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Rig counts fall but new-well production per rig rise as new-well production persists

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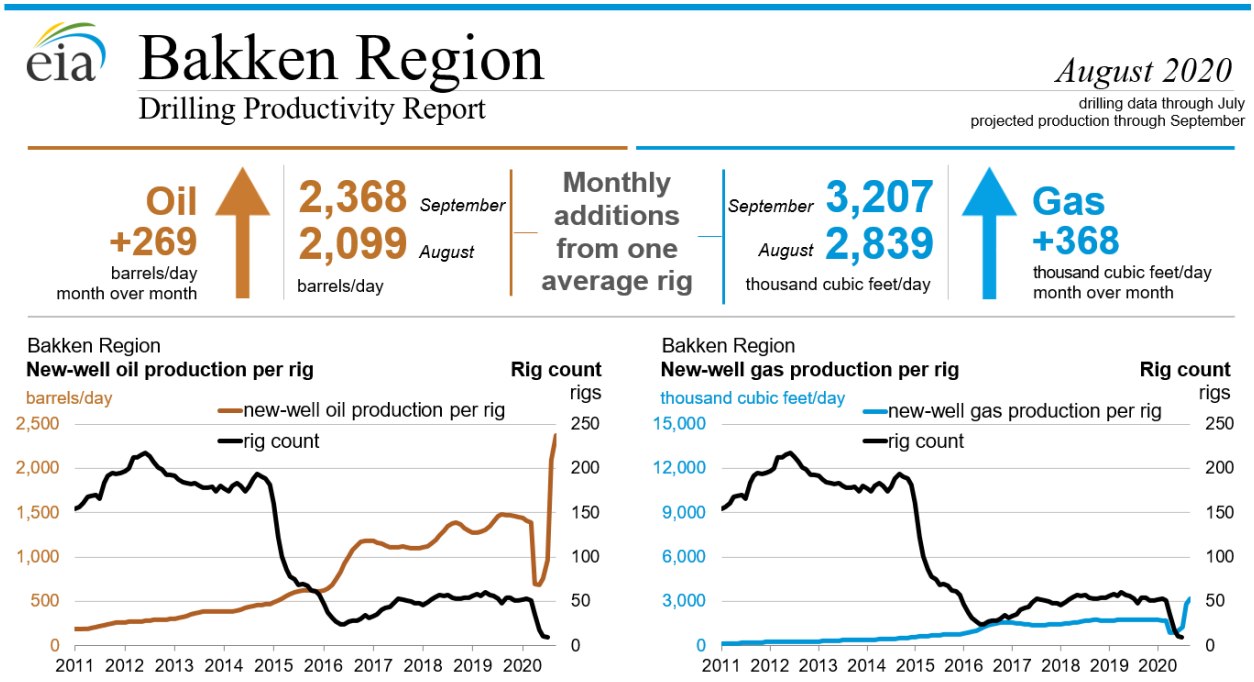
Rig counts fall but new-well production per rig rise as new-well production persists

Both the new-well oil and natural gas production per rig and legacy-well production change measures that the U.S. Energy Information Administration (EIA) publishes in the *Drilling Productivity Report* (DPR) have exhibited unprecedented volatility in recent months. In particular, EIA has noted a striking increase in new-well[1] oil and natural gas production per rig (as illustrated in Figure 1). The rapid increase in this metric is directly related to low rig counts causing a disproportional rise in new-well production per rig and is not a direct measurement of each active rig's productivity. Further, the completion of backlogged drilled but uncompleted (DUC) wells may continue to impact new-well production and corresponding production changes. For illustrative purposes, this analysis focuses on DPR trends in the Bakken region, though other regions are showing similar patterns.

In response to the rapid decline in crude oil demand, filling storage, and the corresponding decline in crude oil prices, producers reduced capital expenditures, halted drilling and completion activities, curtailed and shut in existing wells, and delayed the start of production of already completed wells. Although both new-well oil and natural gas production per rig measures have reached record-high levels, the numbers of drilling rigs and completion crews have both dropped to record lows. For example, in the Bakken region, only 10 rigs and 1 completion crew were working on July 10, 2020. These totals represent only a fraction of rigs and crews that were working in the region in March, when 51 rigs and 25 crews were operating.

Figure 1. Bakken new-well production per rig



Source: U.S. Energy Information Administration, *Drilling Productivity Report*

[1] A new well is defined as one that is producing for a full calendar month for the first time. Even though the well began producing for the first time in the previous (partial) month, the first full month is typically the greatest contribution to regional production. Each well belongs to the new-well category for only one month. Reintroduced shut-ins, reworked wells, and recompleted wells are excluded from the calculation.

New-well production per rig dropped in the Bakken region in April and May 2020, but has since recovered; however, this recovery was not the primary driver of growth since June. The return to production of previously shut-in and curtailed wells has driven the production growth. EIA estimates that the DPR's new-well production per rig metric will increase to almost 2,400 barrels per day (b/d) and over 3.2 million cubic feet per day, respectively, by September.

Wells that were either shut in or curtailed during April and May and subsequently returned to production in July and August have compensated for the legacy-well declines. Despite the significant drop in production during the period of well shut-ins, the subsequent return of the curtailed or shut-in wells has allowed for a temporary net increase in legacy-well growth.

Consequently, EIA forecasts that production will increase through September 2020. Thereafter, production may decline, as most of the shut-in wells that have returned to production begin to decline. The production from freshly drilled wells alone will likely not be able to overcome the collective legacy-well declines, unless the completion of new wells is supplemented with the completion of backlogged DUC wells.

New-well production per rig calculation and further considerations

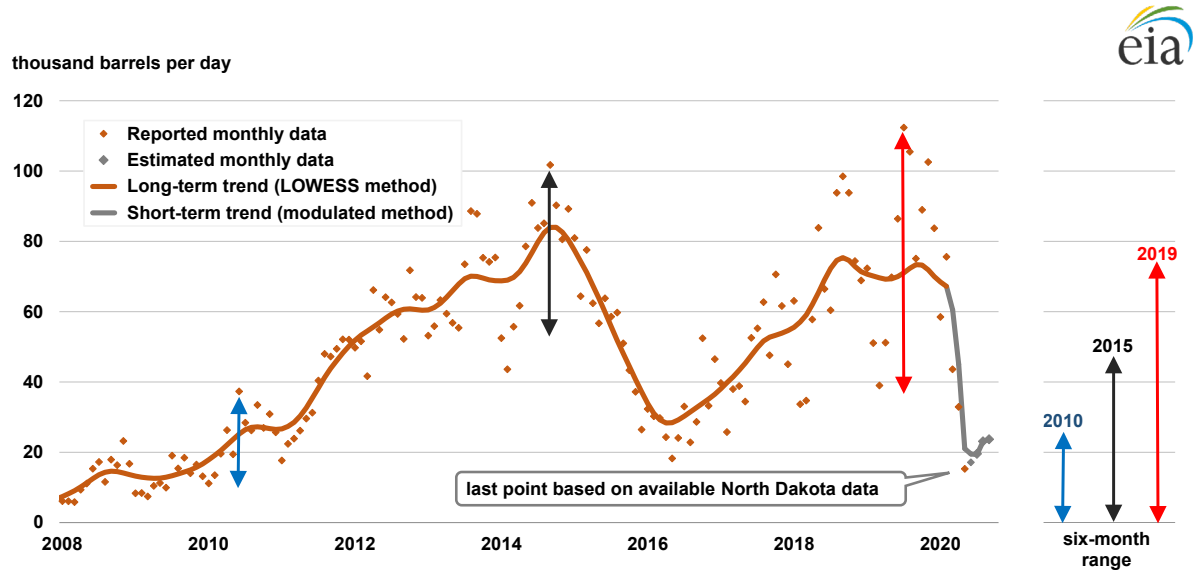
New-well production per rig is calculated as the sum of regional *new-well production* per day divided by the *rig count* as illustrated by the equation below.

$$New\text{-}well\ production\ per\ rig\ = \frac{New\text{-}well\ production}{Rig\ count}$$

The *new-well production* rate in the numerator is a function of the number of new wells and of the new wells' production. The historical time series of the new-well production rate is illustrated in Figure 2. The scattered diamonds illustrate the reported values of the new-well production rates. As a result of delays in reporting well-level data, EIA estimates the last four months of new-well production (gray diamonds) in the Bakken region. The new wells' production volumes are estimated from the latest demonstrated wells' productivity data and the number of new wells is estimated from the historical relationships to the rig count and the number of new wells filed on FracFocus.org. However, because of the extraordinary low levels of drilling and completion activities and the backlog of already completed wells, the confidence in the accuracy of estimating recent new-well production based on historical relationships is low.

EIA uses the smoothing function LOWESS (Locally Weighted Scatterplot Smoothing) to obtain the underlying trend. The trend line which is normally fully derived by smoothing the monthly additions using the LOWESS function is now a combination of two sections to reflect current conditions. The first section reflects the long-term trend through March 2020. The second section, starting with April 2020, reflects anticipated divergence from the historical trend. To consider the anticipated changes, the second section is modulated to reflect the most probable outcome of new-well production.

Figure 2. Monthly new-well production in the Bakken region

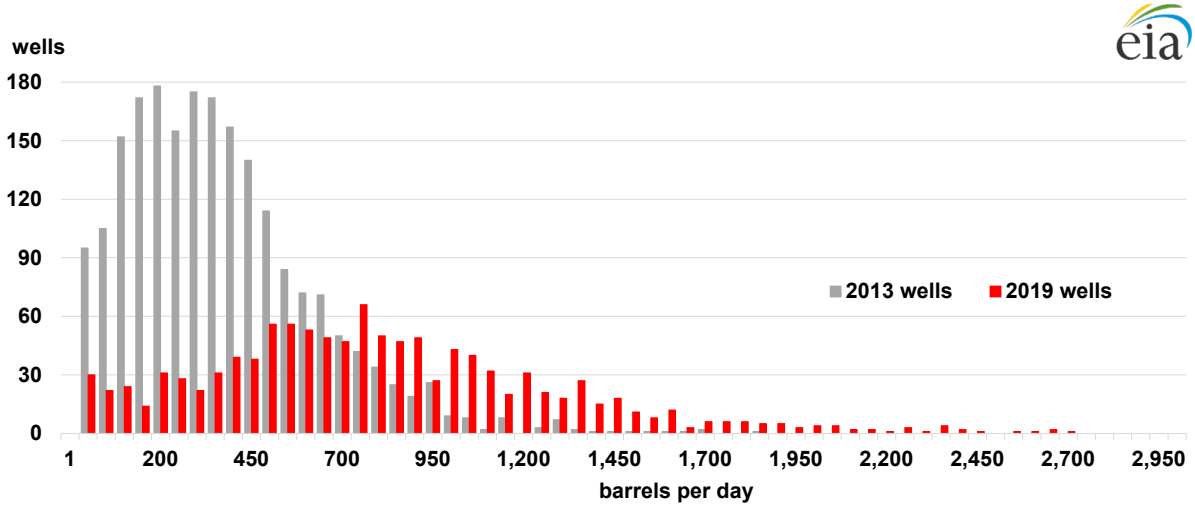


Source: U.S. Energy Information Administration, *Drilling Productivity Report*

Figure 2 also illustrates the growing variability of new-well production. The difference between the maximum and minimum values of the rolling span of a six-month window grew from about 20,000 b/d in 2010 to almost 80,000 b/d in 2019. The growing range in new-well production rates reflects the increase in variability in initial well production rates. This variability has made it more difficult to pinpoint not only the new-well production rates but also the projected monthly additions from an average rig in the region.

The increased range in new-well production depends on factors such as lateral length, geology, and operator. As seen in Figure 3, the performance of Bakken wells dramatically increased from about 300 b/d in 2013 to 700 b/d in 2019 because of longer lateral length and improvements in well completions.

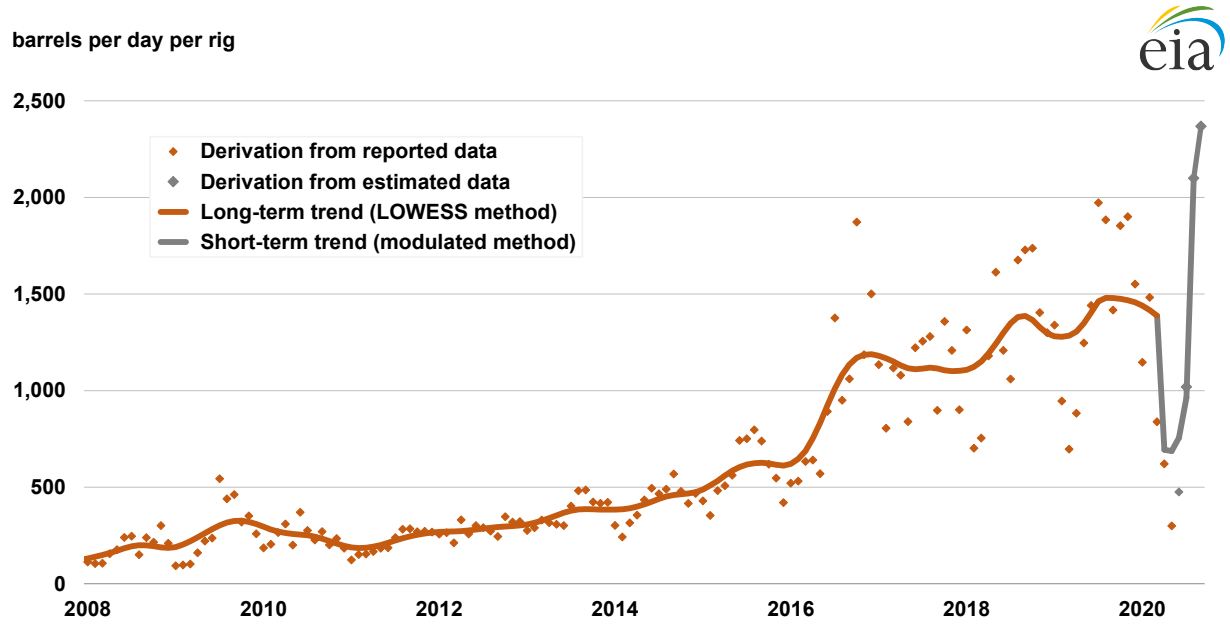
Figure 3. Bakken new-well production range in 2013 and 2019



Source: U.S. Energy Information Administration, *Drilling Productivity Report*

Increased new-well production variability also contributes to the difficultly of estimating new-well production per rig, which Figure 4 illustrates. The scattered diamonds represent the widely fluctuating monthly crude oil additions per rig from new wells. The gray diamonds manifest the estimated values from new-well production estimation process. The trend line is created with the same method as discussed above. All monthly data are subject to further revisions, and the combined new-well oil production per rig line, which is also the new-well oil production per rig line in the DPR (Figure 1), represents the most probable estimates of monthly new-well oil production per rig at this time.

Figure 4. New-well oil production per rig in the Bakken region



Source: U.S. Energy Information Administration, *Drilling Productivity Report*

Because of record-low levels of activities in active frack crews, the addition of new wells ready for production has slowed down. The remaining frack crews continue to complete only a few wells every month. However, a backlog of recently completed wells still awaits production. This backlog is anticipated to bring a small but steady volume of new-well production, regardless of how low the rig count will be.

Unless the completion activity increases, total new-well production will remain relatively low and most likely will not be sufficient to keep production at the current level because EIA anticipates that legacy-well production change will converge to the long-term trend when the shut-in wells return to service.

Legacy-wells change considerations

Figure 5 illustrates the interactions of new-well oil production rates with legacy-well change and the resulting net production change. Net crude oil production increases if new-well production exceeds legacy-well declines (Figure 5a). Conversely, net crude oil production decreases if new-well production is smaller than legacy-well declines from existing wells (Figure 5b).

Figure 5. Production from new wells and change in legacy wells

Figure 5a. Net increase

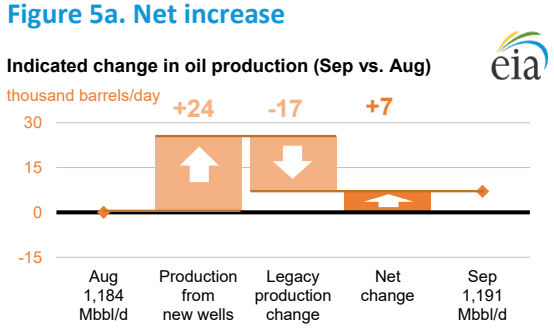
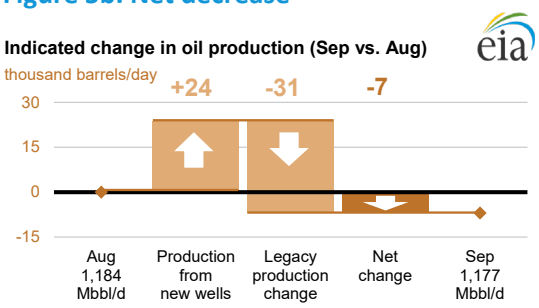


Figure 5b. Net decrease

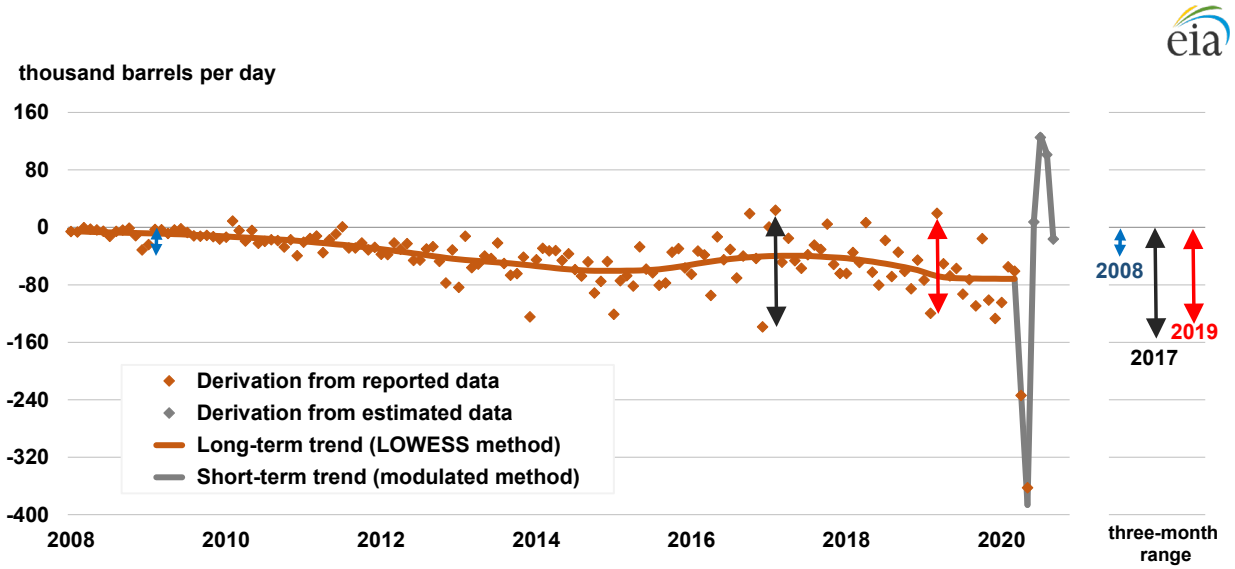


Source: U.S. Energy Information Administration, *Drilling Productivity Report*

To sustain current production rates, the production from new wells must equal or exceed the legacy-well declines. However, volatility in both new-well production rates and legacy-well declines has increased considerably. The combination of these trends is further reflected in volatility of monthly production changes.

Legacy-well change data (Figure 6) are derived by reversing the process described in Figure 5. Subtracting new-well production from monthly production change calculates the corresponding change in production from all other producing wells. The trend line is again created using the previously discussed method.

Figure 6. Legacy-well change in the Bakken region



Source: U.S. Energy Information Administration, *Drilling Productivity Report*

The long-term legacy-well change trend line (the first section) provides the ability to estimate regional month-on-month production rate decline should there be no new wells added to production. Furthermore, the decreasing trend-line slope (2011-2014) reflects the addition of new wells and the decreasing average age of wells. In contrast, the increasing trend-line slope (2015-2016) suggests fewer

wells are added and the overall age of wells is increasing, thus resulting in a lower decline rate in the region. The ratio of long-term legacy-well change to production reflects variations of geological factors and average age of wells and can be used to estimate the natural decline factor of all producing wells.

Although the variability in volatility of new-well production is sensitive to geological factors and well completion, the variability in volatility of legacy-well change is a result of production interruptions due to completions of neighboring wells, weather conditions, well services, and maintenance of oil and gas infrastructure. Weather impact on production is seasonal and usually has the greatest effect during the winter and spring. Well service activities often result in temporary production interruptions that can last for several months.

EIA normally does not consider operator production decisions including well shut-ins and curtailments in deriving production changes. However, EIA now estimates these factors using the second section of the legacy-well change trend line. The second section reflects the anticipated divergence from natural declines, which is derived by extrapolating the long-term trend using the natural decline factor. The area below the extrapolated line represent shut-ins and the area above the extrapolated line represents production from previously shut-in wells. Once all shut-in wells are returned to production, the second section of the trend line will converge with the extrapolated long-term trend and the areas above and below the trend line will be similar in size.

As illustrated in the Figure 6, the recent crude oil production changes in the Bakken region are truly extraordinary. The May 2020 legacy-well changes reflect the stark contrast between current and previous production disruptions in DPR history.

Production implication

With constrained capital outlays in the current low oil price environment, producers will focus on improving production efficiency and will likely target the best available locations for drilling and completing new wells based on geology, contracts, and other infrastructure related factors. The locations where new wells are drilled and completed have the potential to become a key factor when assessing crude oil production from new wells.