Natural Gas Production Report

Q3

July to September 2018

Production Trends

For the third quarter of 2018, recent data from the Pennsylvania Department of Environmental Protection (DEP) show that total natural gas production volume was 1,570.1 billion cubic feet (bcf) (see **Table 1**). Compared to the third quarter of 2017, total production grew by 18.5 percent. That rate is considerably higher than the first (9.9 percent) and second (10.0 percent) quarters.

Table 1: Production Volume (bcf)

	Third Quarter			Calendar Year-to-Date		
	2017	2018	Growth	2017	2018	Growth
Horizontal	1,323.0	1,567.5	18.5%	3,954.0	4,465.0	12.9%
Vertical	2.3	2.6	12.2%	7.6	6.4	-14.9%
Total	1,325.3	1,570.1	18.5%	3,961.6	4,471.5	12.9%

Table 2 decomposes third quarter and calendar year production volume from horizontal wells by spud year. All of the production growth in the third quarter was from wells spud in 2016 and 2017. Wells spud in 2016 or 2017 comprised more than one-third of all production in the quarter (39.5 percent). Wells spud in 2015 showed the largest decline in production (-29.7 percent) and production from wells spud in 2014 or earlier declined by 15.0 percent.

Table 2: Production Volume by Spud Year (bcf)

	Third Quarter				Calendar Year-to-Date			
Spud Year	2017	2018	Growth	Share	2017	2018	Growth	Share
2018	n.a.	25.9	n.a.	1.7%	n.a.	26.2	n.a.	0.6%
2017	25.5	406.4	n.a.	25.9%	26.9	883.7	n.a.	19.8%
2016	193.4	213.4	10.3%	13.6%	356.7	696.8	95.3%	15.6%
2015	230.0	161.7	-29.7%	10.3%	748.6	505.8	-32.4%	11.3%
2014	294.8	247.3	-16.1%	15.8%	966.2	786.2	-18.6%	17.6%
2013	191.6	160.0	-16.5%	10.2%	611.9	497.5	-18.7%	11.1%
2012	135.4	118.3	-12.6%	7.5%	428.6	362.2	-15.5%	8.1%
2011	252.3	234.5	-7.1%	15.0%	815.2	706.7	-13.3%	15.8%
Total	1,323.0	1,567.5	18.5%	100.0%	3,954.0	4,465.0	12.9%	100.0%

Notes: Horizontal wells only. This table displays 2017 and 2018 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 2017 and the third quarter of 2018. Spud year 2011 includes all wells spud in 2011 or earlier.

Figure 1 displays horizontal well production over the last nine quarters. From the third quarter of 2016 to the third quarter of 2018, horizontal production increased by 24.1 percent. There has been a quarter-over-quarter increase in horizontal production in eight consecutive quarters.

Figure 1: Horizontal Well Production History (bcf)

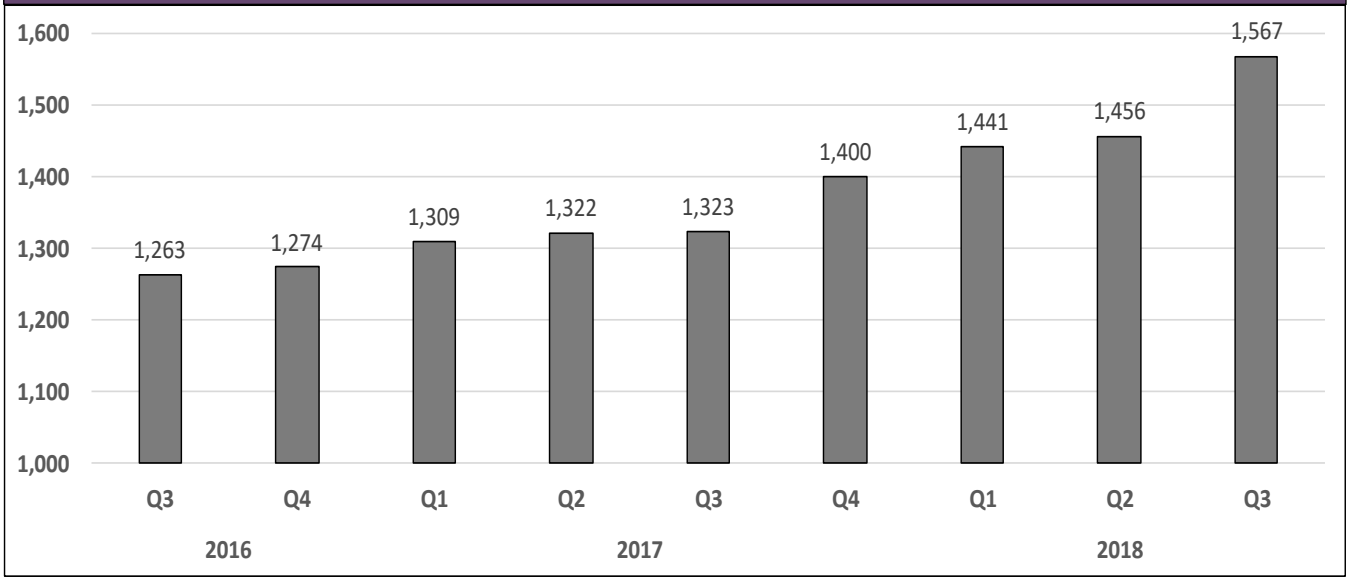
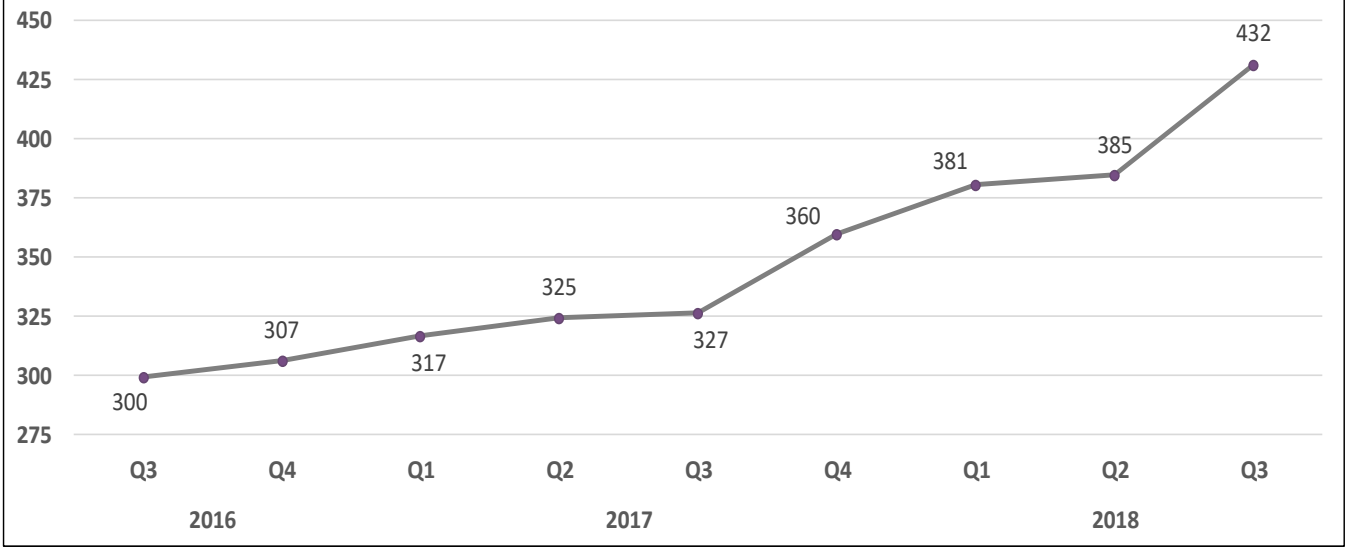


Figure 2 displays the average production per well for selected horizontal wells. Each data point in this figure represents horizontal wells that (1) were spud at least three quarters before the reporting period and no earlier than 12 quarters before that date and (2) produced above 90 mcf per day (i.e., did not qualify for stripper well status). From the third quarter of 2016 to the third quarter of 2018, average production per well increased by 44.0 percent. There has been a quarter-over-quarter increase in average production per well in eight consecutive quarters.

Figure 2: Average Production Per Well (mmcf)



Well Count Trends

Table 3 displays the number of wells in the third quarter of 2018 and provides a breakdown based on well type (horizontal vs. vertical) and production status. There were 8,431 producing horizontal wells in the third quarter, an 11.2 percent increase over the prior year. Total producing wells increased by 10.4 percent compared to the prior year. Total non-producing wells declined by 0.2 percent, with horizontal wells declining by 2.8 percent and vertical wells increasing by 1.8 percent.

Table 3: Number of Wells, Third Quarter

	Producing			Non-Producing			Total		
	2017	2018	Growth	2017	2018	Growth	2017	2018	Growth
Horizontal	7,582	8,431	11.2%	2,134	2,074	-2.8%	9,716	10,505	8.1%
Vertical	494	486	-1.6%	500	509	1.8%	994	995	0.1%
Total	8,076	8,917	10.4%	2,634	2,583	-0.2%	10,710	11,500	7.4%

Table 4 shows a history of well counts broken down by well type and producing status over the last nine quarters. It also provides detail for non-producing horizontal wells. Since the third quarter of 2016, total producing wells have increased by 20.7 percent, while total non-producing wells increased by 1.4 percent.

Table 4: Quarterly Well Count History

	2016		2017				2018		
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Producing Wells									
Horizontal	6,897	7,070	7,204	7,347	7,582	7,778	7,916	8,197	8,431
Vertical	492	501	495	506	494	493	493	482	486
Total	7,389	7,571	7,699	7,853	8,076	8,271	8,409	8,679	8,917
Non-Producing Wells									
Horizontal	2,046	2,048	2,093	2,168	2,134	2,149	2,206	2,137	2,074
Vertical	501	492	498	487	500	501	501	513	509
Total	2,547	2,540	2,591	2,655	2,634	2,650	2,707	2,650	2,583
Horizontal Detail									
Shut In	871	820	843	833	780	851	846	751	723
Spud, Not Completed	681	709	727	783	809	719	773	784	736
Plugged	470	485	487	522	532	566	570	583	597
Other	22	32	36	30	13	13	17	19	18
Total	2,044	2,046	2,093	2,168	2,134	2,149	2,206	2,137	2,074

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 is comprised of horizontal wells that fall into the "Shut In" or "Spud, Not Completed" categories. These are wells that are already spud and considered available to be brought into production in the future. The inventory of wells for the third quarter of 2018 decreased by 76 wells (-5.0 percent) from the previous quarter. Figure 4 displays the number of new horizontal wells spud in each quarter over the last five calendar years. For the third quarter of 2018, there were 171 new horizontal wells spud, which is a decrease of 42 wells from the previous quarter and a decrease of 31 wells from the same period in 2017.

Figure 3: Inventory of Wells

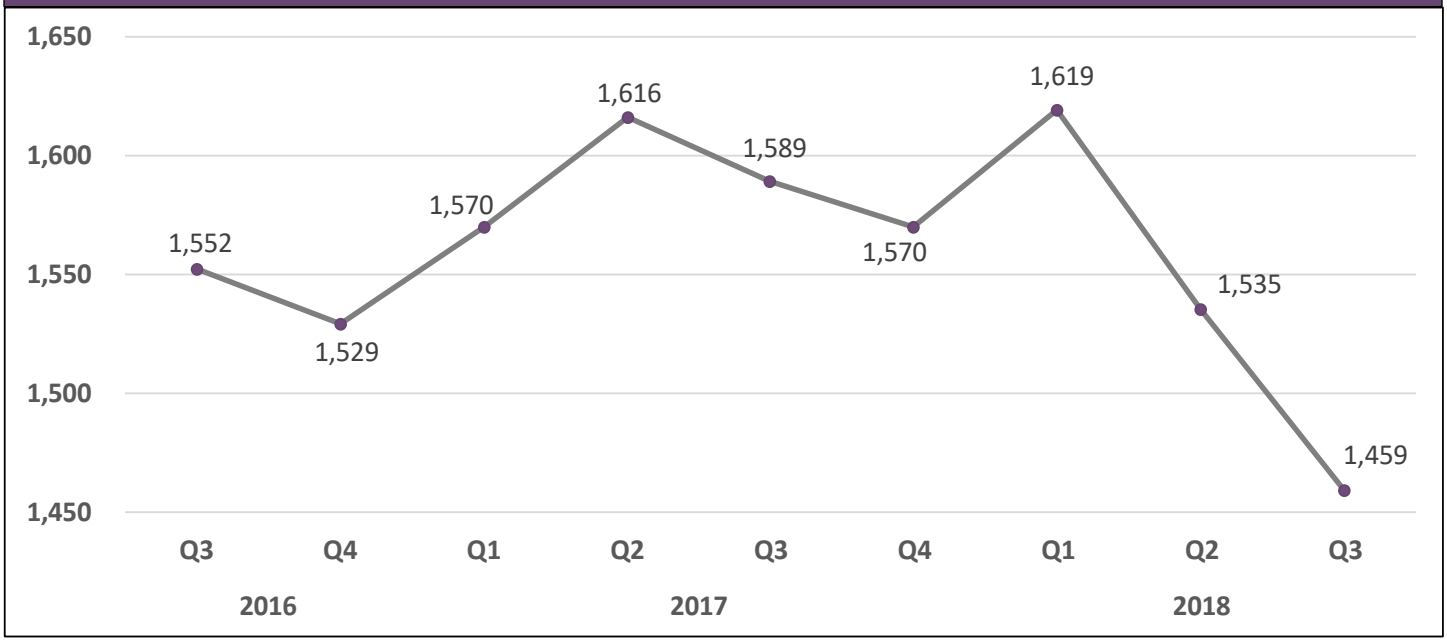
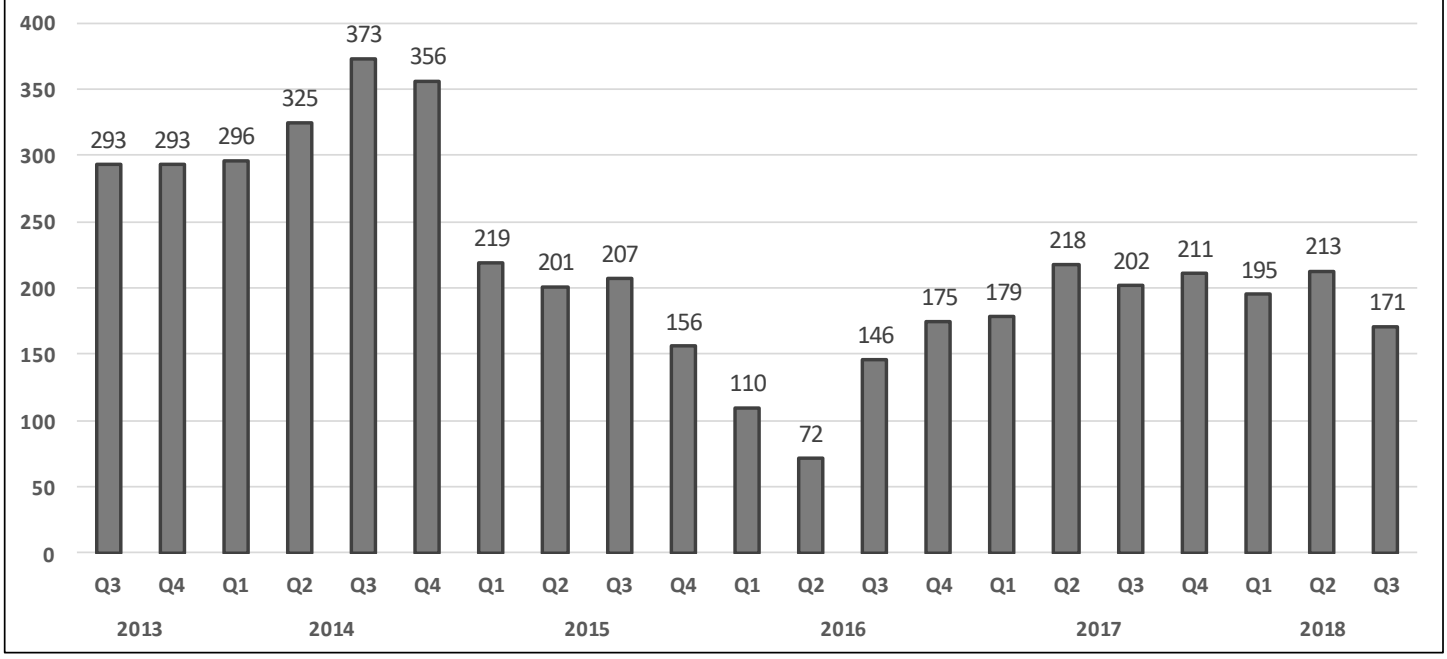


Figure 4: New Horizontal Wells Spud

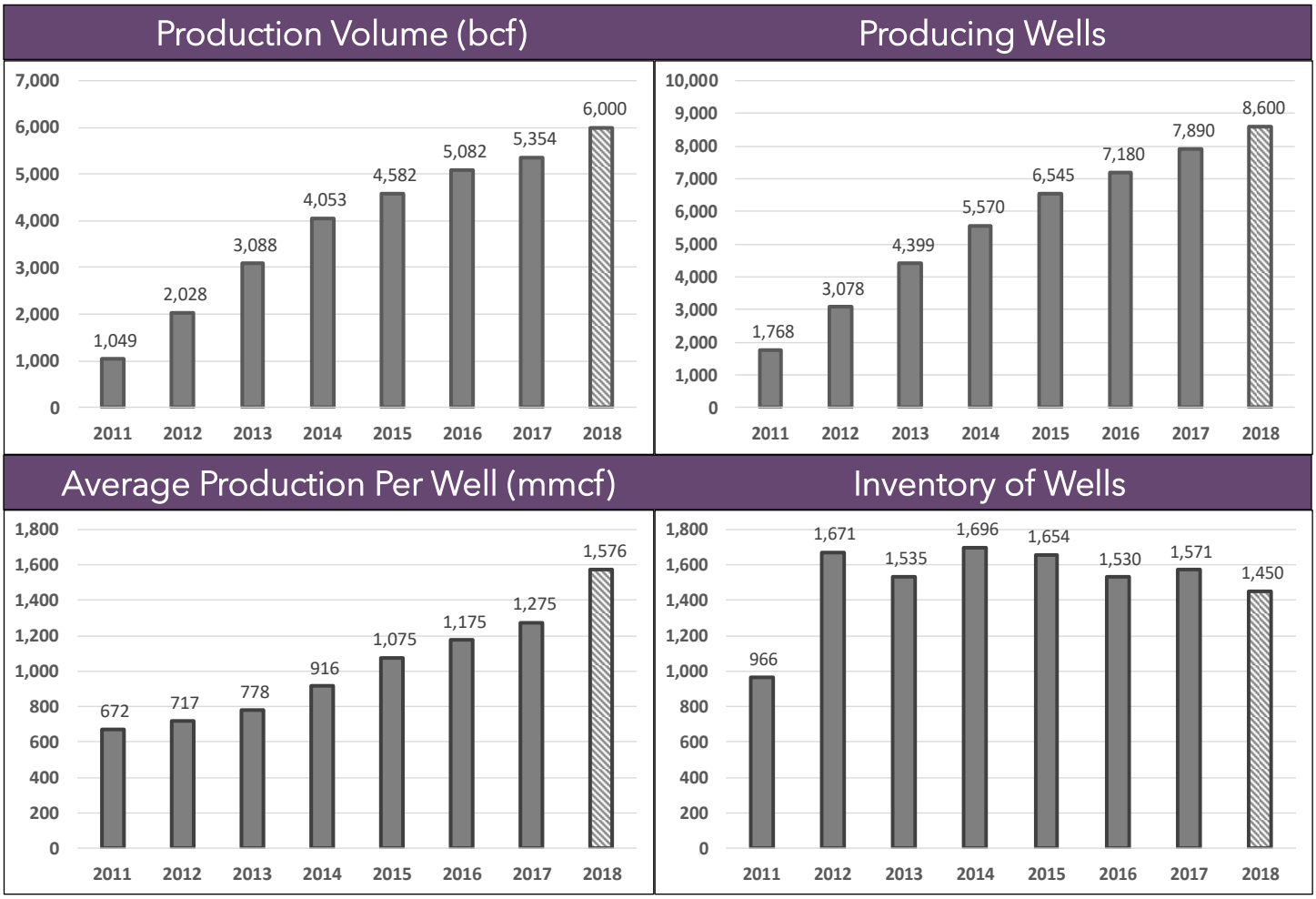


Annual Trends

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 production and well counts. Figures for 2018 are estimates based on year-to-date spud and production data published by DEP and forecasts by Bentek Energy. Figures for 2011 to 2017 are based on DEP data for the full calendar year.

The graphs illustrate the dramatic increase in drilling and production activity since 2011. From 2011 to 2017, production volume increased at an average rate of 31.2 percent per annum while the number of producing wells increased by 28.3 percent per annum. For 2018, production volume is projected to increase by 12.1 percent (6,000 bcf) while the number of producing wells expands by 9.0 percent (8,600 wells).

The graphs also illustrate that average well production has increased every year. The dramatic increase for 2018 is likely attributable to increased production from active wells due to (1) new pipeline capacity from recent projects throughout the state, (2) improving drilling technology and (3) higher natural gas prices. For the remainder of 2018, actual production volume and average production will depend on weather-related demand for natural gas.



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

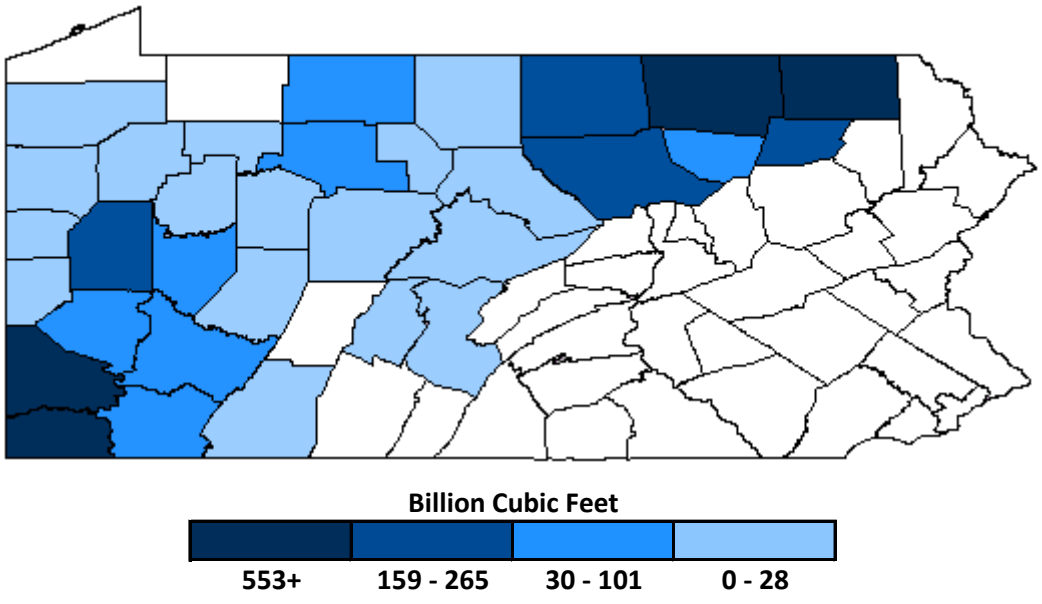
Table 5 shows county-level production volume and producing well counts for the first three quarters of the calendar year. Four counties (Susquehanna, Washington, Greene and Bradford) comprised two-thirds of statewide production. Among those in the top ten, all counties except Lycoming and Sullivan registered production gains. **Figure 5** displays a map of calendar year-to-date production by county.

Table 5: Calendar Year Production, by County

		Production Volume (bcf)				Number of Producing Wells			
		Calendar Year		2018 Metrics		Calendar Year		2018 Metrics	
Rank	County	2017	2018	Share	Growth	2017	2018	Share	Growth
1	Susquehanna	966.1	1,069.3	23.9%	10.7%	1,151	1,305	15.3%	13.4%
2	Washington	677.9	862.4	19.3%	27.2%	1,301	1,485	17.4%	14.1%
3	Greene	495.0	559.8	12.5%	13.1%	830	964	11.3%	16.1%
4	Bradford	538.3	553.4	12.4%	2.8%	1,066	1,172	13.7%	9.9%
5	Wyoming	252.6	264.8	5.9%	4.8%	230	242	2.8%	5.2%
6	Lycoming	268.4	259.6	5.8%	-3.3%	758	805	9.4%	6.2%
7	Tioga	154.3	222.0	5.0%	43.9%	598	632	7.4%	5.7%
8	Butler	133.6	159.1	3.6%	19.0%	385	453	5.3%	17.7%
9	Sullivan	101.9	100.8	2.3%	-1.0%	103	118	1.4%	14.6%
10	Allegheny	48.2	74.4	1.7%	54.1%	80	98	1.1%	22.5%
11	All Other	317.8	339.5	9.3%	6.8%	1,141	1,250	12.4%	9.6%

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

Figure 5: Calendar Year Production, by County



State Comparison

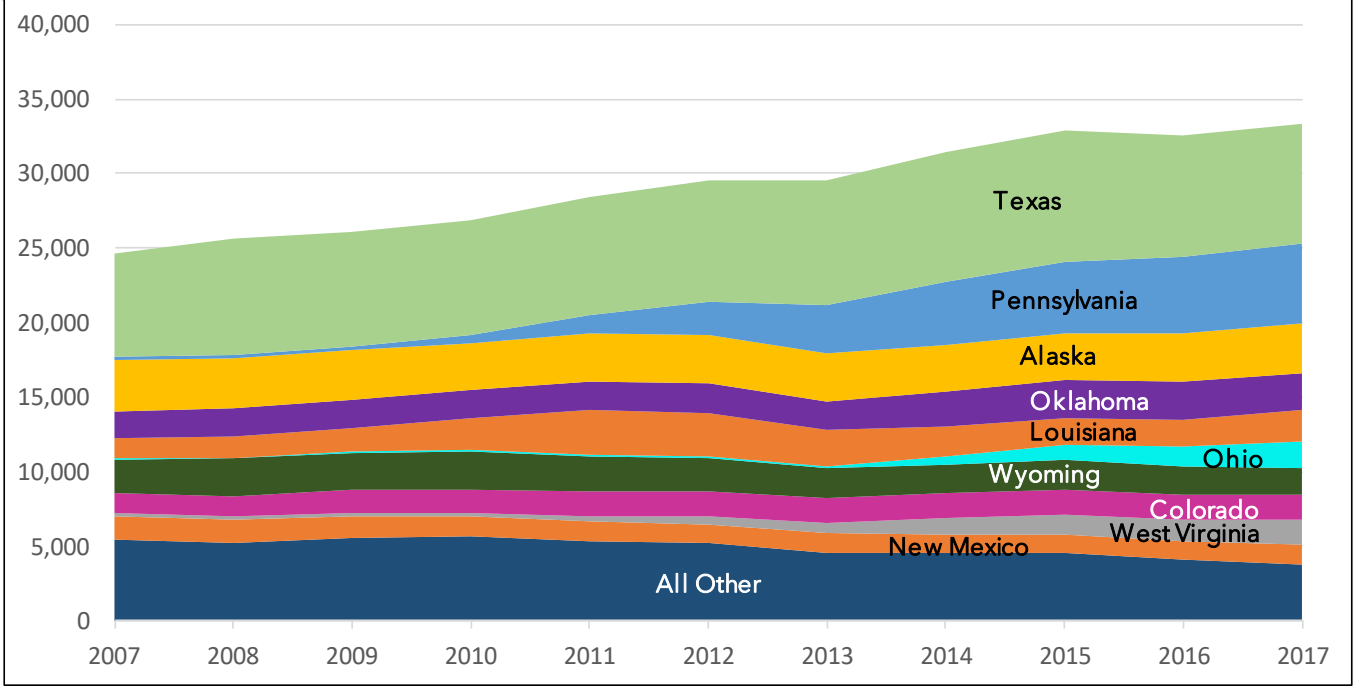
Table 6 provides a state comparison of gross natural gas production from all well types. Among the top-ten producing states, Louisiana and Ohio recorded the largest year-over-year production gains for the first eight months of 2018 while Alaska and Wyoming were the only states in the top ten to register a decline. **Figure 6** displays the composition of total U.S. production by state over the last decade.

Table 6: State Production Comparison (bcf)

		Production Volume			Annual Growth Rate		
Rank	State	CY 2016	CY 2017	CY 2018	CY 2016	CY 2017	CY 2018
1	Texas	8,156.3	7,995.7	5,703.1	-7.3%	-2.0%	8.5%
2	Pennsylvania	5,210.2	5,463.9	4,010.3	8.3%	4.9%	11.6%
3	Alaska	3,230.2	3,250.8	2,132.6	1.7%	0.6%	-0.1%
4	Oklahoma	2,468.3	2,513.9	1,909.6	-1.3%	1.8%	17.3%
5	Louisiana	1,793.4	2,147.6	1,840.5	-1.1%	19.8%	39.5%
6	Ohio	1,437.3	1,772.9	1,511.3	42.7%	23.4%	36.9%
7	Colorado	1,688.4	1,687.7	1,193.5	0.0%	0.0%	7.9%
8	West Virginia	1,384.5	1,601.1	1,150.6	5.3%	15.6%	12.1%
9	Wyoming	1,848.6	1,804.7	1,150.3	-7.4%	-2.4%	-3.1%
10	New Mexico	1,282.7	1,324.9	978.9	-1.1%	3.3%	12.9%
11	All Other	4,091.8	3,794.2	2,432.4	-1.6%	0.4%	8.0%

Note: CY 2018 includes production through August and the corresponding growth rate is based on the same time period in CY 2017.
Source: U.S. Energy Information Administration. Production does not directly correspond to DEP data.

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.
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 28, 2018.