The Distribution of U.S. Oil and Natural Gas Wells by Production Rate

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Introduction

Technological innovation in drilling and completions has recently caused rapid growth in U.S. oil and natural gas production. Exploring how U.S. oil and natural gas wells have changed provides deeper insight into this rapid growth. In this report, we present data on the distribution of wells by size and technology and analyze emerging trends.

U.S. oil production, which includes crude oil and condensate, reached 11.2 million barrels per day (b/d) in December 2020, and U.S. natural gas production (gross withdrawals) reached 112.6 billion cubic feet per day (Bcf/d) in December 2020. U.S. oil production and natural gas production (gross withdrawals) both increased in 2021; oil production reached 11.6 million b/d, and natural gas natural gas production (gross withdrawals) reached 118.7 Bcf/d in December 2021. U.S. crude oil and natural gas production increased in 2021 because of higher demand and increased rig counts.

The number of producing wells in the United States reached a high of just over 1 million (1,031,183) wells in 2014 and declined to just under 1 million (916,934) wells in 2021—mostly because of lower oil prices and less rig activity (Figure 1). The increase in the share of horizontal wells during the past decade from 5.4% to 18.1% (2011–21) shows the impact of technological change on well type (Figure 2). Since 2013, more than half of U.S. oil (Figure 3) and natural gas (Figure 4) production comes from wells that produce between 100 barrels of oil equivalent per day (BOE/d) and 3,200 BOE/d. In terms the number of wells, the share of U.S. oil and natural gas wells producing less than 15 BOE/d has remained steady at about 80% from 2000 through 2021 (Figure 1).

This report provides yearly estimates of producing oil and natural gas wells in the United States, which are grouped according to volume in one of 22 production volume brackets that range from less than 1 BOE/d to more than 12,800 BOE/d. We designate wells as either oil or natural gas wells based on a gas-oil ratio (GOR) of 6,000 cubic feet of natural gas to 1 cubic foot per barrel (cf/b) of oil for each year’s production. If the GOR is equal to or less than 6,000 cf/b, then we classify the well as an oil well. If the GOR is greater than 6,000 cf/b, we classify the well as a natural gas well.

The distribution tables for the production rates of all U.S. oil and natural gas wells range from calendar years 2000 through 2021. Appendix B provides summary breakouts for the total United States, each state, the Federal Offshore Gulf of Mexico, and the Federal Offshore Pacific. You can use the Appendix C spreadsheet to generate figures for all regions and for additional variables.

The quality and completeness of the available data we used to build the tables varies by state. The data originate from state administrative records of monthly well- or lease-level natural gas and liquid fuel production. We receive the data from the commercial source Enverus, which collects the data from various state agencies. Some state agencies do not make well-production data available until years after production occurs, and others have never made well-production data available. For the late-reporting states—Kentucky, Maryland, Missouri, and Tennessee—we use the last year of reported data to populate recent missing years to achieve the most complete U.S. total well counts. Data are not

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available for Illinois and Indiana. Appendix A shows the reporting status for each state and year covered in the report and the availability of completion, well, and lease data by state.

**Figure 1. U.S. total wells by production rate brackets**

![Graph showing U.S. total wells by production rate brackets.](image)

Data source: U.S. Energy Information Administration and Enverus

Note: BOE=barrels of oil equivalent

**Figure 2. U.S. horizontal wells total production by production rate bracket**

![Graph showing U.S. horizontal wells total production by production rate bracket.](image)

Data source: U.S. Energy Information Administration and Enverus

Note: BOE=barrels of oil equivalent
Figure 3. Oil production from U.S. wells by production rate brackets

Data source: U.S. Energy Information Administration and Enverus
Note: BOE=barrels of oil equivalent

Figure 4. Natural gas production from U.S. wells by production rate brackets

Data source: U.S. Energy Information Administration and Enverus
Note: BOE=barrels of oil equivalent
Definition of a Well

How we define wells
This report and its tables include five well types:

- Single wellhead
- Sidetrack
- Completion
- Recompletion
- Lease

This report includes every producing entity in the Enverus database. When we know the number of wells on a lease, we distribute the total lease production equally among the wells; however, in some cases, the commercial source has allocated individual well production in proportion to well test results. Sometimes, only a lease and its total production are available (without the well counts), which leads to undercounted wells in some areas.

Production volume accounting
We removed identified, reinjected, and recycled natural gas from the gross natural gas volumes reported by some states, such as Alaska. For fields identified as having undergone or as currently undergoing natural gas injection, we reduced production levels by an equal share of the field-level injected natural gas that the state reported. We did not include injection wells in the counts unless they were producing wells at one time; in such cases, we included those wells for the years they were producing.

The pressure base that producers use to record natural gas volumes varies by state. For consistency, we converted all natural gas volumes to the federal pressure base of 14.73 pounds per square inch absolute (psia). We did not, however, adjust to account for differences in the temperature base; instead, we assumed states used 60°F as the temperature base. Because states vary in how they define a well type (oil or natural gas), we used a GOR of greater than 6,000 cf/b to designate a natural gas well. We designated wells with less than or equal to 6,000 cf/b as oil wells.

We excluded storage wells, dry holes, and wells that produce exclusively within CO2 fields.

Consistency with other data sources
The total volumes in the distribution tables represent a snapshot of available data at the time we assembled the report and may not exactly equal other related data, including other EIA sources. Differences sometimes exist in:

- The timing of updates from state and commercial sources
- The availability of state-level aggregate production data versus well-level data
- The definition of a well and which entities we counted and summed

Methodology
How we analyzed and aggregated the data
First, we used the number of days of production activity to convert volumes to a daily rate for the BOE-rate classes in the tables. For this calculation, we did not use the reported days on production measure for a well because it is often not available in the database. Instead, we used calendar days for consistency. To calculate the months in production, we determined the monthly production data for the first month and for the first year of production and the last month and last year of production for each well. We counted days of production using the number of calendar days in each month for the first year and last year of production. For the middle years of production, we used full years of 365 (or 366) days for days of production.

Next, we added the monthly oil and natural gas volumes, multiplied by the number of days of production, to determine annual totals for each well. We converted the annual natural gas volume to BOE using the GOR of 6,000 cf/b, and as previously mentioned, used the GOR to help classify a well as gas or oil. We classified the well as an oil well if its production of barrels of oil was greater than the natural gas production converted to BOE. We classified it as a natural gas well if its BOE production was greater than the oil production. We then added the natural gas BOE to the liquid fuel value for a total BOE for each year of the well’s production. We divided this total BOE by the number of calendar days the well was in production status, which often reflected partial years for the first and last years and full years for years in between. Each well is then classified in the appropriate BOE/d rate class in the tables.

Finally, we added the well counts and production levels for each rate class to produce the yearly state tables for the report.

**Frequently Asked Questions**

**What is the average production rate of a well, and how does this rate differ between oil wells and natural gas wells?**

In 2021, the average oil well produced 26 b/d (or roughly 33.5 BOE/d if including natural gas), and the average natural gas well produced about 181,647 cf/d (slightly more than 33.5 BOE/d of total oil and natural gas). The distribution by well size, however, is generally skewed. Many wells produce smaller volumes per day, and fewer wells produce very large volumes per day. In 2021, 77.9% of the more than 916,934 U.S. wells produced less than 15 BOE/d, and 6.4% of the wells produced more than 100 BOE/d.

**What are some of the key conclusions from our data?**

The total number of operating U.S. oil and natural gas wells has decreased about 11.1% from a peak in 2014 to 2021—from more than 1,031,183 wells to about 916,934 wells. The total number of horizontally drilled wells has increased 67.9%, from slightly less than 99,000 wells in 2014 to about 166,160 wells in 2021. Oil and natural gas wells drilled horizontally through hydrocarbon-bearing formations are among the most productive wells in the United States.

We published several *Today in Energy* articles on this topic, based on earlier versions of the data:

- Associated natural gas production declines in 2020, following three years of growth, August 23, 2021
• U.S. crude oil and natural gas production increased in 2018, with 10% fewer wells, February 3, 2020
• Horizontally drilled wells dominate U.S. tight formation production, June 6, 2019
• U.S. crude oil and natural gas production increased in 2017 with fewer wells, November 14, 2018

What is the source of our data, and how do we collect it?
Our data source is Enverus. We receive a monthly download from Enverus containing the most recent production information. This commercial data source collects data from various state agencies involved in regulating oil and natural gas production.

How often do we collect well-production data for the Lower 48 states?
Some states make data available within a few months after a new well begins production, and other states may take more than 18 months to release that data. The average lag between a new well’s first production and reported production in the database is six to eight months.

In addition, states sometimes revise historical data because they continue collecting and digitizing older well datasets or their databases. States may also revise data if they identify inaccuracies.

How often will we update this report?
We plan to update this report each year by November or December, when complete or nearly complete data for the previous year are available for most states.

Does a natural gas well remain a natural gas well during its entire production history?
In this report, we sometimes classify a well as a natural gas well in one year and as an oil well in another year, and vice versa, depending on a well’s GOR. We use this approach because the respective volumes of liquid fuel and natural gas produced by a well can change significantly during the well’s production history.

Do we distinguish between associated natural gas and nonassociated natural gas?
The report distinguishes between associated and nonassociated natural gas based on whether we classify the well as an oil well or a natural gas well. If we classify the well as a natural gas well, then we consider the natural gas as nonassociated gas and the liquid fuel as condensate, which is counted as oil. If we classify the well as an oil well, then we consider the natural gas as associated gas and the liquid fuel as oil.

How do we account for lags in data reporting?
We include notes in the tables to indicate states that are missing current data because of a lag in annual reporting. For missing years, we repeat a state’s latest data. We don’t attempt to estimate data that may be missing within a reported year. Appendix A provides a summary table of missing or incomplete state data.
How long after a well starts producing is it classified into a production-rate bracket?

We include a well in our analysis as soon as data for the first month of production are available in our database.

Do all wells produce both oil and natural gas?

Most wells produce both oil and natural gas, but some wells produce only one or the other.

Does the specific reservoir, formation, or play determine the amount of oil and natural gas produced?

Yes. Different zones within the same reservoir (depending on the hydrocarbon content, depth, and burial history) will produce only liquids, a mix of liquids and natural gas, or only natural gas.

Why do some states have productive drilling sites and others do not?

The best producing areas are often large basins with thick layers of sedimentary rock that accumulated over a long time and also contain oil and natural gas. States such as North Dakota, Texas, and Pennsylvania have productive drilling sites because they cover large areas of these basins. Subsurface geology and paleogeography are the most important factors in determining whether a state may be an oil and natural gas producer.

Has the productivity of wells changed since horizontal drilling technology and hydraulic fracturing technology have advanced?

Horizontal drilling and hydraulic fracturing have greatly increased both oil and natural gas production rates of onshore wells in the United States. The decline rates of hydraulically fractured horizontal wells within shale or tight formations are typically greater than for wells drilled vertically into conventional reservoirs.

What is a stripper well?

A stripper well, also called a marginal well, is an oil or natural gas well that is nearing the end of its economically useful life. These wells can continue to produce small volumes for long periods. Many of these wells are still operating, and together they produced approximately 7% of total U.S. oil and natural gas in 2021. The Interstate Oil and Gas Compact Commission defines a stripper well as a well that produces 10 b/d or less of oil or 60,000 cf/d or less of natural gas during a 12-month period. The Internal Revenue Service (IRS)—for tax purposes—defines this type of well as one that produces 15 b/d or less of oil over a calendar year. In addition, 15 b/d or less of oil converts to 90,000 cubic feet or less of natural gas per day over a calendar year. We use the IRS definition.

What happens to a well after it stops producing oil or natural gas?

Operators usually plug and abandon nonproducing wells. If they suspect significant amounts of hydrocarbons are still in the reservoir, the well may undergo secondary or tertiary recovery.
What is the difference between gross natural gas, wet natural gas, and dry natural gas?
You can find definitions for natural gas gross withdrawals, wet natural gas, and dry natural gas in our glossary.

Are any wells still drilled using only conventional drilling practices?
Yes, many vertical wells are still drilled and completed without hydraulic fracturing; however, these wells and older completion techniques are becoming less common. Based on the larger number of wells and footage drilled, horizontal drilling combined with hydraulic fracturing has become standard practice for oil and natural gas production in the United States.
Suggestions for Querying the Appendix C Excel Data File

Data are provided in a flat-file format for all states for each year from 2000 through 2021 and by well-size class. The Filter tool in Excel is one of the fastest methods for viewing a subset of the data (Figure 5). For example, the filters in Figure 6 are set to select only Alaska (AK) and the year 2021. In Figure 7, the filters are set to select Alaska totals for all years and to sort chronologically.

Figure 5. Example of data provided in flat-file format with filter tool added

Data source: U.S. Energy Information Administration

Figure 6. Example of data with filters set to select Alaska (AK) and the year 2021

Data source: U.S. Energy Information Administration
Figure 7. Example of filters set to select Alaska (AK) totals for all years and to sort chronologically

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Data source: U.S. Energy Information Administration

We also set up a pivot table to help organize the data to make charts. In Figure 8, the United States is selected in cell B1, and the subtotal rows have been deselected in cell A4. Figure 9 shows a chart of the data in Figure 8.
Figure 8. Example of a pivot table to help organize data to make charts

Data source: U.S. Energy Information Administration

Figure 9. Example of a chart made with a pivot table

Data source: U.S. Energy Information Administration and Enverus
Note: BOE=barrels of oil equivalent
Appendix A
Appendix A contains information about data availability.

Reporting status by state and year ................................................................. A1
Availability of completion, well, and lease data by state ............................ A2

Appendix B
Appendix B contains oil and natural gas well summary statistics.
U.S. oil and natural gas well summary statistics for years 2000–2021 ........ B1-B22
Most recent year of available data for each state and federal offshore regions ........ B23-B55

Appendix C
Appendix C is a separate Excel flat file with all data.