TIGHT OIL REALITY CHECK

REVISITING THE U.S. DEPARTMENT OF ENERGY PLAY-BY-PLAY FORECASTS THROUGH 2040 FROM ANNUAL ENERGY OUTLOOK 2015

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post carbon institute
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About the Author

David Hughes is an earth scientist who has studied the energy resources of Canada for four decades, including 32 years with the Geological Survey of Canada as a scientist and research manager. He developed the National Coal Inventory to determine the availability and environmental constraints associated with Canada’s coal resources. As Team Leader for Unconventional Gas on the Canadian Gas Potential Committee, he coordinated the publication of a comprehensive assessment of Canada’s unconventional natural gas potential.

Over the past decade, Hughes has researched, published and lectured widely on global energy and sustainability issues in North America and internationally. His work with Post Carbon Institute includes: a series of papers (2011) on the challenges of natural gas being a "bridge fuel" from coal to renewables; Drill, Baby, Drill (2013), which took a far-ranging look at the prospects for various unconventional fuels in the United States; Drilling California (2013), which critically examined the U.S. Energy Information Administration’s (EIA) estimates of technically recoverable tight oil in the Monterey Shale, which the EIA claimed constituted two-thirds of U.S. tight oil (the EIA subsequently wrote down its resource estimate for the Monterey by 96%); Drilling Deeper (2014), which challenged the U.S. Department of Energy’s expectation of long-term domestic oil and natural gas abundance with an in-depth assessment of all drilling and production data from the major shale plays through mid-2014; and Shale Gas Reality Check (2015), a gas-focused update to Drilling Deeper. Separately from Post Carbon, Hughes authored BC LNG: A Reality Check in 2014 and A Clear View of BC LNG in 2015, which examined the issues surrounding a proposed massive scale-up of shale gas production in British Columbia for LNG export.

Hughes is president of Global Sustainability Research, a consultancy dedicated to research on energy and sustainability issues. He is also a board member of Physicians, Scientists & Engineers for Healthy Energy (PSE Healthy Energy) and is a Fellow of Post Carbon Institute. Hughes contributed to Carbon Shift, an anthology edited by Thomas Homer-Dixon on the twin issues of peak energy and climate change, and his work has been featured in Nature, Canadian Business, Bloomberg, USA Today, as well as other popular press, radio, and television.

About Post Carbon Institute

Post Carbon Institute’s mission is to lead the transition to a more resilient, equitable, and sustainable world by providing individuals and communities with the resources needed to understand and respond to the interrelated environmental, energy, economic, and equity crises of the 21st century.
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1 Introduction

The U.S. Energy Information Administration’s (EIA) forecasts regarding tight oil production—published in its Annual Energy Outlook (AEO)—are commonly viewed by industry and government as the best available assessment of what to expect in the longer-term, with the EIA’s reference case typically viewed as the most likely scenario for future production. In my Drilling Deeper\(^1\) report published last October, I developed alternate production forecasts for two major tight oil plays, the Bakken and Eagle Ford, and reviewed the credibility of EIA AEO2014\(^2\) forecasts for other major plays based on the fundamental geological characteristics of each play. In most plays the AEO2014 production projections were found to be highly to extremely optimistic when reviewed in the light of play fundamentals. For the Bakken and Eagle Ford plays, AEO2014 overestimated the likely recovery of oil by 2040 by 42% compared to my “Most Likely” drilling rate case found in Drilling Deeper.

The EIA recently released AEO2015\(^3\) and kindly provided the underlying play-by-play production estimates for tight oil that make up its reference case. These new forecasts are compared in this report to the “Most Likely” case in Drilling Deeper and to the AEO2014 forecasts. Such comparisons are instructive in evaluating the volatility of EIA estimates for the same plays in forecasts separated by just one year, which reflects on their likely long-term accuracy, and in comparison to forecasts based on key play fundamentals set forth in Drilling Deeper.

Key fundamentals used in projecting future production of tight oil plays \textit{in Drilling Deeper} were:

- **Rate of well production decline:** Tight oil plays have high well production decline rates, typically in the range of 75-85% in the first three years.

- **Rate of field production decline:** Tight oil plays have high field production declines, typically in the range of 30-45% per year, which must be replaced with more drilling to maintain production levels.

- **Average well quality:** All tight oil plays invariably have “core” areas or “sweet spots” where individual well production is highest and hence the economics are best. Sweet spots are targeted and drilled off early in a play’s lifecycle, leaving lesser quality rock to be drilled as the play matures (requiring higher oil prices to be economic); thus the number of wells required to offset field decline inevitably increases with time. Although technological innovations including longer horizontal laterals, more fracturing stages, more effective additives, and higher volume treatments have increased well productivity in the early stages of the development of all plays, they have provided diminishing returns over time and cannot compensate for poor quality reservoir rock.

- **Number of potential wells:** Plays are limited in area and therefore have a finite number of locations that can be drilled. Once the locations run out, production goes into terminal decline.

- **Rate of drilling:** The rate of production is directly correlated with the rate of drilling, which is determined by the level of capital investment.

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\(^3\) Energy Information Administration, \textit{Annual Energy Outlook 2015}, http://www.eia.gov/forecasts/aeo/.
So how have the EIA’s projections changed in 2015? In Figure 1 I compare these new projections (AEO2015) to my “Most Likely” drilling rate forecasts in *Drilling Deeper* and to the EIA’s 2014 projections (AEO2014).

**Figure 1. Cumulative recovery by play from 2014 to 2040 comparing AEO2014, AEO2015 and Drilling Deeper “Most Likely” projections.**

Significant increases occur in the Bakken, Niobrara, Bone Spring and Wolfcamp plays, whereas all others are flat or downgraded. Overall production from 2014 to 2040 has increased by 6.2 billion barrels (or 15%) in AEO2015 compared to AEO2014.

Some general observations with respect to the assumptions and projections in the AEO2015 reference case:

- EIA assumes WTI oil prices will remain low and will not exceed $100/barrel until 2031.
- EIA assumes tight oil production, along with overall U.S. oil production, will peak in 2020 followed by a very gradual decline through 2040. Overall tight oil production from 2014 to 2040 has increased by 15% in AEO2015 compared to AEO2014.
- The seven major plays analyzed in *Drilling Deeper*, which constituted 82% of AEO2014 projected tight oil production through 2040, have increased to 84% of the AEO2015 forecast. Production from plays other than the major seven is essentially unchanged between the two EIA forecasts.
- Fifty-one percent of tight oil production through 2040 is projected to come from the Bakken and Eagle Ford in AEO2015, compared to 43% in AEO2040—highlighting yet again that high quality tight oil plays are not ubiquitous.
- Considering that AEO2014 and AEO2015 are just 12 months apart, there is a lot of change in projected production profiles for individual plays, and in cumulative recovery, which raises questions about the robustness, or lack thereof, of the EIA’s forecasting methods.
1.1 PRODUCTION AND PRICE PROJECTIONS

Figure 2 illustrates the AEO2015 reference case for U.S. oil production by source and price projections. Tight oil constitutes the largest source of supply, comprising 49% of cumulative production from 2014 through 2040, and 45% of 2040 production. Production from other major sources such as onshore and offshore conventional oil is projected to be essentially flat. Overall U.S. production is projected to fall 11% by 2040 from a peak of 10.6 mbd (million barrels per day) in 2020. Prices are projected to remain below $100/barrel until 2031, and 2040 production would meet just 55% of projected 2040 U.S. crude oil demand.

This is a very bullish forecast, especially given projections of oil prices that are considerably below the levels that prevailed prior to mid-2014 in the medium- to long-term. Since the oil price downturn in mid-2014 there has been much industry rhetoric about lower break-even prices for tight oil as a result of greater rig efficiency, better technology and reduced drilling costs. This is true to a certain extent and production has proven to be somewhat more resilient than many thought, however production is falling in several major tight oil plays and is being supported by short-term factors such as the inventory of “DUCs” (drilled but uncompleted wells) and by focusing drilling efforts on the core area of plays. Also important is the drillers’ continued ability to attract investment from the financial community, and the fact that some still have hedges in place at higher prices.4 Due to the several-month lag in the reporting of accurate production data for most plays the fallout of the drop in oil prices on production rates is still unfolding, but it is clear, at a minimum, that production growth has stalled. The number of DUCs and the number of drilling locations in core areas are limited, so in the longer term prices will have to go considerably higher to maintain production or even stem declines. A look at the tight oil forecast by individual play gives a better perspective on the credibility of the EIA projections.

2 Tight Oil Production by Play

Figure 3 illustrates the AEO2015 reference case forecast by tight oil play compared to AEO2014. Half of projected 2014-2040 production comes from two plays, the Bakken and Eagle Ford, and the Bakken alone is responsible for nearly a third. Cumulative production through 2040 in AEO2015 is 6.2 billion barrels higher (15%) than AEO2014. Tight oil production is projected to peak at 5.6 mbd in 2020 in AEO2015 versus 4.8 mbd in 2021 in AEO2014.

Figure 3. AEO2015 reference case forecast of oil production by tight oil play from 2012-2040, compared to AEO2014.

The EIA is even more bullish overall than last year, increasing cumulative 2014-2040 production by 15%, or 6.2 billion barrels, and projecting a tight oil production peak in 2020.
2.1 **Bakken Play**

Figure 4 illustrates the AEO2015 reference case forecast for the Bakken compared to AEO2014 and the “Most Likely” drilling rate from *Drilling Deeper*. In AEO2015, the Bakken is forecast to produce 30% of all tight oil production from 2014 to 2040.

The EIA has increased 2014-2040 recovery from the Bakken in its AEO2015 projection by 85%, or 6.6 billion barrels, compared to AEO2014, and is 8.8 billion barrels higher (154%) than my “Most Likely” forecast. This is more than double the recent USGS assessment\(^5\) of technically recoverable resources from the Bakken (including Three Forks) of 7.4 billion barrels (the AEO2015 forecast would see 15.5 billion barrels recovered between 2000 and 2040). Some observations:

- There is no apparent justification for nearly doubling the expected recovery from the Bakken through 2040, hence the AEO2015 projection has to be rated “extremely optimistic”.

- The only way production could keep growing to an all-time high of 1.7 mbd in 2024, nearly 50% higher than today, is with a massive ramp up in drilling which, given declining well quality, would require much higher prices.

- Drilling rates in my “Most Likely” forecast, which projects a three-fold increase in producing wells over current levels, would see remaining drilling locations run out by 2028. The production projections in AEO2015 would see locations run out much sooner, so assuming the Bakken will continue to produce above current levels and exit 2040 at 1.5 mbd lacks any credibility whatsoever based on fundamentals.

- The drop in rig counts in the Bakken (70 in August 2015 vs. 198 in October 2014) has not impacted well completion rates as much as it might have due to the large number of drilled but uncompleted wells that

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are now coming on line. This is a temporary buffer, however, and Bakken production appears to have peaked in December 2014. The decline in the Bakken could be stemmed or temporarily reversed with a ramp up in drilling rates, but even so the projections in AEO2015 are extremely unlikely to be realized.

2.2 EAGLE FORD PLAY

Figure 5 illustrates the AEO2015 reference case forecast for the Eagle Ford compared to AE02014 and the “Most Likely” drilling rate from Drilling Deeper. In AE02015, the Eagle Ford is forecast to produce 21% of all tight oil production from 2014 to 2040.

Figure 5. Eagle Ford Play production for the “Most Likely” drilling rate forecast from Drilling Deeper compared to the EIA’s AEO2014 and AEO2015 forecasts. Also shown are the cumulative wells that would have to be drilled for the “Most Likely” drilling rate.

The AEO2015 projection parallels my “Most Likely” forecast until 2024, although it projects a slightly lower peak in 2017 versus my peak in 2016. Total projected production is down 4% over AEO2014 but is 40% above my “Most Likely” forecast. Some observations:

- The AEO2015 Eagle Ford production projection is very close to the peak of 1.6 mbd projected in my “Most Likely” rate forecast in Drilling Deeper and is slightly lower than that projected in AEO2014. The number of new wells added per month is falling and is now below the rate I had assumed, so production is likely to begin to fall off before 2016 and may have peaked in March 2015, although it is still too early to say given that recent data are subject to revisions.

- My “Most Likely” forecast projects a three-fold increase in the number of producing wells over current levels before drilling locations run out in 2024. A reduction in the drilling rate below the rate I assumed would extend drilling for perhaps a couple of years and reduce production rates somewhat over those I projected. The AEO2015 projection is perfectly reasonable out to 2024, when available drilling locations run out. The flattening of the production decline post-2024 in AEO2015, and the suggestion that production will exit 2040 at .63 mbd, would require far more drilling locations than are estimated to be
available, and hence the overall optimism bias of AEO2015 must be rated as “high”, unchanged from AEO2014.

- The drop in rig counts in the Eagle Ford (101 in August 2015 vs. 218 in October 2014) has caused a drop in additions of new producing wells below that assumed in Drilling Deeper. Production can therefore be expected to be somewhat below that projected in the “Most Likely” forecast out to 2024, and be somewhat higher for a year or two after that, given that lower drilling rates extend the inventory of available drilling locations. It is highly unlikely that production levels can be maintained much beyond 2024 at the rates projected in AEO2015.

2.3 WOLFCAMP PLAY

Figure 6 illustrates the AEO2015 reference case forecast for the Wolfcamp compared to AEO2014. In AEO2015, the Wolfcamp, which is one of the largest plays in the Permian Basin, is forecast to produce 10.2% of all tight oil production from 2014 to 2040.

The AEO2015 projection has nearly doubled projected 2014-2040 oil recovery from the Wolfcamp compared to AEO2014. The Wolfcamp is an old play being redeveloped with the latest technology and has already seen much vertical and more recently horizontal drilling. More than 10,400 wells have been drilled since 1950 of which 3,301 were drilled post-2010. There are currently 6,200 producing wells. Production has been growing and in May 2015, was at .28 mbd, not far off the projected AEO2014 peak rate. Drilling Deeper rated the AEO2014 forecast as having a “high” optimism bias, given the play fundamentals and the assumption that production would continue on a very gentle decline after a 2019 peak. The rating for AEO2015 must be upped to a “very high” optimism bias. Some observations:

- Permian Basin plays like the Wolfcamp are not typical “shale” plays like the Bakken and Eagle Ford. They have produced much oil over many decades utilizing conventional production techniques and are now

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Figure 6. Wolfcamp Play actual production through 2014 compared to the EIA's AEO2014 and AEO2015 forecasts.

The EIA has nearly doubled its optimistic estimate of 2014-2040 recovery made in AEO2014. The AEO2015 forecast is for the Wolfcamp Play to contribute more than 10% of total 2014-2040 U.S. production.
benefiting from redevelopment with horizontal drilling and hydraulic fracturing. Production from the Wolfcamp is thus from a mix of “conventional” and “unconventional” sources. Drilling Deeper did not develop a range of production projections for these older plays but did evaluate the fundamentals of each play for assessment of the EIA projections.

- The Wolfcamp is one of the best Permian Basin plays and appears to have significant upside. It has produced nearly a billion barrels since the 1950s and has seen extensive drilling. AEO2015’s assumptions that production can grow nearly three-fold by 2025, and produce another 4.9 billion barrels by 2040, is an extremely aggressive forecast, given play fundamentals, hence the “very high” optimism bias rating.

- The drop in rig counts in the Permian Basin (255 in August 2015 vs. 568 in November 2014) will undoubtedly affect the Wolfcamp drilling rates (rig counts are not disaggregated at the play level in the Permian Basin), although production is currently still rising. AEO2015 projections that production can nearly triple and exit 2040 above current production levels after producing nearly 5 billion barrels of oil, however, are highly unlikely to happen.

2.4 SPRABERRY PLAY

Figure 6 illustrates the AEO2015 reference case forecast for the Spraberry compared to AEO2014. In AEO2015, the Spraberry, which is one of the largest plays in the Permian Basin, is forecast to produce 9.3% of all tight oil production from 2014 to 2040.

![Figure 6. Spraberry Play actual production through 2014 compared to the EIA’s AEO2014 and AEO2015 forecasts.](image)

The EIA has reduced its very optimistic forecast of cumulative 2014-2040 recovery by 28% in AEO2015.

The AEO2015 projection has reduced projected 2014-2040 oil recovery from the Spraberry compared to AEO2014 by 28%. The Spraberry is an old play being redeveloped with the latest technology and has already seen much vertical and, more recently, horizontal drilling. More than 38,300 wells have been drilled since 1950 of which 12,086 were drilled post-2010. There are currently 29,500 producing wells. Production has been growing
and in May 2015, was at .55 mbd, not far off the projected AE02015 peak rate. The AE02015 forecast is much more reasonable than that in AE02014, which Drilling Deeper rated as having a “very high” optimism bias, and therefore the optimism bias is reduced to “moderate”. Some observations:

- The Spraberry is not a typical “shale” play like the Bakken and Eagle Ford. It has produced much oil over many decades utilizing conventional production techniques and is now benefiting from redevelopment with horizontal drilling and hydraulic fracturing. Production from the Spraberry is thus from a mix of “conventional” and “unconventional” sources. Drilling Deeper did not develop a range of production projections for this play but did evaluate the fundamentals for assessment of the EIA projections.

- The Spraberry is one of the best Permian Basin plays and one of its largest producers, although it appears to be fairly close to peak production. It has produced more than two billion barrels since the 1950s and has seen very extensive drilling. AE02015’s assumption that production can grow somewhat by 2021 appears reasonable. The assumption that production will decline at a slow rate after this, and exit 2040 at near current production rates after producing an additional 4.4 billion barrels, is optimistic, however, hence the overall rating of a “moderate” optimism bias.

- The drop in rig counts in the Permian Basin (255 in August 2015 vs. 568 in November 2014) will undoubtedly affect the Spraberry drilling rate (rig counts are not disaggregated at the play level in the Permian Basin) although production is currently still rising.

2.5 NIOBARRA PLAY

Figure 6 illustrates the AE02015 reference case forecast for the Niobrara compared to AE02014. In AE02015, the Niobrara is forecast to produce 6.8% of all tight oil production from 2014 to 2040. The Niobrara is one of the largest plays in the Denver-Julesburg (D-J) Basin.

![Figure 6: Niobrara Play actual production through 2014 compared to the EIA’s AE02014 and AE02015 forecasts.](image)

The EIA has nearly doubled its estimate of 2014-2040 recovery in AE02015 compared to AE02014.
The AEO2015 projection has nearly doubled 2014-2040 oil recovery from the Niobrara compared to AEO2014. The Niobrara is an old play being redeveloped with the latest technology and has already seen much vertical and more recently horizontal drilling. More than 29,000 wells have been drilled since 1950 of which 7,538 were drilled post-2010. There are currently 18,200 producing wells. Production from the Niobrara peaked in mid-2014 at .17 mbd and has since fallen to .13 mbd. Drilling Deeper rated the AEO2014 forecast as having a “high” optimism bias. The rating for AEO2015 must be upped to an “extremely high” optimism bias, given the play fundamentals and the assumptions that production will grow to a peak nearly triple current production rates by 2035 and exit 2040 at double the current peak rate—all after producing more than six times as much oil as produced to date. Some observations:

- The Niobrara is not a typical “shale” play like the Bakken and Eagle Ford. It has produced much oil over many decades utilizing conventional production techniques and is now benefiting from redevelopment with horizontal drilling and hydraulic fracturing. Production from the Niobrara is thus from a mix of “conventional” and “unconventional” sources. Drilling Deeper did not develop a range of production projections for the Niobrara but did evaluate the fundamentals for assessment of the EIA projections.

- The Niobrara is now significantly below its mid-2014 peak. Whether or not increased drilling rates can grow production beyond this peak remains to be seen. It has produced nearly a half billion barrels since the 1950s and has seen extensive drilling. AEO2015’s assumptions that production can grow nearly three-fold by 2035, and produce another 3.3 billion barrels by 2040, is an extremely aggressive forecast, given play fundamentals, hence the “extremely high” optimism bias rating.

- The drop in rig counts in the Niobrara (31 in August 2015 vs. 64 in October 2014) has undoubtedly affected drilling rates and hence production. Should drilling rates increase significantly the current production decline will likely reverse, at least temporarily. The AEO2015 projections that production can nearly triple and exit 2040 at double current production levels after producing an additional 3.3 billion barrels of oil are, however, highly unlikely to happen.
2.6 **Bone Spring Play**

Figure 6 illustrates the AEO2015 reference case forecast for the Bone Spring (termed Avalon/Bone Spring by the EIA) compared to AEO2014. In AEO2015 the Bone Spring, which is one of the better plays in the Permian Basin, is forecast to produce 4.7% of all tight oil production from 2014 to 2040.

The EIA has revised its extremely conservative AEO2014 forecast to one which is now likely too optimistic. The AEO2015 projection has nearly quadrupled projected 2014-2040 oil recovery from the Bone Spring compared to AEO2014. The Bone Spring is an old play being redeveloped with the latest technology and has already seen much vertical and, more recently, horizontal drilling. More than 4,000 wells have been drilled since 1970 of which 2,593 were drilled post-2010. There are currently 3,300 producing wells. Production has been growing rapidly and in May 2015 was at .27 mbd, not far off the projected AEO2015 peak rate.

**Figure 9. Bone Spring Play actual production through 2014 compared to the EIA’s AEO2014 and AEO2015 forecasts.**

The EIA has revised its extremely conservative AEO2014 forecast to one which is now likely too optimistic.

The Bone Spring is not a typical “shale” play like the Bakken and Eagle Ford. It has produced much oil over many decades utilizing conventional production techniques and is now benefiting from redevelopment with horizontal drilling and hydraulic fracturing. Production from the Bone Spring is thus from a mix of “conventional” and “unconventional” sources. Drilling Deeper did not develop a range of production projections for this play but did evaluate the fundamentals for assessment of the EIA projections.

- The Bone Spring is one of the better Permian Basin plays and appears to have significant upside. It has produced 304 million barrels since the 1970s and has seen extensive drilling. AEO2015’s assumptions that production can grow to a peak in 2029 and recover an additional 2.3 billion barrels by 2025 are optimistic, but not excessively so given play fundamentals, hence the “moderate” optimism bias rating.
• The drop in rig counts in the Permian Basin (255 in August 2015 vs. 568 in November 2014) will undoubtedly affect Bone Spring drilling rates (rig counts are not disaggregated at the play level in the Permian Basin) although production is currently still rising.

2.7 AUSTIN CHALK PLAY

Figure 6 illustrates the AEO2015 reference case forecast for the Austin Chalk compared to AEO2014. In AEO2015, the Austin Chalk is forecast to produce 2.2% of all tight oil production from 2014 to 2040.

![Figure 6. Austin Chalk Play actual production through 2014 compared to the EIA’s AEO2014 and AEO2015 forecasts.](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAQAAAABcAM...</figure>

The EIA has scaled back its extremely optimistic growth scenario of AEO2014 by 78%, but still assumes the Austin Chalk will nearly quadruple production by 2024. This is an old play being redeveloped with the latest technology and has already seen much vertical and, more recently, horizontal drilling. More than 14,100 wells have been drilled since 1950 of which 561 were drilled post-2010. There are currently 4,700 producing wells. Production is up slightly over recent months and in May 2015, was at .04 mbd, but is well below the all-time peak which occurred in the early 1990s at .17 mbd. Although the AEO2015 forecast is more reasonable than the wildly optimistic projection in AEO2014, which Drilling Deeper rated as having a “very high” optimism bias, AEO2015 has a “high” optimism bias as it assumes production will return to the early 1990s peak rate, will produce as much oil from 2014-2040 as it has to date, and will exit 2040 at three times current production levels. Some observations:

• The Austin Chalk has produced much oil over many decades utilizing conventional production techniques and is now benefiting somewhat from redevelopment with horizontal drilling and hydraulic fracturing. Drilling Deeper did not develop a range of production projections for this play but did evaluate the fundamentals for assessment of the EIA projections.

• The Austin Chalk has produced 1.1 billion barrels of oil since the 1950s, with peak production in the early 1990s, and has seen very extensive drilling. Although some future growth from the current low levels is a
reasonable assumption, AE2015’s projection that production can nearly quadruple by 2024 and exit 2040 at triple current levels is highly optimistic, hence the overall rating of a “high” optimism bias.

- The drop in rig counts in Texas (905 in November 2014 vs. 383 in August 2015), and in Louisiana, will undoubtedly affect the Austin Chalk drilling rates, although production is currently rising.

2.8 "Other" Plays

"Other" plays account for 16% of projected 2014 to 2040 tight oil production in AE2015, down from 18.2% in AE2014. These include the Woodford and Monterey plays, estimated at 0.5% and 0.7% of 2014 to 2040 production, respectively, and other unnamed plays which make up the remaining 14.8%. Figure 11 illustrates the AE2015 reference case forecast for “other” plays compared to AE2014.

![Figure 11. Other plays production in the AE2014 and AE2015 forecasts.](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAIQAAAAgCAYAAAiqNh7AAAABGdBTUEAALGPC/xhBQAAAC1BMVEUAAAL3iQABAAMCAgAAAlEQURUxRzzysQPAAAAAElFTkQ1cGA0/OzAAAABJRU5ErkJggg==)

AE2015 has assumed roughly the same 2014 to 2040 recovery from these plays, although it has changed the production profile.

The AE2015 production projection has been re-profiled from AE2014, pushing the highest production levels back to the latter part of the 2014-2040 period, although the cumulative recovery over this period is essentially the same as in AE2014. The AE2015 projection for “other” plays is optimistic, given the 50% increase from current production levels to a peak in 2035, followed by a gradual decline and 2040 exit at near peak levels. It also underscores the fact that exceptional tight oil plays like the Bakken and Eagle Ford are rare, not ubiquitous as one might be led to believe from investor presentations. The seven major plays reviewed in this report account for 84% of projected 2014-2040 tight oil production, and the Bakken and Eagle Ford alone account for 51%. All other established and emerging plays in the U.S., even allowing for the EIA’s optimism, account for just 16%.
3 All Plays Comparison

Figure 12 illustrates the comparison of aggregate production for the Bakken and Eagle Ford from the Drilling Deeper “Most Likely” production forecasts, compared to forecasts from AEO2014 and AEO2015. Also shown is total tight oil production projected from all plays in the reference case of AEO2014 and AEO2015. The entire net increase in cumulative production between AEO2014 and AEO2015 is a result of the EIA’s extremely optimistic revision of the Bakken, whereas the revisions in the other major plays, although significant, tend to cancel each other out. Whereas the AEO2014 projection overstated cumulative 2014-2040 production in the Bakken by 42% compared to the “Most Likely” Drilling Deeper forecast, the AEO2015 projection overstates it by 92%. As noted in the discussion of the Bakken play there is no basis for this increase, which, if realized, would see the Bakken recover more than double the USGS mean estimate of “technically” recoverable resources by 2040 (“technically” recoverable resources are not necessarily “economically” recoverable).

The AEO2015 projections represent a good news story for those hoping for a lasting tight oil boom at low prices. Notwithstanding the major changes in the outlook for individual plays between AEO2014 and AEO2015, the overall forecast is even more optimistic than AEO2014—but it is not supported by an analysis of key play fundamentals. Given that the AEO2015 projections for individual plays range in the “optimistic” to “extremely optimistic” categories, the overall rating for AEO2015 is “highly optimistic”, considering the fundamentals of these plays and their advancing state of drilling maturity.

Figure 12. Comparison of the AEO2014 and AEO2015 forecasts for the Bakken and Eagle Ford plays compared to the “Most Likely” forecast for these plays in Drilling Deeper.

Also illustrated is the total production forecast for AEO2014 and AEO2015 including “other” plays. AEO2015 projects recovery of 48% more oil from the Bakken and Eagle Ford plays than forecast in the “Most Likely” case in Drilling Deeper.

The AEO2015 projections represent a good news story for those hoping for a lasting tight oil boom at low prices. Notwithstanding the major changes in the outlook for individual plays between AEO2014 and AEO2015, the overall forecast is even more optimistic than AEO2014—but it is not supported by an analysis of key play fundamentals. Given that the AEO2015 projections for individual plays range in the “optimistic” to “extremely optimistic” categories, the overall rating for AEO2015 is “highly optimistic”, considering the fundamentals of these plays and their advancing state of drilling maturity.
3.1 **VOLATILITY OF EIA PLAY-LEVEL FORECASTS**

One measure of the potential reliability of future production estimates from the EIA is how much successive forecasts change over time. Certainly everyone is entitled to change their mind, but the geological fundamentals of the major tight oil plays are now relatively well known and don’t change wildly from year to year. Wild swings in projected production rates and cumulative recovery indicate a basic lack of robustness in the methodology used for estimation, unless there is significant new information to account for it.

Despite the fact that the EIA projections by play examined herein were made only 12 months apart, they exhibit major differences in future production rates and in estimated oil recovery. Figure 13 illustrates the magnitude of production rate differences between AEO2014 and AEO2015 by play in percentage terms. Plays have been revised both upward and downward by amounts exceeding 50 percent in some plays/years.

![Figure 13. Comparison of projections by play from AEO2015 and AEO2014.](image)

Comparison is made in terms of the percentage difference in production rates for the years 2020, 2025, 2030, 2035 and 2040. Revisions in production rates are typically more than 50% in all plays except the Eagle Ford, Spraberry and “Other”.
Figure 14 illustrates the changes in total oil recovery from 2014 through 2040 between AEO2014 and AEO2015. Although 3 of the 7 major plays have been revised downward, the upward revisions of the Bakken, Niobrara, Bone Spring and Wolfcamp plays result in a total increase in production of 6.2 billion barrels, or 15% more in AEO2015 than AEO2014. Upward revisions in the Bakken alone increase projected recovery by 85% between AEO2015 and AEO2014.

![Figure 14](image)

**Figure 14. Comparison of projections by play from AEO2015 and AEO2014 in terms of total oil production from 2014 through 2040.**

Overall production has increased by 6.5 billion barrels, or 15%, in AEO2015 compared to AEO2014.

The EIA offers no explanations for the volatility and optimism of its projections. Geological fundamentals appear to have little to do with it, given that major plays are now quite well understood. Assumptions of vastly improved technology in the future may be a factor, although improvement in average well quality has stagnated or is falling in sweet spot counties of major plays like the Bakken and Eagle Ford—as expected as sweet spots are drilled off.6 Another factor may be the assumption of much closer downspacing, resulting in far larger numbers of available drilling locations than previously thought, although well interference is already being observed in the most densely drilled counties which discounts this. The volatility and increase in overall production cannot be attributed to changes in future oil price assumptions either, given that prices for WTI are $20.00/barrel lower in AEO2015 than in AEO2014 out to 2030.

The volatility, optimism, and lack of transparency in EIA play-level tight oil production projections inspire little confidence in their reliability. This is a major concern for future energy policy decisions given the weight that many in government and industry place on them.

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4 Summary and Implications

The future production of tight oil plays is a function of well quality variation by area, drilling rates, decline rates and number of available drilling locations.

Notwithstanding the issues with individual play-level forecasts pointed out in this report, a key overall conclusion is that high quality tight oil plays like the Bakken and Eagle Ford are quite rare. Despite years of intense exploration by industry, until recently in an environment of high oil prices, no plays of the size and quality of the Bakken and Eagle Ford have been found. More than half of projected 2014-2040 tight oil production is forecast to come from these two plays with much of the rest from redevelopment of older plays in the Permian Basin and elsewhere.

Although much is made by industry of the role of technological improvements in increasing the amount of oil recovered per well, an analysis of the country’s two best tight oil plays, the Bakken and Eagle Ford, shows that after a period of growth over the past few years, well productivity is declining or flat in the most productive counties of each play.

A rule of thumb is that companies, given the choice, drill their best locations first. Drilling in the Bakken and Eagle Ford has been concentrated in top counties. These counties can only absorb a finite number of wells before drilling must move out into lower quality parts of the reservoir. Furthermore, wells spaced too close together will exhibit interference, reducing their ultimate output. Although there are locations available to drill triple the current number of wells in the Bakken and Eagle Ford, top counties such as Mountrail in the Bakken and Karnes in the Eagle Ford appear to be exhibiting well interference, as average well quality is declining, suggesting well concentration is becoming saturated.

The forecasting methods used in Drilling Deeper evaluated well quality, decline rates and available locations by subarea and built them into the modeling process. Given that trying to predict prices (and their inevitable effect on drilling rates) is a mug’s game, as we have seen in recent months, several cases assuming different drilling rates over time were presented. The bottom line is that although changing drilling rates has a considerable effect on near-term production, it doesn’t significantly change the total recovery through 2040.

The EIA uses a system known as the National Energy Modeling System (NEMS) for forecasting which, although purported to be based on a county-level analysis for tight oil, is complex and is not transparent; its outputs for future tight oil play production at times defy logic. A statement at the EIA’s NEMS link says: “Most people who have requested NEMS in the past have found out that it was too difficult or rigid to use.”

This raises some important questions: If NEMS is truly a robust system for forecasting, why is there so much difference at the play level between AEO2014 and AEO2015? Why does the Bakken rise 40% from current levels, recover more than twice as much oil by 2040 as the latest USGS mean estimate of technically recoverable resources, and exit 2040 at production levels considerably above current levels? How can the Niobrara recover twice as much oil in AEO2015 as was assumed just a year ago in AEO 2014? What was the thinking behind the wildly optimistic forecast for the Austin Chalk in AEO2014 that required a 78% reduction in estimated cumulative recovery in AEO2015? How can overall tight oil production increase by 15% in AEO2015 compared to AEO2014 while assuming oil prices are $20/barrel lower over the 2015-2030 period?

The EIA forecasts for these plays belie the fundamentals given what is known from an analysis of all available well production data. What is the EIA thinking? Do they assume an as-yet unknown spurt of technology will somehow overcome the geological realities of these plays, and/or that downspacing will result in far more wells than previously projected without interference? If that is the case, it would behoove them—and benefit the American public and policymakers who determine critically important energy and related investments and policies—to be candid about such assumptions.

Ratings for the EIA’s projections for the major tight oil plays described herein range from “optimistic” to “extremely optimistic”. Industry is pushing for crude oil exports on the assumption that tight oil production will be robust for the foreseeable future at relatively low prices. Getting it wrong has very serious implications for energy policy and future energy security, considering that the EIA is the country’s premier source for future production projections.