1,042,153,002	2,417,794,965	15.0	4,661	25,518,975	2.32	59,204,022
1998	199,745	1,104,683,975	2,165,180,591	15.2	4,203	23,318,244	1.96	45,703,758
1999	207,766	1,138,979,506	2,494,365,118	15.3	3,546	19,802,637	2.19	43,367,775
2000	223,222	1,258,726,664	4,632,114,124	15.4	3,534	19,864,614	3.68	73,101,780
2001	234,507	1,353,516,378	5,414,065,512	15.8	3,600	20,761,200	4.00	83,044,800
2002	245,961	1,418,273,779	4,183,907,648	15.8	3,870	22,318,290	2.95	65,838,956
2003	260,563	1,478,105,524	7,213,154,957	15.5	3,883	21,968,073	4.88	107,204,194
2004	271,856	1,539,960,495	8,408,184,303	15.5	4,129	23,359,818	5.46	127,544,604
2005	288,898	1,760,063,552	12,901,265,836	16.7	4,517	27,519,080	7.33	201,714,854
2006	304,000	1,716,319,702	10,967,282,896	15.5	4,463	25,197,154	6.39	161,009,814
2007	322,160	1,763,592,746	11,022,454,663	15.0	5,155	28,219,893	6.25	176,374,329
2008	326,242	1,831,573,892	14,597,643,920	15.4	5,075	28,491,891	7.97	227,080,370
2009	331,474	2,152,462,929	7,899,538,950	17.8	5,381	34,942,162	3.67	128,237,736
2010	353,490	2,171,645,538	9,713,211,951	16.8	6,333	38,906,420	4.47	174,300,760
2011	361,053	2,091,335,077	8,239,026,685	15.9	6,803	39,402,267	3.94	155,638,954
2012	357,654	2,079,381,360	5,528,031,064	15.9	9,119	53,017,403	2.66	141,026,293
2013	374,580	2,101,632,966	7,840,411,518	15.4	7,541	42,309,821	3.73	157,815,632
2014	388,062	2,069,908,061	9,050,200,896	14.6	8,266	44,090,507	4.37	192,675,515
2015	377,977	1,955,292,380	5,131,618,630	14.2	7,301	37,768,393	2.62	98,953,189

By estimated production, more than 13,100 oil wells producing 9.4 million barrels of oil, and 7,300 natural gas wells producing 37.8 million Mcf of natural gas, annually, were plugged and abandoned in the U.S. in 2015. The estimated market value of the lost production from these wells totaled \$517.3 million in 2015 - \$418.4 million for oil and \$98.9 million for natural gas.

Over the past decade a cumulative total of more than 113,500 oil wells and 65,400 natural gas wells have been plugged and abandoned with a total market value of lost production estimated at \$7.8 billion measured in the year production ceased.

### The economic impact of plugged and abandoned wells

The direct and spillover economic impacts of the output lost from marginal wells plugged and abandoned in 2015 is estimated in Table 8. The impacts are based on the amount of earnings and employment that would have been required to produce an additional year's output at prevailing market prices for oil and natural gas.

In total, the \$517.3 million in lost oil and gas output from wells plugged and abandoned in 2015 would have directly supported an estimated 1,623 full- and part-time jobs with annual earnings of \$126.3 million.

Spillover economic impacts to other sectors of the economy are formed using the average effective multiplier for both oil and natural gas across the 29 marginally-producing states. With spillover effects included, total lost output from plugged and abandoned wells in 2015 produced an estimated total decline in output of goods and services in the survey states of \$821 million. This in turn reduces total employment in the survey

states by 4,621 full- and part-time jobs and total earnings by an estimated \$244.8 million annually.

Again, the impact estimates reflect only one year of reduced production from the wells plugged and abandoned in 2015. Nonetheless, the reduced output from plugged and abandoned wells could persist for many years going forward. This is true as well for each annual cohort of wells plugged and abandoned prior to 2015. Hence, the annual estimates in Table 8 provide a lower bound for the estimate of the potential lifetime value of production from plugged and abandoned wells.

**Table 8. Economic Impact of Plugged and Abandoned Wells in 2015**

Well Type	Direct Impact			Multipliers			Total Impact		
	Lost Output (\$)	Earnings Loss (\$)	Employment Loss	Output	Earnings	Employment	Lost Output (\$)	Earnings Loss (\$)	Employment Loss
Crude Oil	418,371,038	102,580,563	1,279	1.59	1.94	2.85	663,864,938	198,740,431	3,641
Natural Gas	98,953,189	23,768,509	344	1.59	1.94	2.85	157,017,448	46,049,305	980
Total	517,324,227	126,349,072	1,623	-	-	-	820,882,385	244,789,737	4,621



# Conclusion

The resurgence in domestic oil and natural gas production the past decade has not diminished the critical role played by marginal wells in U.S. energy production. Currently, an estimated 786,000 marginally-producing wells – more than 408,000 oil wells and nearly 378,000 natural gas wells - serve a strategic role within the U.S. energy production framework.

Most operating wells in the U.S. in 2015 are marginal producers, including 69.1 percent of all oil wells and 75.9 percent of all natural gas wells. Overall, 72.2 percent of all operating wells in the U.S. in 2015 are marginal.

The 292.5 million barrels of marginal oil produced in the U.S. in 2015 represent 8.5 percent of total domestic oil production of 3.44 billion barrels. For perspective, the volume of marginal oil produced in 2015 exceeds the total oil production of every state except Texas and North Dakota. Marginal oil production exceeds the total oil output of California, Alaska, and Oklahoma, the third-, fourth-, and fifth-largest oil-producing states.

Marginal natural gas production in the U.S. totaled a reported 1.96 billion Mcf in 2015. This represents 6.8 percent of the 28.8 billion Mcf of natural gas produced domestically in 2015. Marginal natural gas output exceeds the total natural gas output of all but four states – Texas, Louisiana, Pennsylvania, and Wyoming – and exceeds the total natural gas output of other top-tier natural gas producing states such as Oklahoma, Colorado, and New Mexico.

The estimated value of marginal oil and natural gas produced in 2015 totaled \$18.1 billion. This is nearly 50 percent below recent years and reflects historically low prices for both oil and natural gas. The value of the 292.5 million barrels of marginal oil produced totaled \$13.0 billion based on an average price of \$44.40 per barrel. The 1.96 billion Mcf of marginal natural gas produced in 2015 is valued at \$5.1 billion based on an average natural gas price of \$2.62 per Mcf.

Marginal oil and natural gas production in the U.S.

continues to exert tremendous spillover economic activity across the energy-producing regions. The hypothetical elimination of \$18.1 billion in marginal oil and natural gas production in 2015 would trigger an estimated direct loss of 57,560 jobs and \$4.4 billion in earnings within the oil and natural gas industry. Including spillover effects to other industries, total output of goods and services across the survey states would fall by \$28.8 billion, 163,864 jobs would be lost, and household earnings would decline by \$8.6 billion.

Texas, California, and Oklahoma would suffer the greatest loss in total output of goods and services from the elimination of marginal oil and natural gas production. These three states suffer estimated declines in output of \$11.7 billion, \$3.4 billion, and \$2.4 billion, respectively. Total earnings (and total employment) lost in the three hardest-hit states reaches \$3.7 billion (70,817 jobs) in Texas, \$966 million (15,955 jobs) in California, and \$735 million (13,918 jobs) in Oklahoma. Three additional states - Kansas, New Mexico, and Colorado - all suffer estimated losses in total economic output ranging from \$1.1 billion to \$1.7 billion after accounting for spillover effects. Seven states - Louisiana, North Dakota, Kentucky, Illinois, West Virginia, Ohio, and Pennsylvania - suffer estimated output declines of between \$500 million and \$1 billion. Seven additional states - Michigan, Utah, Arkansas, Wyoming, Alabama, Montana, and Indiana - have estimated lost output of between \$25 million and \$100 million. Four states – Mississippi, Nebraska, New York and Virginia - have estimated lost output of between \$50 million and \$100 million. The five smallest marginally-producing states - Arizona, Maryland, Missouri, Nevada, and South Dakota - experience less than \$10 million in lost direct and spillover output of goods and services.

The recent collapse in crude oil prices placed tremendous pressure on U.S. marginal oil producing states. The average price for crude oil dropped 52 percent between the 2012 and 2015 survey periods, from \$92.82 to \$44.40 per barrel. As a result, the value of U.S. marginal oil produced dropped by about half

(49.4 percent) from \$25.6 billion to only \$13.0 billion. Including spillover losses, the impact of the drop in crude oil prices on economic output is heavily concentrated in seven of the largest marginal oil producing states. These include Texas (-\$8.4 billion), California (-\$3.3 billion), Oklahoma (-\$1.2 billion), Colorado (-\$1.0 billion), Kansas (-\$1.0 billion), Louisiana (-\$956 million), and New Mexico (-\$956 million), all with output declines of roughly \$1 billion or more. Two additional states – North Dakota and Illinois – suffered a total estimated decline in the output of goods and services of more than \$500 million.

The large number of plugged and abandoned wells each year presents an ongoing economic cost to U.S. energy production. Over the past decade, a cumulative total of more than 179,000 wells – 113,600 oil wells and 65,500 natural gas wells – have been plugged and abandoned. The lost production from these wells has an estimated market value of \$7.8 billion annually (measured in the year production ceased). The estimated market value of the lost production from these wells in 2015 totaled \$517.3 million - \$418.4 million for oil and \$98.9 million for natural gas. Including estimated spillover effects, the reduction in output from wells plugged and abandoned in 2015 creates a total decline in U.S. output of \$821 million. This in turn reduces total employment by an estimated 4,621 full- and part-time jobs and total household earnings by an estimated \$244.8 million annually across the survey states.

# Appendix A. Marginal Well Survey

## Data Notes

Marginal well production data for calendar years 2013, 2014, and 2015 were collected by IOGCC in a recent survey of state oil and gas reporting entities. Data reported for years prior to 2013 are either from earlier IOGCC surveys detailed in prior Marginal Well annual reports or represent revised estimates provided by the states in the latest survey.

Twenty-seven of the twenty-nine survey states report the production of both marginal oil and marginal natural gas; Nevada reports only oil and Maryland only natural gas.

A few states not included in the survey have very small amounts of marginal oil and gas production. These states include Alaska, Florida, Georgia, Nevada (gas), South Carolina, and Tennessee. Omitting the small amounts of production from these states does not materially affect the results presented in the report.

### Marginal oil production data:

Oil production data is as reported from the IOGCC annual marginal well survey for the following 23 states: Alabama, Arizona, Arkansas, California, Indiana, Kentucky, Louisiana, Maryland, Michigan, Mississippi, Montana, Nebraska, Nevada, New Mexico, New York, North Dakota, Ohio, South Dakota, Texas, Utah, Virginia, West Virginia, and Wyoming. For the remaining states:

**Colorado:** The state of Colorado reports stripper production only for oil wells producing 15 barrels or less of oil per day. To match IOGCC's definition of a marginal well, estimates of production for wells producing 10 barrels or less per day are formed for 2013-2015 using production ratios by well size from the 2009 Distribution and Production of Oil and Gas Wells by State series provided by EIA. The number of oil wells was adjusted in the same manner using the ratio of wells by well size from the same survey.

**Illinois:** Total oil production for 2013-2015 is from EIA. Consistent with past surveys, all oil production is assumed marginal. The number of marginal wells for 2013-2015 is estimated using the output per marginal well from 2009.

**Kansas:** Total oil production for 2015 is from EIA. **Missouri:** Total oil production for 2013-2015 is from EIA. Consistent with past surveys, all oil production is assumed marginal. The number of marginal wells for 2015 is estimated using the output per marginal well from 2012.

**Oklahoma:** Total oil production for 2013-2015 is from EIA. Marginal oil production for 2013-2015 is estimated using a linear model based on total oil production, total oil production per well, and historical marginal production. The number of marginal wells for 2013-2015 is estimated using the output per marginal well derived from a time series model using the 2009 Distribution and Production of Oil and Gas Wells by State series provided by EIA.

**Pennsylvania:** Total oil production for 2013-2015 is from EIA.

### Marginal natural gas production data:

Natural gas production data is as reported from the IOGCC annual survey for the following 23 states: Alabama, Arizona, Arkansas, California, Indiana, Kentucky, Louisiana, Michigan, Mississippi, Montana, Nebraska, Nevada, New Mexico, New York, North Dakota, Ohio, Pennsylvania, South Dakota, Texas, Utah, Virginia, West Virginia, and Wyoming. For the remaining states:

**Colorado:** The state of Colorado reports stripper production only for natural gas wells producing 90 Mcf or less of gas per day. To match IOGCC's definition of a marginal well, estimates of production for wells producing 60 Mcf or less per day are formed using production ratios by well size from the 2009 Distribution

and Production of Oil and Gas Wells by State series provided by EIA. The number of natural gas wells was adjusted in the same manner using the ratio of wells by well size from the same survey.

**Illinois:** Total gas production for 2013-2015 is from EIA. Marginal gas production for 2013-2015 is estimated using the ratio of marginal production to total production from 2009. The number of marginal gas wells for 2013-2015 is estimated using the output per marginal well from 2009.

**Kansas:** Total gas production for 2015 is from EIA. Maryland: Consistent with past surveys, marginal gas production is assumed equal to total gas production in the 2013-2015 period. The small number of marginal gas wells for 2013-2015 is assumed unchanged from 2012.

**Missouri:** Total gas production for 2013-2015 is from EIA. Consistent with past surveys, all oil production is assumed marginal. The small number of marginal gas wells for 2013-2015 is assumed unchanged from 2012.

**Oklahoma:** Total natural gas production for 2013-2015 is from EIA. Marginal gas production for 2013-2015 is estimated using a linear model based on total gas production, total gas production per well, and historical marginal gas production. The number of marginal gas wells for 2013-2015 is estimated using the output per marginal well derived from a time series model using the 2009 Distribution and Production of Oil and Gas Wells by State series provided by EIA.

# Appendix B. Additional Tables

## Economic Impact of Hypothetical Elimination of Marginal Oil and Natural Gas Production

State	Direct Impact			Multipliers			Total Impact		
	Lost Output (\$)	Earnings Loss (\$)	Employment Loss	Output	Earnings	Employment	Lost Output (\$)	Earnings Loss (\$)	Employment Loss
Texas	6,810,192,704	1,762,477,872	19,119	1.72	2.12	3.70	11,708,083,296	3,740,506,787	70,817
California	2,197,433,594	522,110,222	5,571	1.53	1.85	2.86	3,354,821,867	965,747,277	15,955
Oklahoma	1,538,454,692	387,998,273	4,299	1.57	1.90	3.24	2,416,296,939	735,373,127	13,918
Kansas	1,144,143,803	262,237,760	4,896	1.48	1.72	1.96	1,693,904,900	451,783,212	9,586
New Mexico	1,111,942,629	247,852,012	3,416	1.45	1.72	2.40	1,607,646,653	426,032,823	8,199
Colorado	674,347,587	172,902,721	1,874.1	1.66	2.07	3.66	1,116,517,300	358,185,278	6,860
Louisiana	576,378,454	141,846,737	1,632	1.57	1.92	3.07	905,663,464	272,374,105	5,011
North Dakota	533,414,646	123,592,174	1,581	1.45	1.66	2.20	774,411,383	205,706,814	3,475
Kentucky	467,489,401	101,398,451	2,366	1.42	1.68	1.72	664,816,677	169,882,965	4,080
Illinois	419,759,697	95,033,595	2,125	1.50	1.83	1.79	630,437,088	173,721,412	3,797
West Virginia	386,204,247	87,089,058	2,018	1.47	1.70	1.72	567,256,798	148,025,271	3,476
Ohio	359,938,779	80,842,250	1,675	1.48	1.81	1.87	533,285,294	146,130,450	3,129
Pennsylvania	323,241,921	74,507,263	804	1.56	1.94	3.17	502,802,808	144,514,287	2,549
Michigan	322,026,129	72,971,121	1,670	1.42	1.72	1.74	457,148,293	125,378,980	2,909
Utah	238,084,759	59,140,254	763	1.59	1.96	3.15	379,007,129	115,843,930	2,404
Arkansas	209,711,648	47,646,486	876	1.46	1.77	2.02	306,493,573	84,439,103	1,772
Wyoming	185,231,342	42,603,209	445	1.40	1.61	2.47	260,194,467	68,548,563	1,101
Alabama	166,838,838	37,622,158	879	1.42	1.67	1.74	236,594,156	62,979,492	1,530
Montana	138,501,979	29,736,375	432	1.43	1.74	2.42	198,099,380	51,678,846	1,044
Indiana	104,642,034	21,807,400	287	1.40	1.67	2.44	146,289,564	36,398,731	699
Nebraska	64,888,969	14,165,262	327	1.34	1.58	1.60	86,886,329	22,334,368	524
Mississippi	58,053,480	13,178,140	172	1.45	1.72	2.53	84,282,042	22,661,129	436
Virginia	37,981,637	7,755,850	178	1.37	1.63	1.64	51,860,128	12,668,406	291
New York	37,592,536	7,807,970	93	1.36	1.57	2.09	51,005,553	12,278,032	194
Missouri	6,149,400	1,318,431	30	1.42	1.68	1.71	8,744,447	2,213,383	52
Nevada	3,075,561	680,622	16	1.36	1.63	1.63	4,188,914	1,107,167	26
South Dakota	2,606,728	544,024	13	1.30	1.51	1.57	3,379,623	819,627	20
Arizona	995,989	212,743	5	1.39	1.68	1.73	1,382,334	358,239	9
Maryland	113,433	22,222	1	1.34	1.60	1.58	152,000	35,554	1
Survey States	18,119,436,615	4,417,100,654	57,560	2	2	3	28,751,652,400	8,557,727,361	163,864

## Value of Marginal Crude Oil and Natural Gas Production (2015)

State	Marginal Oil Wells					Marginal Natural Gas Wells					All Marginal Wells		
	Number of Marginal Oil Wells	Production from Marginal Oil Wells (Bbls)	Crude Oil Price (\$/Bbl)	Value of Marginal Oil Production (\$)	Value of Production per Well (\$)	Number of Marginal Gas Wells	Production from Marginal Gas Wells (Mcf)	Natural Gas Price (\$/Mcf)	Value of Marginal Gas Production (\$)	Value of Production per Well (\$)	Value of Marginal Oil and Gas Production	Value of Total Oil and Gas Production (\$)	Marginal Share of Total Value of Production
Alabama	638	734,617	44.55	32,727,187	51,297	5,416	51,417,194	2.61	134,111,651	24,762	166,838,838	874,901,145	19.1%
Arizona	21	19,528	44.39	866,848	41,278	3	53,728	2.40	129,141	43,047	995,989	2,008,500	49.6%
Arkansas	4,658	3,315,331	43.04	142,691,846	30,634	3,878	29,843,423	2.25	67,019,801	17,282	209,711,648	2,545,123,678	8.2%
California	37,262	47,702,697	45.63	2,176,674,064	58,415	819	7,288,955	2.85	20,759,530	25,347	2,197,433,594	9,840,724,190	22.3%
Colorado	9,992	5,829,735	40.51	236,162,554	23,634	18,915	189,207,817	2.32	438,185,033	23,166	674,347,587	9,059,236,595	7.4%
Illinois	29,386	9,521,000	43.97	418,638,370	14,246	640	427,987	2.62	1,121,327	1,753	419,759,697	427,608,982	98.2%
Indiana	4,320	1,996,902	44.51	88,882,108	20,575	1,059	6,525,005	2.42	15,759,926	14,882	104,642,034	116,268,926	90.0%
Kansas	18,375	16,954,840	43.16	731,770,894	39,824	16,932	166,696,500	2.47	412,372,909	24,355	1,144,143,803	2,649,174,123	43.2%
Kentucky	26,192	2,289,229	45.38	103,885,192	3,966	19,439	139,090,703	2.61	363,604,209	18,705	467,489,401	493,136,867	94.8%
Louisiana	20,576	8,996,596	48.43	435,705,144	21,175	15,449	56,865,395	2.47	140,673,310	9,106	576,378,454	7,384,191,769	7.8%
Maryland	-	-	44.39	-	-	7	43,295	2.62	113,433	16,205	113,433	-	-
Michigan	2,305	3,624,877	45.38	164,496,918	71,365	7,886	71,072,012	2.22	157,529,211	19,976	322,026,129	537,566,407	59.9%
Mississippi	992	1,170,601	46.81	54,795,833	55,238	1,475	1,335,810	2.44	3,257,647	2,209	58,053,480	1,242,016,278	4.7%
Missouri	426	138,000	44.39	6,125,820	14,382	4	9,000	2.62	23,580	5,895	6,149,400	6,149,400	100.0%
Montana	2,880	2,047,372	40.38	82,687,418	28,711	5,393	26,219,406	2.13	55,814,561	10,349	138,501,979	1,205,282,967	11.5%
Nebraska	1,697	1,596,393	40.10	64,015,359	37,723	141	375,328	2.33	873,609	6,196	64,888,969	109,024,192	59.5%
Nevada	43	69,285	44.39	3,075,561	71,525	0	0	2.62	-	-	3,075,561	12,501,297	24.6%
New Mexico	17,263	16,462,950	44.40	730,954,980	42,342	14,292	122,454,849	3.11	380,987,649	26,657	1,111,942,629	10,378,934,352	10.7%
New York	3,629	283,089	44.39	12,566,321	3,463	6,699	9,202,778	2.72	25,026,215	3,736	37,592,536	60,768,964	61.9%
North Dakota	3,087	12,834,028	41.42	531,585,440	172,201	155	797,909	2.29	1,829,206	11,801	533,414,646	19,245,992,071	2.8%
Ohio	13,213	5,473,187	38.40	210,170,381	15,906	32,154	55,311,561	2.71	149,768,398	4,658	359,938,779	3,720,088,315	9.7%
Oklahoma	28,351	15,188,479	44.96	682,873,995	24,086	45,340	310,610,973	2.75	855,580,697	18,870	1,538,454,692	13,978,506,963	11.0%
Pennsylvania	21,284	1,423,504	38.98	55,488,186	2,607	65,755	102,196,082	2.62	267,753,735	4,072	323,241,921	12,823,333,538	2.5%
South Dakota	29	47,194	42.73	2,016,600	69,538	66	225,240	2.62	590,129	8,941	2,606,728	109,473,880	2.4%
Texas	152,376	126,659,423	44.95	5,693,341,064	37,364	56,561	406,325,755	2.75	1,116,851,640	19,746	6,810,192,704	68,287,784,234	10.0%
Utah	2,710	4,019,088	40.69	163,536,691	60,346	2,905	30,135,108	2.47	74,548,069	25,662	238,084,759	2,551,606,448	9.3%
Virginia	3	958	44.39	42,526	14,175	1,731	14,480,577	2.62	37,939,112	21,917	37,981,637	347,114,936	10.9%
West Virginia	3,641	838,731	33.72	28,282,009	7,768	52,684	136,611,541	2.62	357,922,237	6,794	386,204,247	3,650,525,225	10.6%
Wyoming	3,141	3,291,306	40.64	133,758,676	42,585	2,180	20,468,449	2.51	51,472,667	23,611	185,231,342	8,383,911,986	2.2%
Survey States	408,490	292,529,299	44.40	12,987,817,985	31,795	377,977	0	2.62	5,131,618,630	13,577	18,119,436,615	181,076,519,270	10.0%

## State Rankings - Value of Marginal Production (2015)

State	Value of Marginal Oil Production (\$)	State	Value of Marginal Gas Production (\$)	State	Value of Marginal Oil and Gas Production (\$)	State	Value of Total Oil and Gas Production (\$)	State	Marginal Share of Total Value of Production
Texas	10,562,584,990	Texas	1,170,675,241	Texas	11,733,260,231	Texas	77,194,536,259	Maryland	100.0%
California	4,423,188,284	Oklahoma	811,764,134	California	4,443,083,344	California	21,286,344,242	Missouri	100.0%
Kansas	1,458,002,525	Kentucky	476,189,290	Oklahoma	2,260,593,770	North Dakota	21,049,962,505	Illinois	99.4%
Oklahoma	1,448,829,636	Pennsylvania	445,174,592	Kansas	1,901,043,556	Louisiana	14,712,027,044	Indiana	80.9%
New Mexico	1,392,018,966	West Virginia	443,145,280	New Mexico	1,762,775,974	Oklahoma	13,278,596,096	Ohio	75.8%
Louisiana	1,043,944,698	Kansas	443,041,031	Louisiana	1,194,158,215	New Mexico	11,403,044,367	Kentucky	69.9%
Illinois	869,297,040	New Mexico	370,757,008	Colorado	1,132,383,154	Wyoming	10,376,980,299	Nebraska	62.0%
Colorado	797,419,561	Colorado	334,963,592	Illinois	870,002,134	Colorado	8,241,972,305	New York	60.2%
Ohio	360,875,639	Michigan	180,475,603	Kentucky	711,619,638	Pennsylvania	6,218,685,084	Michigan	47.9%
Wyoming	353,797,354	Ohio	170,280,494	Pennsylvania	626,863,507	Kansas	4,587,765,753	Kansas	41.4%
Utah	288,479,593	Louisiana	150,213,517	Ohio	531,156,133	Utah	3,729,578,219	Arizona	34.7%
Michigan	281,821,000	Alabama	135,840,307	West Virginia	515,402,053	Arkansas	3,197,426,690	West Virginia	30.9%
Arkansas	279,213,598	Wyoming	99,262,863	Michigan	462,296,603	Montana	2,815,400,333	California	20.9%
Kentucky	235,430,347	Montana	84,745,505	Wyoming	453,060,217	Mississippi	2,222,126,430	Oklahoma	17.0%
Montana	219,937,828	Utah	63,939,185	Utah	352,418,778	West Virginia	1,666,434,644	Nevada	15.8%
North Dakota	208,638,433	Arkansas	60,299,853	Arkansas	339,513,451	Alabama	1,571,740,197	New Mexico	15.5%
Pennsylvania	181,688,916	Virginia	36,137,369	Montana	304,683,332	Kentucky	1,017,346,345	Texas	15.2%
Indiana	166,608,081	New York	31,081,475	Alabama	229,900,574	Michigan	964,814,085	Alabama	14.6%
Nebraska	131,323,016	California	19,895,060	North Dakota	210,675,729	Illinois	874,949,540	Colorado	13.7%
Mississippi	117,902,169	Indiana	19,451,945	Indiana	186,060,027	Ohio	700,505,250	Montana	10.8%
Alabama	94,060,267	Nebraska	2,885,061	Nebraska	134,208,077	Virginia	389,621,423	Arkansas	10.6%
West Virginia	72,256,773	Mississippi	2,868,495	Mississippi	120,770,664	Indiana	229,873,373	Pennsylvania	10.1%
New York	32,872,166	North Dakota	2,037,296	New York	63,953,640	Nebraska	216,394,654	Utah	9.4%
Missouri	16,351,960	South Dakota	962,917	Virginia	36,152,398	South Dakota	185,962,553	Virginia	9.3%
Nevada	5,503,900	Illinois	705,094	Missouri	16,445,060	New York	106,230,438	Louisiana	8.1%
South Dakota	3,746,979	Missouri	93,100	Nevada	5,503,900	Nevada	34,783,360	Mississippi	5.4%
Arizona	1,759,679	Maryland	82,955	South Dakota	4,709,896	Missouri	16,445,060	Wyoming	4.4%
Virginia	15,029	Arizona	42,735	Arizona	1,802,414	Arizona	5,194,662	South Dakota	2.5%
Maryland	-	Nevada	-	Maryland	82,955	Maryland	82,955	North Dakota	1.0%
Survey States	25,047,568,426	Survey States	5,557,010,996	Survey States	30,604,579,423	Survey States	212,277,431,604	Survey States	14.4%

## National Plugged and Abandoned Wells

Year	Oil Wells Plugged/ Abandoned	Average Daily Production per Well (Bbls)	Lost Oil Production (Bbls)	Price of Oil (\$/Bbl)	Lost Value of Oil Production (\$)	Gas Wells Plugged/ Abandoned	Average Daily Production per Well (Mcf)	Lost Gas Production (Mcf)	Price of Gas (\$/Mcf)	Value of Lost Gas Production (\$)	Total Wells Plugged/ Abandoned	Value of Lost Oil and Gas Production (\$)
1992	16,211	2.23	13,165,874	15.99	210,522,325	3,161	14.1	16,242,253	1.74	28,261,520	19,372	238,783,845
1993	16,914	2.16	13,312,882	14.25	189,708,572	3,162	14.6	16,898,345	2.04	34,472,623	20,076	224,181,194
1994	17,896	2.10	13,747,768	13.19	181,333,058	3,163	16.2	18,664,556	1.85	34,529,429	21,059	215,862,487
1995	16,389	2.10	12,562,169	14.62	183,658,903	3,189	15.9	18,507,362	1.55	28,686,410	19,578	212,345,314
1996	16,674	2.06	12,537,181	18.46	231,436,354	4,671	16.0	27,278,640	2.17	59,194,649	21,345	290,631,003
1997	15,172	2.11	11,684,716	17.23	201,327,653	4,661	15.0	25,518,975	2.32	59,204,022	19,833	260,531,675
1998	13,912	2.14	10,866,663	10.87	118,120,629	4,203	15.2	23,318,244	1.96	45,703,758	18,115	163,824,387
1999	11,227	2.10	8,605,496	15.56	133,901,510	3,546	15.3	19,802,637	2.19	43,367,775	14,773	177,269,285
2000	10,718	2.16	8,450,071	26.72	225,785,902	3,534	15.4	19,864,614	3.68	73,101,780	14,252	298,887,682
2001	12,234	2.15	9,600,632	21.84	209,677,792	3,600	15.8	20,761,200	4.00	83,044,800	15,834	292,722,592
2002	13,635	2.21	10,998,673	22.51	247,580,124	3,870	15.8	22,318,290	2.95	65,838,956	17,505	313,419,079
2003	14,300	2.18	11,378,510	27.56	313,591,736	3,883	15.5	21,968,073	4.88	107,204,194	18,183	420,795,929
2004	11,977	2.14	9,355,235	36.77	343,991,980	4,129	15.5	23,359,818	5.46	127,544,604	16,106	471,536,583
2005	11,058	2.20	8,871,323	50.28	446,050,143	4,517	16.7	27,519,080	7.33	201,714,854	15,575	647,764,997
2006	11,738	2.10	9,017,782	59.69	538,271,399	4,463	15.5	25,197,154	6.39	161,009,814	16,201	699,281,213
2007	11,296	2.01	8,291,533	66.52	551,552,758	5,155	15.0	28,219,893	6.25	176,374,329	16,451	727,927,087
2008	10,328	1.92	7,251,523	94.04	681,933,222	5,075	15.4	28,491,891	7.97	227,080,370	15,403	909,013,592
2009	10,070	1.85	6,781,894	56.35	382,159,727	5,381	17.8	34,942,162	3.67	128,237,736	15,451	510,397,463
2010	10,483	1.86	7,097,870	74.97	530,281,836	6,333	16.8	38,906,420	4.47	174,300,760	16,816	704,582,595
2011	10,698	1.87	7,307,527	93.73	699,549,542	6,803	15.9	39,402,267	3.94	155,638,954	17,500	855,188,495
2012	12,839	1.87	8,755,627	92.82	827,581,862	9,119	15.9	53,017,403	2.66	141,026,293	21,958	968,608,155
2013	11,571	1.99	8,386,254	95.58	804,996,535	7,541	15.4	42,309,821	3.73	157,815,632	19,112	962,812,167
2014	11,387	2.00	8,295,248	87.31	724,921,703	8,266	14.6	44,090,507	4.37	192,675,515	19,653	917,597,218
2015	13,161	1.96	9,424,894	44.40	418,371,038	7,301	14.2	37,768,393	2.62	98,953,189	20,462	517,324,227

<sup>1</sup> Hydrocarbons include crude oil and condensate, liquids, and refining gains. See: “United States remains largest producer of petroleum and natural gas hydrocarbons.” U.S. Energy Information Administration. Available online at: <http://www.eia.gov/todayinenergy/detail.cfm?id=26352>

<sup>2</sup> See country-level production data at: International Energy Statistics. U.S. Energy Information Administration. Available online at: <http://www.eia.gov/cfapps/ipdbproject/>

<sup>3</sup> Recent Marginal Wells reports are available online at: <http://iogcc.ok.gov>

<sup>4</sup> The market value of marginal production is estimated using state-level prices for oil and natural gas as reported by the U. S. Energy Information Agency (EIA). Oil prices reflect the first purchase price of crude oil field production, while natural gas prices are reported as the wellhead price through 2010 and the ratio of the 2010 wellhead price to the current year spot price for Henry Hub natural gas for 2011-2015. The market value of total U.S. production is estimated using the U.S. crude oil first purchase price for oil and the wellhead price for natural gas.

<sup>5</sup> For a state-level profile of marginal well operators, see: Snead, Mark and R. Dale Martinez. Dec. 2006. “A Demographic and Economic Profile of Oklahoma’s Marginal Oil and Gas Well Operators.” Center for Applied Economic Research, Oklahoma State University. Available online at: <http://digitalprairie.ok.gov/cdm/ref/collection/stgovpub/id/16844>

<sup>6</sup> The multipliers are based on the 2013 regional update of the input-output model underlying the RIMS II estimates.

<sup>7</sup> Caution must always be used when using input-output multipliers to assess the total economic activity ‘supported’ by an existing industry or firm. Input-output multipliers are intended to predict the change in economic activity that results from an incremental change in the current state of a regional economy. More specifically, the estimates provided for marginal oil and natural gas production reflect predictions from the RIMS II input-output model of the incremental impact that would result if industry revenue in the marginally producing states contracted incrementally. The actual realized impact is determined by the unique adjustment process that would take place in each state as marginal production changes.

<sup>8</sup> The estimated spillover effects include both indirect and induced effects. The indirect effect is the statewide inter-industry economic activity resulting from purchases by the state’s marginal producers, while the induced effect reflects the economic activity resulting from new household spending out of employee earnings received as part of the direct and indirect effects. For convenience, the spillover impacts are typically summarized using economic impact multipliers. The multipliers quantify the amount of spillover activity resulting from each dollar of activity in the state oil and natural gas sector. The indirect and induced effects are derived using Type II multipliers calculated as  $(\text{direct} + \text{indirect} + \text{induced})/\text{direct}$ . More generally, RIMS II output multipliers provide an estimate of the amount of output generated statewide per dollar of new output generated in the oil and natural gas industry. Employment multipliers provide an estimate of the number of full- and part-time jobs generated statewide per new job added in the oil and gas industry. Earnings multipliers provide an estimate of the amount of new labor income received by households statewide per new dollar of labor income added in the oil and natural gas industry.

<sup>9</sup> A well-known limitation of input-output models is that they do not account for subsequent general equilibrium-type effects such as changes in the relative prices of goods and services or changes in wage rates at the industry level.

<sup>10</sup> The resulting net effect is an empirical modeling question that cannot be answered with certainty. The estimates are best viewed as providing an upper bound on the spillover effects.

<sup>11</sup> The State of Colorado reports only the total number of wells plugged and abandoned and has not differentiated between oil and natural gas wells since 2009. Based on historical reports prior to 2009, there is an approximately even split between the two well types. Estimates of the number of plugged and abandoned wells by type for Colorado for 2010-2015 are based on an equal split between oil and gas wells.

<sup>12</sup> The 2009 Distribution and Production of Oil and Gas Wells by State series by EIA is available online at: [http://www.eia.gov/pub/oil\\_gas/petrosystem/petrosysog.html](http://www.eia.gov/pub/oil_gas/petrosystem/petrosysog.html)



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