

Natural Gas Production Report

Q3

July to September 2019

Production Trends

For the third quarter of 2019, recent data from the Pennsylvania Department of Environmental Protection (DEP) show that total natural gas production volume was 1,714.7 billion cubic feet (bcf) (see **Table 1**). This output represents an increase of 9.1 percent from the third quarter of the prior year, the lowest such growth rate in two years. Calendar year production is up 12.7 percent compared to the same period in 2018.

Table 1: Production Volume (bcf)

	Third Quarter			Calendar Year		
	2018	2019	Growth	2018	2019	Growth
Horizontal	1,568.6	1,713.1	9.2%	4,466.1	5,036.5	12.8%
Vertical	<u>2.6</u>	<u>1.7</u>	<u>-36.5%</u>	<u>6.4</u>	<u>4.9</u>	<u>-23.2%</u>
Total	1,571.3	1,714.7	9.1%	4,472.5	5,041.5	12.7%

Table 2 decomposes third quarter and calendar year production volume from horizontal wells by spud year. All of the production growth for the quarter was from wells spud in 2018. These wells comprised 23.3 percent of all production for the quarter. Wells spud in 2016 showed the largest decline in production (-23.8 percent) and production from wells spud in 2017 or earlier declined by 17.8 percent (not shown in table).

Table 2: Production Volume by Spud Year (bcf)

Spud Year	Third Quarter				Calendar Year			
	2018	2019	Growth	Share	2018	2019	Growth	Share
2019	n.a.	45.5	n.a.	2.7%	n.a.	53.7	n.a.	1.1%
2018	25.9	399.6	n.a.	23.3%	26.2	933.3	n.a.	18.5%
2017	406.4	328.3	-19.2%	19.2%	883.6	1,084.0	22.7%	21.5%
2016	213.4	162.6	-23.8%	9.5%	696.8	542.3	-22.2%	10.8%
2015	161.7	128.9	-20.3%	7.5%	505.8	408.3	-19.3%	8.1%
2014	247.3	192.4	-22.2%	11.2%	786.2	609.3	-22.5%	12.1%
2013	160.0	140.7	-12.0%	8.2%	497.5	431.6	-13.2%	8.6%
2012	<u>353.9</u>	<u>315.0</u>	<u>-11.0%</u>	<u>18.4%</u>	<u>1,070.1</u>	<u>973.9</u>	<u>-9.0%</u>	<u>19.3%</u>
Total	1,568.6	1,713.1	9.2%	100.0%	4,466.1	5,036.5	12.8%	100.0%

Notes: Horizontal wells only. This table displays 2018 and 2019 production based on the year wells were spud. For example, wells with spud year 2014 were spud during calendar year 2014, and their production is shown for the third quarter of 2018 and the third quarter of 2019. Spud year 2012 includes all wells spud in 2012 or earlier.

Figure 1 displays horizontal well production over the last nine quarters. From the third quarter of 2017 to the third quarter of 2019, horizontal production increased by 29.5 percent. There has been a quarter-over-quarter increase in horizontal production for thirteen consecutive quarters.

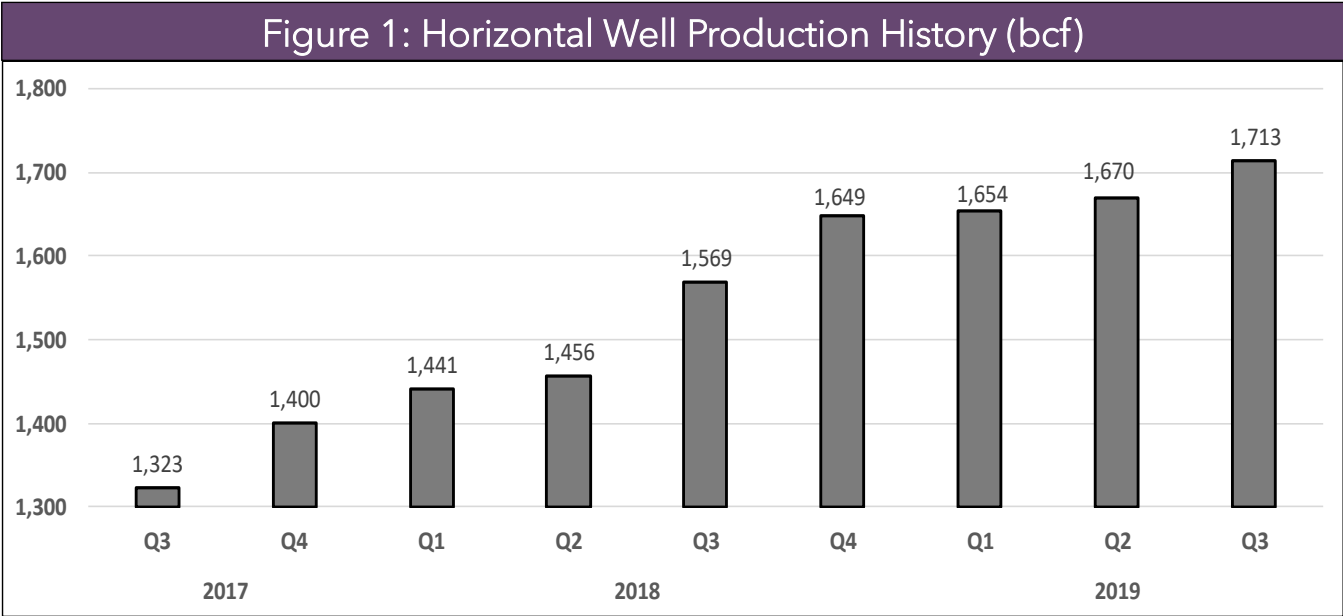
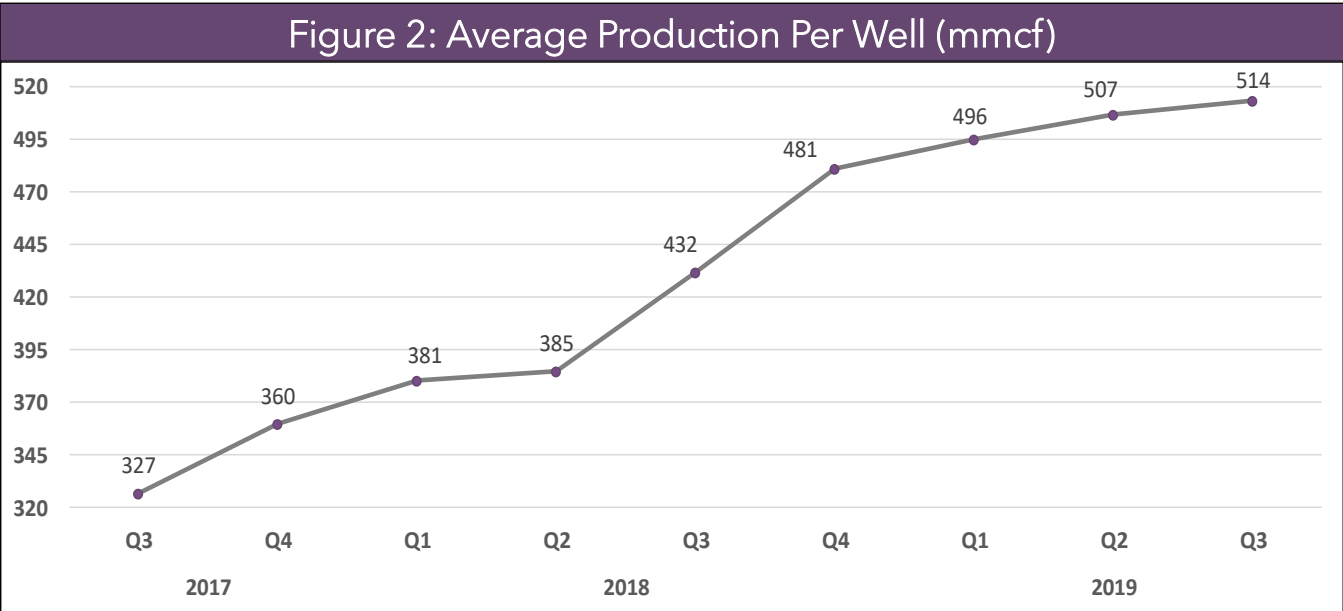


Figure 2 displays the average production per well for selected horizontal wells. Each data point in this figure represents horizontal wells that (1) were spud at least three quarters before the reporting period and no earlier than twelve quarters before that date and (2) produced above 90 mcf per day (i.e., did not qualify for stripper well status). After recording significant gains in 2018 (33.9 percent for the year), average production per well growth moderated in 2019 (6.7 percent through Q3).



Well Count Trends

Table 3 displays the number of wells in the third quarter of 2019 and provides a breakdown based on well type (horizontal vs. vertical) and production status. There were 9,116 producing horizontal wells in the third quarter, an 8.1 percent increase over the prior year. Total producing wells increased by 7.5 percent compared to the prior year. Total non-producing wells increased by 1.1 percent compared to the prior year.

Table 3: Number of Wells, Third Quarter

	<u>Producing</u>			<u>Non-Producing</u>			<u>Total</u>		
	2018	2019	Growth	2018	2019	Growth	2018	2019	Growth
Horizontal	8,432	9,116	8.1%	2,077	2,091	0.7%	10,509	11,207	6.6%
Vertical	<u>488</u>	<u>474</u>	<u>-2.9%</u>	<u>510</u>	<u>525</u>	<u>2.9%</u>	<u>998</u>	<u>999</u>	<u>0.1%</u>
Total	8,920	9,590	7.5%	2,587	2,616	1.1%	11,507	12,206	6.1%

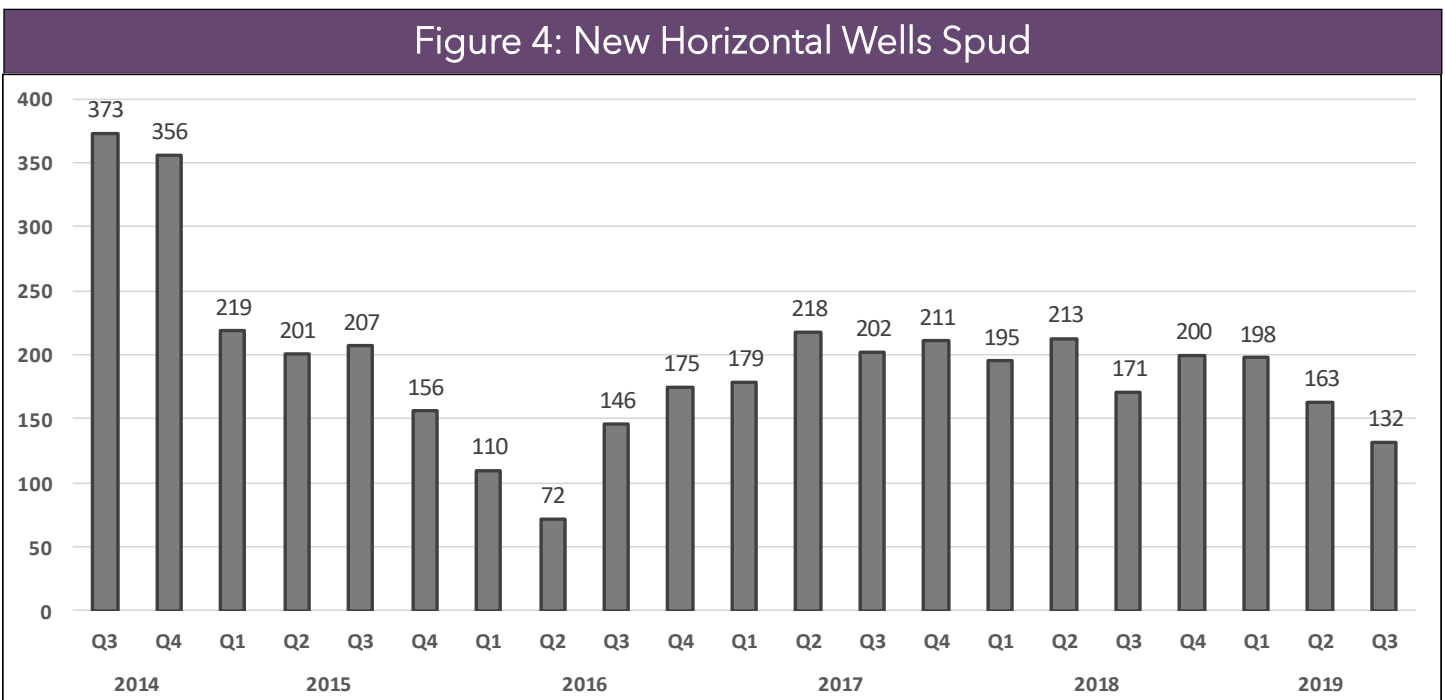
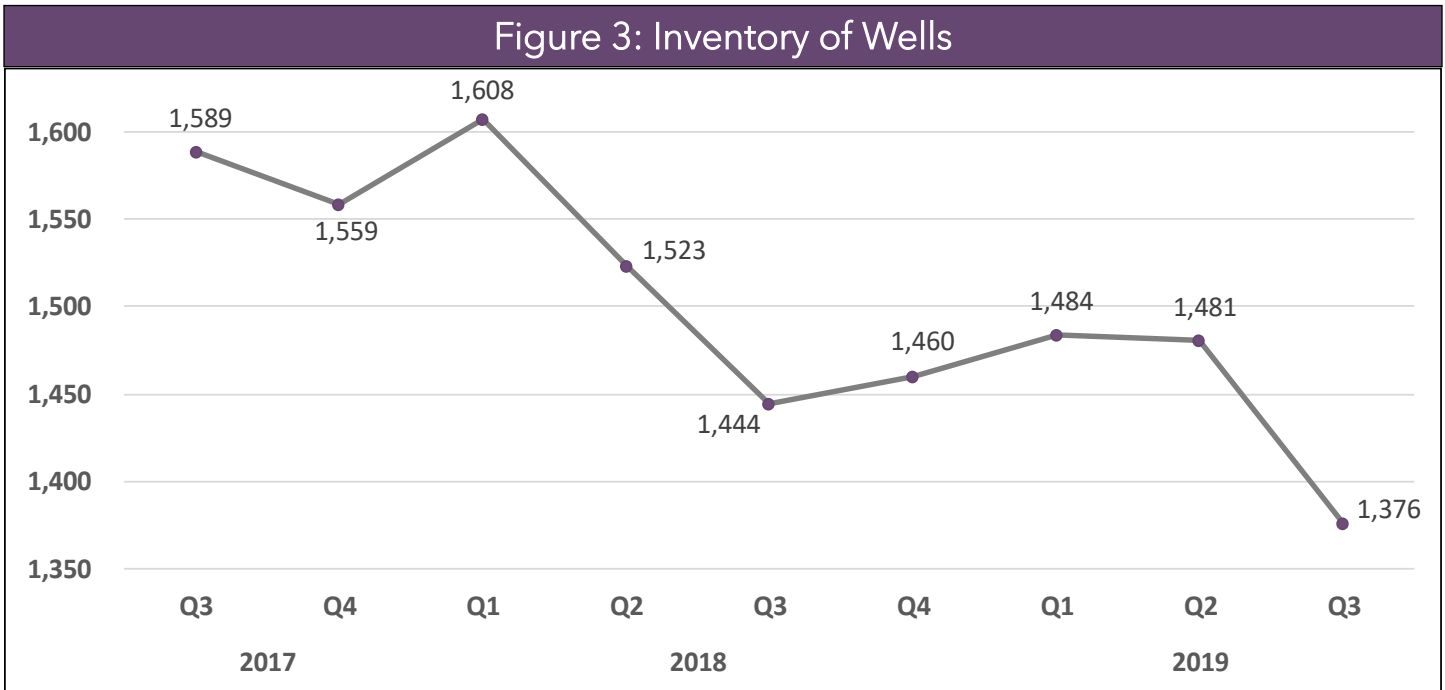
Table 4 shows a history of well counts broken down by well type and production status over the last nine quarters. It also provides detail for non-producing horizontal wells. Since the third quarter of 2017, total producing wells increased by 18.7 percent, while total non-producing wells decreased by 1.0 percent.

Table 4: Quarterly Well Count History

	<u>2017</u>		<u>2018</u>				<u>2019</u>		
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Producing Wells									
Horizontal	7,582	7,779	7,917	8,197	8,432	8,606	8,765	8,897	9,116
Vertical	<u>494</u>	<u>493</u>	<u>494</u>	<u>483</u>	<u>488</u>	<u>486</u>	<u>478</u>	<u>479</u>	<u>474</u>
Total	8,076	8,272	8,411	8,680	8,920	9,092	9,243	9,376	9,590
Non-Producing Wells									
Horizontal	2,140	2,154	2,209	2,141	2,077	2,103	2,142	2,173	2,091
Vertical	<u>503</u>	<u>504</u>	<u>503</u>	<u>515</u>	<u>510</u>	<u>512</u>	<u>520</u>	<u>520</u>	<u>525</u>
Total	2,643	2,658	2,712	2,656	2,587	2,615	2,662	2,693	2,616
Horizontal Detail									
Shut In	778	854	843	747	722	756	733	746	709
Spud, Not Completed	811	705	765	776	722	704	751	735	667
Plugged	545	588	593	611	621	640	647	667	695
Other	<u>6</u>	<u>7</u>	<u>8</u>	<u>7</u>	<u>12</u>	<u>3</u>	<u>11</u>	<u>25</u>	<u>20</u>
Total	2,140	2,154	2,209	2,141	2,077	2,103	2,142	2,173	2,091

Notes: All characterizations of wells are based on information submitted by the operator or DEP. "Other" includes wells with miscellaneous designations such as abandoned.

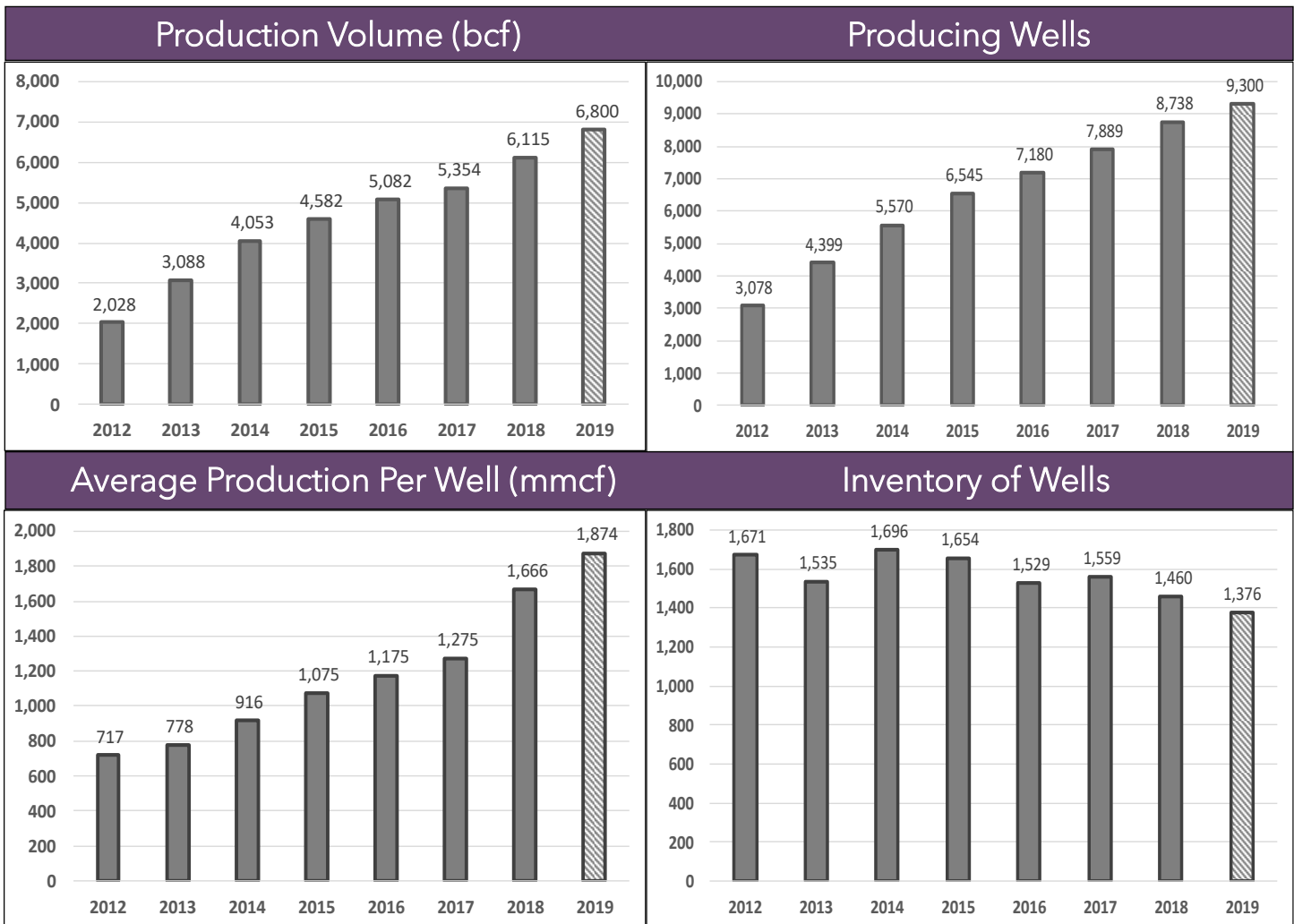
Figures 3 and 4 display recent trends in well counts. Figure 3 shows the quarterly history of the inventory of wells in Pennsylvania. Well inventory includes horizontal wells that are in the “Shut In” or “Spud, Not Completed” categories from Table 4. These wells are already spud and considered available to be brought into production in the future. The inventory of wells for the third quarter represents a decrease of 68 wells (-4.7 percent) from the prior year. Figure 4 displays the number of new horizontal wells spud in each quarter over the last five calendar years. There were 132 new horizontal wells spud in the third quarter of 2019, a decrease of 39 wells (-22.8 percent) from the prior year. This figure represents the lowest number of new wells spud since the second quarter of 2016.



Annual Trends

The following graphs display annual totals for production volume, producing well counts, average production per well and inventory well counts (i.e., non-producing wells that could produce at some point in the future). These graphs pertain only to horizontal wells. Figures for 2019 are estimates based on year-to-date spud and production data published by DEP and forecasts by Bentek Energy. Figures for 2012 to 2018 are based on DEP data for the full calendar year.

The graphs illustrate the dramatic increase in drilling and production activity since 2012. From 2012 to 2018, production volume increased at an average rate of 17.1 percent per annum while the number of producing wells increased by 16.1 percent per annum. For 2019, production volume is projected to increase by 11.2 percent (6,800 bcf) while the number of producing wells expands by 6.4 percent (9,300 wells). The graphs also illustrate that average production per well is projected to increase by 12.5 percent in 2019, decelerating from the growth rate of the prior year (30.7 percent). The dramatic increase in 2018 was attributable to increased production from active wells due to new pipeline capacity and higher natural gas prices. The deceleration in 2019 is likely the result of lower natural gas prices and the diminishing gain from last year's increased pipeline capacity.



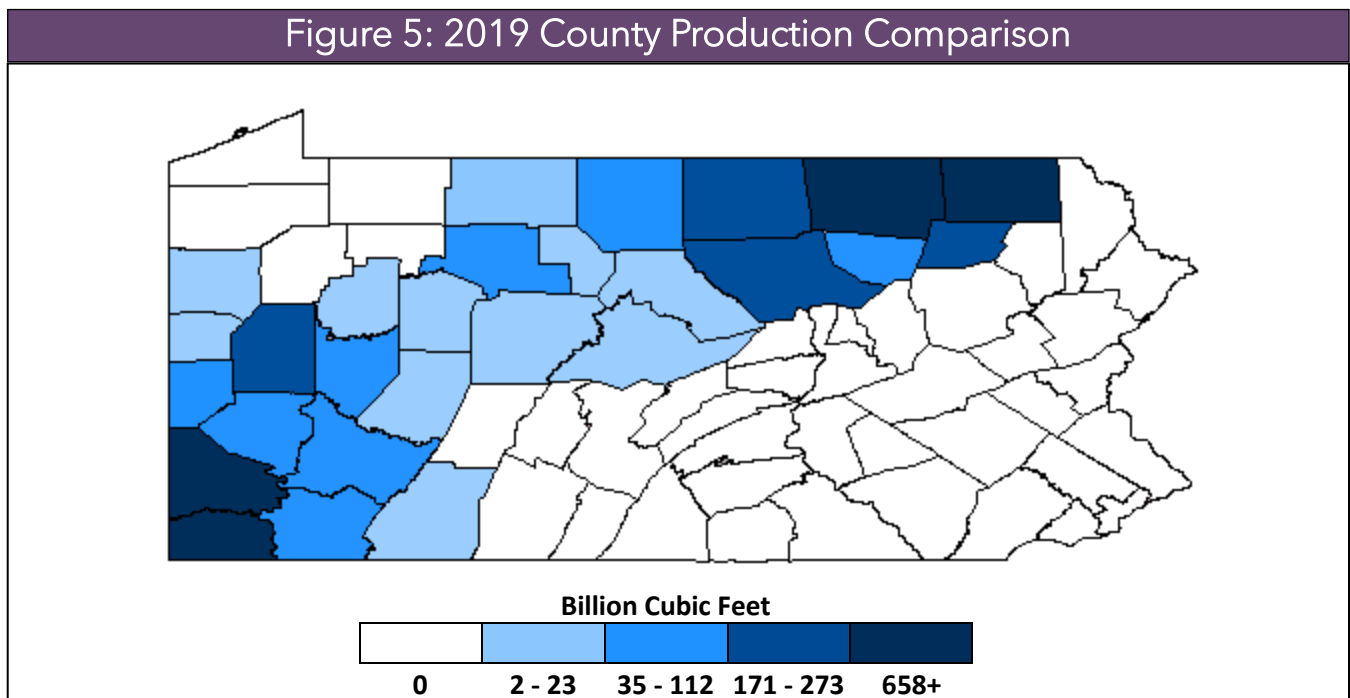
Notes: Producing Wells represents the number of wells that produced gas at any point during the year. Average Production Per Well represents horizontal wells that produced above the stripper well threshold of 90 mcf per day and were spud in any of the previous three years. Inventory of Wells represents the number of wells that did not produce gas at any point during the year and were characterized as shut in or spud, but not completed at the end of the listed calendar year.

County Comparison

Table 5 shows county-level production volume and producing well counts through the third quarter of 2018 and 2019. Four counties (Susquehanna, Washington, Greene and Bradford) comprised over two-thirds of statewide production. Among those in the top ten, all counties except Wyoming registered production gains. **Figure 5** displays a map of calendar year production by county.

Table 5: 2019 County Production Comparison										
Rank	County	Production Volume (bcf)				Number of Producing Wells				
		Calendar Year		2019 Metrics		Calendar Year		2019 Metrics		
		2018	2019	Share	Growth	2018	2019	Share	Growth	
1	Susquehanna	1,069	1,245	24.7%	16.4%	1,305	1,458	15.8%	11.7%	
2	Washington	862	876	17.4%	1.6%	1,485	1,579	17.1%	6.3%	
3	Greene	560	749	14.9%	33.8%	964	1,093	11.8%	13.4%	
4	Bradford	553	659	13.1%	19.0%	1,172	1,255	13.6%	7.1%	
5	Lycoming	260	273	5.4%	5.2%	805	830	9.0%	3.1%	
6	Tioga	223	254	5.0%	13.9%	633	694	7.5%	9.6%	
7	Wyoming	265	224	4.5%	-15.3%	242	273	3.0%	12.8%	
8	Butler	159	171	3.4%	7.7%	453	483	5.2%	6.6%	
9	Allegheny	74	111	2.2%	49.7%	98	119	1.3%	21.4%	
10	Sullivan	101	111	2.2%	10.1%	118	129	1.4%	9.3%	
11	All Other	339	363	7.2%	6.9%	1,250	1,332	14.4%	6.6%	

Note: Horizontal wells only. Data shown pertain to the first three quarters of the calendar year.



State Comparison

Table 6 provides a state comparison of gross natural gas production from all well types. Nationwide production grew by 10.9 percent in 2018, which was the largest year-over-year increase on record (since 1980). Through August 2019, nationwide production grew by 10.8 percent compared to the prior year, largely driven by significant gains in Texas and Pennsylvania.

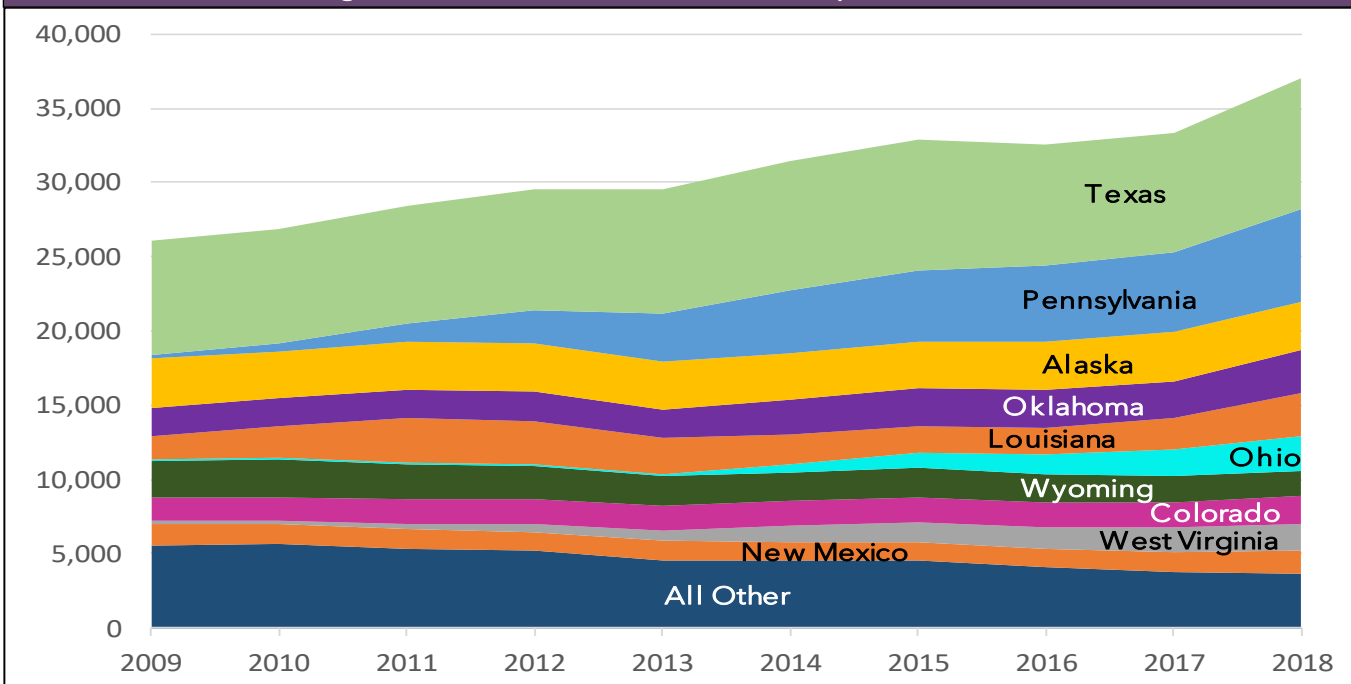
Figure 6 displays the composition of total U.S. production by state over the last decade.

Table 6: State Production Comparison (bcf)

Rank	State	Production Volume			Annual Growth Rate		
		CY 2017	CY 2018	CY 2019	CY 2017	CY 2018	CY 2019
1	Texas	7,9956	8,814	6,621	-2.0%	10.2%	16.0%
2	Pennsylvania	5,464	6,207	4,579	4.9%	13.6%	14.2%
3	Alaska	3,251	3,255	2,151	0.6%	0.1%	0.9%
4	Oklahoma	2,514	2,946	2,097	1.8%	17.2%	9.7%
5	Louisiana	2,148	2,830	2,065	19.8%	31.8%	12.3%
6	Ohio	1,773	2,385	1,698	23.4%	34.5%	12.4%
7	West Virginia	1,601	1,799	1,378	15.6%	12.4%	19.9%
8	Colorado	1,688	1,831	1,304	0.0%	8.5%	9.3%
9	New Mexico	1,325	1,524	1,201	3.3%	15.1%	22.6%
10	Wyoming	1,805	1,721	1,020	-2.4%	-4.6%	-11.4%
11	All Other	3,794	3,697	2,506	-7.3%	-2.6%	3.0%

Source: U.S. Energy Information Administration. Production does not directly correspond to DEP data. Data and growth rates for CY 2019 are through August.

Figure 6: State Production Comparison (bcf)



Glossary of Natural Gas Terminology

Abandoned	No longer producing, but not plugged, and without an available operator.
Bcf	Billion cubic feet. Used as a measure of production volume.
Completed	Capable of producing. Includes drilling and casing and, in the case of an unconventional well, fracturing the shale formation to release gas.
Mcf	Thousand cubic feet. Used as a measure of production volume.
MMcf	Million cubic feet. Used as a measure of production volume.
Non-Producing	A well with no production activity during the time period.
Plugged	Permanently sealed with cement or by some similar method.
Production	The natural gas recovered from a well.
Shut In	Temporary suspension of production activity. Directly corresponds to the term Capped, as defined in Act 13 of 2012.
Spud	The commencement of drilling activity. Often refers to the first stage at which casing is placed into the wellbore. Spud Year refers to the year in which a well was spud, as reported to the Department of Environmental Protection.
Unconventional	Requiring technological methods that go beyond merely drilling a well and capturing the gas. These methods usually include horizontal drilling into deep formations and fracturing with fluids.

About the Report

The IFO publishes this report on a quarterly basis each May, August, November and February for the preceding quarter using monthly production data submitted to DEP by natural gas extractors that operate in the state. Unless otherwise noted, this report uses those data, in conjunction with DEP data on wells spud, to develop statewide tabulations of production volume and well counts. These data pertain only to gas produced from unconventional formations, which include the Marcellus and Utica. The data included in this report are current as of November 27, 2019.

Staff Acknowledgements

This report was produced by Jesse Bushman and Rachel Flaugh. Questions regarding this report can be directed to jbushman@ifso.state.pa.us.