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THE US SHALE GALE:

RELIEVING RECESSION
ONE STATE AT A TIME

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THE US SHALE GALE: RELIEVING RECESSION ONE STATE AT A TIME

America is in the midst of an energy revolution. For the first time ever, the dream of energy self-sufficiency finally seems attainable. By 2015, the US is projected to become the world's top oil producer - surpassing both Russia and Saudi Arabia - to put the country on track to achieve total energy independence by 2035.¹

How have we arrived at this point? In a word: *shale*.

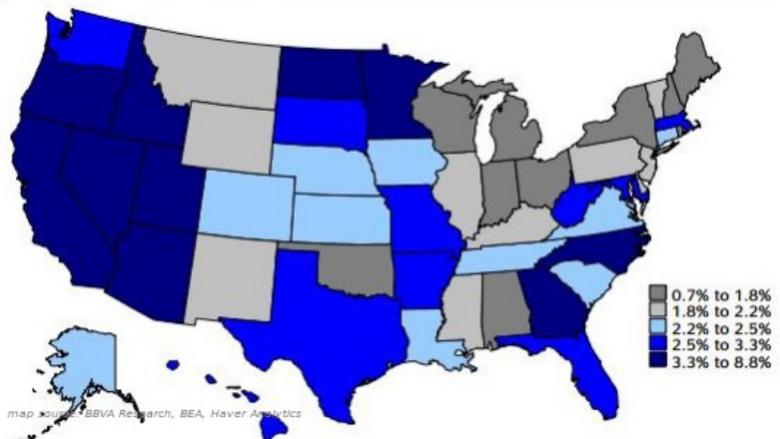
In the midst of a worldwide economic crisis, technological advances in tapping resources from shale created a surprising energy surge that took the nation - and indeed the world - by storm. Consider the astronomical increase of the aptly termed "shale gale" over a miniscule time period: In 2004, shale gas didn't even exist as a realistic energy source; today it's edging toward 30% of the market.

In 1990, we produced 70.706 quadrillion BTU of energy - a statistic that remained fairly steady through 2006. But leaps in drilling technologies brought about an acceleration in production: We hit 78.091 quadrillion BTU in 2011² and rose by another 847,000 barrels per day from 2011 to 2012. This was the largest growth in crude oil production of any country, almost all of this increase coming from shale plays. At the same time, US production of natural gas rose 4.9% in 2012, contributing to the biggest single-year increase in petroleum production in American history.³

Production projections from 2013 have domestic oil output exceeding 6.8 million barrels a day - the most since 1993 - due primarily to increased horizontal drilling and hydraulic fracturing ("fracking") activity in domestic shale plays.



2014 State GDP Growth Year-over-Year Growth



Technically Recoverable Domestic Shale Resources (June 2013) shale oil and shale gas as percentages of total



Shale/tight oil = 58 billion barrels
vs
Non-shale oil = 164 billion barrels

Shale gas = 665 trillion cubic feet
vs
Non-shale gas = 1,766 trillion cubic feet

data from www.eia.gov/todayinenergy/detail.cfm?id=14431

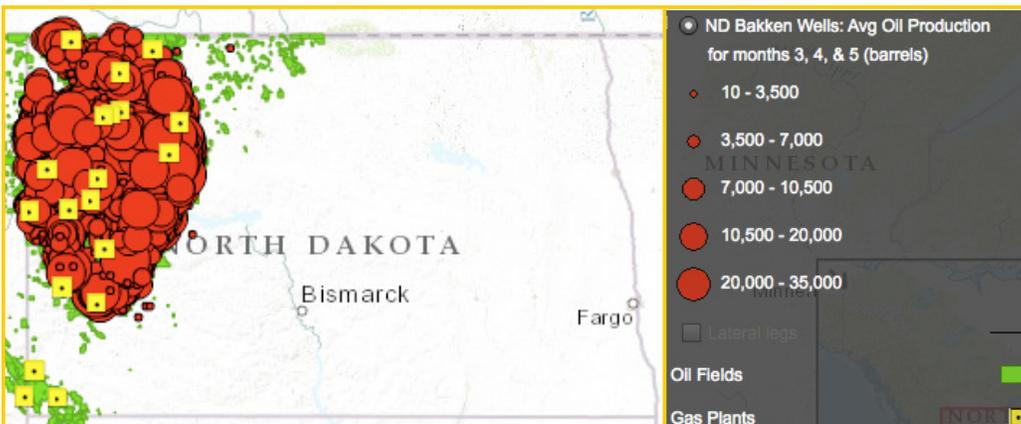
This domestic shale gale has led to unprecedented boom in local economies. Development in the oil and gas segment was occurring in at least 32 states in 2011, many of which involved shale gas, tight oil, or other unconventional resources, primarily on privately owned property.

Because the individual states regulate exploration and production activities on state and private lands within their borders, the states with the most oil and gas activity have felt the biggest impacts. In addition, certain plays are turning up more oil and gas than others. The specific states under which these prolific formations lie are experiencing numerous benefits - in per-capital income increases, employment opportunities, and wage growth - although the challenges of keeping up with the massive growth are not lost to them.

North Dakota is widely regarded as the epicenter of US shale activity, with a handful of other states concurrently developing strong production practices.

NORTH DAKOTA LEADS THE SHALE GALE

North Dakota is the nation's second largest oil-producing state, playing second fiddle only to Texas after surpassing Alaska and California in early 2012 due to its surge in shale production.



To put this surge into perspective, North Dakota's oil production lagged behind seven other states in 2006.⁴ But shale turned it all around: The state's shale production tickled the 875,000 barrels-per-day level in July 2013, setting a record by increasing almost 53,000 barrels per day. During the same time, the state's natural gas production grew to 930 million cubic feet per day.⁵

As the stand-out example of the state's oil surge, the Bakken shale accounts for more than 90% of North Dakota's oil production.⁶ During the record-setting July, the play surged by 50,000 barrels per day to exceed 800,000 barrels per day.⁷ Even with the tremendous production that has cropped up in the short time since the Bakken's bounty was discovered, oilfield service corporations have barely scratched the surface of what this abundant natural resource will yield. Ultimate production could likely exceed 12 billion barrels of recoverable oil and 2 trillion cubic feet of natural gas.⁸

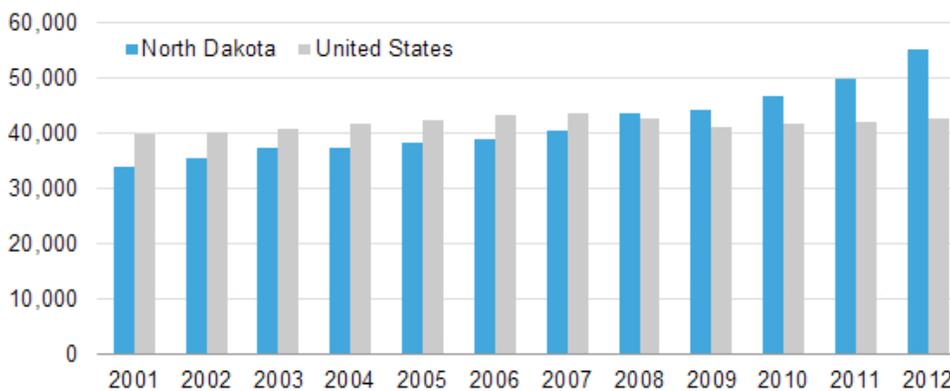
(Read more about the Bakken formation on page 25)

LEADING THE PACK

The surge in shale production is responsible for putting North Dakota at the top of many statistical lists. This rank-climber boasts a robust state economy with a billion-dollar budget surplus, not to mention a tripling in the number of taxpayers reporting adjusted gross income in excess of \$1 million.⁹

Climbing GDP: The state gross domestic product (GDP) per capita was 29% above the national average at \$55,250 in 2012 – quite a climb since ranking 38th out of 50 states in 2001.¹⁰ North Dakota also saw the highest annual increase in real per capita GDP of any state in 2012 for the second consecutive year.¹¹ Real per capita GDP increased by 13.4% in 2012 (compared with the national growth rate of less than 2% or even the state with the next highest growth, Texas, at 4.8%).¹²

North Dakota vs. U.S. real GDP per capita
(2001-12)
chained 2005 dollars



Source: U.S. Energy Information Administration, based on U.S. Department of Commerce, Bureau of Economic Analysis

Exploding Population: North Dakota has the highest rate of population growth, leading all states in net migration: The July 2012 Census Bureau population estimate (699,628) reflects a 4% increase in just two years. Meanwhile, the overall US population rose only 1.7%. What's more, the state's oil-producing regions can anticipate their populations to increase yet another 50% over the next 20 years.¹³ At the heart of the oil boom, Williams County is bracing for a meteoric expansion of 8% by the start of the next decade.¹⁴

And it's not just the working population around the shale plays that's climbing. Permanent residency is also on the rise, as indicated by the increases in school attendance. In Watford City, for example, the school district's total K-12 enrollment was 521 students in 2008. It grew to 867 in 2013 and is projected to exceed capacity (of 1,125) by 2015, hitting 1,622 by 2018 and continuing to grow.¹⁵

Soaring Urban Development: Housing and commercial properties are mushrooming throughout the state to keep up with this continuing influx of new workers. The city of Williston, county seat of Williams County in the Bakken's epicenter, is the fastest-growing area in the nation. Construction and remodeling permit valuations in the city exceeded \$470 million in 2012, and the city has added a dozen new hotels since 2010. At least six new housing units are being built in Williston every day, for 2,000-3,000 every year.

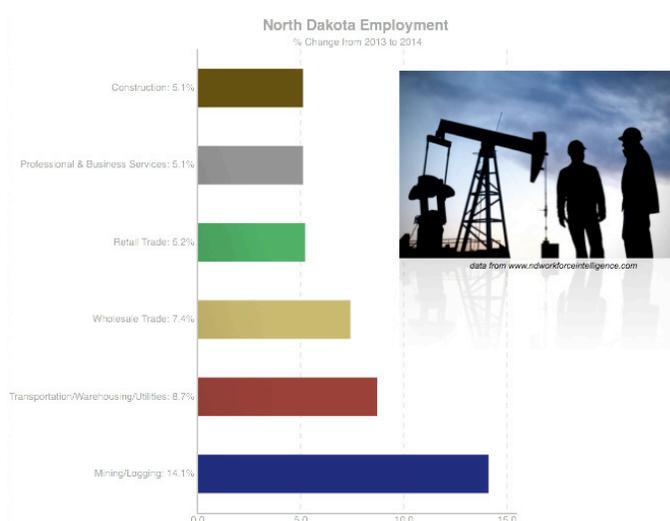
In addition to homes and businesses, the shale gale has reinforced the dire need for infrastructure enhancements on roads and state highway systems. In February 2011, Governor Jack Dalrymple allocated \$720 million for work on state highways and roads¹⁶, to accommodate the escalation in traffic. In fact, it's said that one highway – that workers expanded from two to six lanes – went from 1,400 vehicles a day to 14,000.¹⁷

Skyrocketing Employment: All this extensive development in infrastructure will continue to feed the need for workers. A February 2011 Gallup poll declared that North Dakota has the best job market in the country.¹⁸

Since then, the state's overall unemployment rate has remained the nation's lowest, pulling 3.2% in 2012. The Bakken region's outlook was even stronger, with a scant 1.8% jobless rate. In a short three-year timeframe from 2009-2012, employment increased by more than 60% in the Bakken area's 12 counties¹⁹, with an estimated 14,000 in Williston alone.²⁰

The oil industry estimates some 58,000 jobs in North Dakota, both directly working on the production and supporting the drilling industry. What's more, a demand for workers leads to escalating wages for all industries. This trend is especially noticeable in the Bakken region, where average weekly wages are up 40% since 2009.²¹

In March 2014, statewide employment had expanded by 4.4% over the previous year. An estimated 19,000 more jobs existed; of the top 4 sectors, Mining & Logging posted far and away the most gains.²²



GROWING PAINS

North Dakota's chart-topping statistics should make for a rosy economic outlook. But this booming growth has not been easy on the local communities, as a plethora of economic obstacles are preventing the state from really flourishing in this time of expansion.²³

For one, state fiscal policies are skewed so that individual municipalities don't see much of the shale-generated wealth. In 2012, the state pumped out \$18 billion worth of oil. Even though a majority of the drilling is in the Williston area, its county only pulled in \$1.5 billion in state O&G taxes. (And the disparity is even more visible when compared with neighboring states: While municipalities in Colorado saw 63%, Montana 39%, and Wyoming 35%, the 19 North Dakota counties most affected by the Bakken boom received a lowly 11.2% of state revenue from O&G ventures in fiscal 2012-2013.)

For another, those local revenues can't cover all the expenses needed to keep up with the stresses to the infrastructure. The city of Williston, for example – widely regarded as the epicenter for Bakken activity – has an official population around 16,000. City officials claim that it serves more than double that number: some 38,000 folks rely on city services, and caring for all these extra bodies is straining the city system and draining its coffers. New infrastructure necessary to keep up with the influx of Bakken oil workers could run into the neighborhood of \$625 million, with improvements needed at the airport, on roads, water supplies, and other basic facilities. In fact, the city's wastewater treatment facility is reaching capacity – if upgrades (with price tags upwards of \$100 million) don't happen soon, the city might be forced to halt building permits and restrict further development.²⁴

A third consternation throughout the state is the clogged construction market. To accommodate the mass influx of workers, construction activity is up dramatically in each of three private development sectors: apartments, single-family homes, and commercial real estate.²⁵ Even still, thousands of workers inhabit temporary lodgings from “man camps” to long-term hotel rooms to vehicles. Compounding the frustration, the construction industry encounters severe barriers to expanding development – even basic supplies like concrete and other building materials have become scarce commodities.

Then, even once the new facilities are built, the region can't supply the workforce to support commercial enterprises – in large part due to the housing crunch. Take, for example, the fast food industry: A newly built McDonald's in the Bakken region was forced to delay its opening due to short staffing.²⁶ The chain pulled out all the stops, offering high hourly wages, signing bonuses, and medical benefits.²⁷

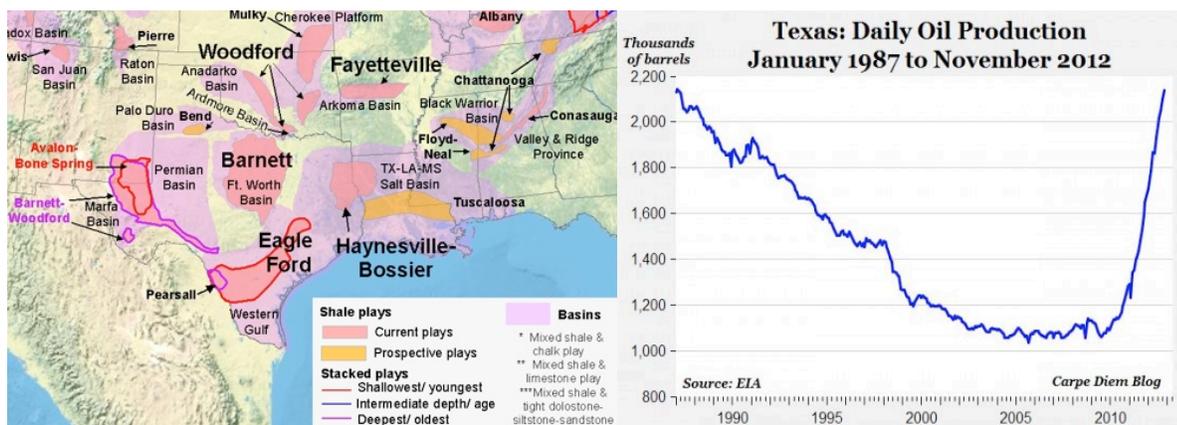
And then there's health care. While typical emergency rooms are notoriously slow, medical care in the Bakken area almost stands still. Williston's only hospital has seen emergency room visits increase 50% in a year and now has average wait times of at least 2 hours – even after a \$25 million expansion that doubled the emergency ward. Overworked hospital staff turn away 30% of the requested medical services each day because there aren't enough health care providers.²⁸

Officials are expecting the Bakken to be productive for at least another two decades.²⁹ Unfortunately, keeping up with today's momentum leaves little time to plan for those coming decades. At least for now, policymakers have back-burnered proactive strategy to focus on reactive decision-making.

EVERYTHING REALLY IS BIGGER IN TEXAS

Texas has long been known as the US oil capital – and for good reason. Ever since oil erupted into Texas way back in 1901 with the famous Lucas Gusher, the oil and gas industry has been the driving force of the state’s economy^{30, 31}. To witness the Lone Star State’s inextricable link with oil, just consider the fact that people all across the country have long referred to oil as “Texas Tea.”

Today, more than 100 years after becoming the epicenter of the nation’s oil production, Texas is once again leading an oil and gas revolution. As the huge, ongoing “shale gale” continues to sweep the nation and put the United States on the path toward true energy independence, Texas finds itself sitting atop the most promising shale plays.



Source: www.eia.gov/oil_gas/rpd/shale_gas.jpg

FRACKING TECHNOLOGY LEADS TO RECORD PRODUCTION

In May 2013, Texas accounted for 34.5% of all US oil production.³² And after a 22-year decline, oil production has doubled in just the past three years across the state, reaching its highest levels since 1981 when the U.S. Energy Information Administration started keeping official records. In September 2013, the state was producing 2.7 million barrels per day.

This rapid increase in oil production is attributed to improvements in hydraulic fracturing (“fracking”), a technique that involves blasting a mixture of water, sand, and chemicals at a high pressure to release trapped oil and gas. Deb Hastings, Vice President of the Texas Oil and Gas Association, expressed little doubt that fracking is solely responsible for the 180-degree turnaround in Texas’ oil production: “Advances in hydraulic fracturing technology are the reason for the dramatic growth in oil and natural gas production in Texas and across the US.”³³ Dr. Mark J. Perry, professor of economics at the Flint campus of The University of Michigan, called the sharp rise in Texas oil output “one of the most remarkable energy success stories in US history.”³⁴

EAGLE FORD LEADS THE WAY

With multiple promising shale plays across the state, Texas is in good shape to maintain its position as the nation's top energy provider for years to come. The head of this pack is the Eagle Ford formation, which spans across 20,000 square miles in South Texas. With more than 200 active rigs, the Eagle Ford is the most active shale play in the entire world.³⁵

This means a huge boon to South Texas' economy. Deanna Jones, vice president of human resources at Newfield Exploration in The Woodlands explains: "Oil and gas production from shale continues to see unprecedented economic growth, and can be directly tied to the creation of significant job opportunities."³⁶ In 2012 alone, the economic impact from the Eagle Ford was \$61 billion. That adds up to 116,000 jobs created, \$1.2 billion generated in state tax revenues, and more than \$1 billion generated in municipal tax revenues.³⁷

(Read more about the Eagle Ford Formation on page 24)

GRANDDADDY LIVES IN TEXAS

Considered "the grandfather" of all shale plays, the Barnett formation of north-central Texas' Fort Worth Basin contains one of North America's largest onshore natural gas fields. Since 1993, the play has yielded more than 13 trillion cubic feet of natural gas,³⁸ exceeding an average 3 billion cubic feet daily – and speculation promises that more than 24 trillion cubic feet more is technically recoverable.

According to the Texas Railroad Commission, as of 2012, 235 operators had their hands in the play. All this activity has spurred employment opportunities. In 2011, the Fort Worth Chamber of Commerce concluded that the development of the Barnett was directly responsible for 119,000 jobs in Texas.³⁹ Beyond jobs, local residents are seeing some rather astronomical payouts. For example, September 2008 bonuses paid to landowners in the southern counties ranged from \$200 to \$28,000 per acre. Leases offer attractive terms as well: some landowners have landed lease terms paying \$15,000-\$22,500 per acre plus royalty payments topping 25%.⁴⁰

(Read more about the Barnett formation on page 28)

PANHANDLING FOR SHALE

Oil and gas activity in the Texas Panhandle's Granite Wash formation began decades ago but yielded unpredictable results – until horizontal drilling met fracking in the early 2000s, and output and profitability burgeoned. The formation could sport at least 15 distinct productive reservoirs, offering oil and gas opportunities for decades. Estimates place its total recoverable resource potential at more than 500 trillion cubic feet of gas equivalent.

Despite a number of geophysical challenges that lead to unpredictable output, the Granite Wash has proven productive with the proper research and development. Total production since inception exceeds 2 trillion cubic feet of natural gas and 110 million barrels of oil.⁴¹ Companies willing to invest in strong geological analysis and evaluation wells have the potential for huge profits. What's more, the formation's high liquids content enhances its profitability: Granite Wash gas has been selling at a premium of 30%-50% over standard prices.

NEWER PLAYS SHOW REMARKABLE PROMISE

Texas has recorded the highest levels of oil production in decades, and activity shows no signs of slowing down. While the “big boys” continue to grab headlines, there are at least ten total shale plays with production potential across the state. So far, only a few of these have been tapped, but analysts already have their eyes set on one particularly appealing find that could dwarf even the Eagle Ford.

The **Cline** is a new shale play that could contain recoverable reserves of 30 billion barrels of oil.⁴² Located in West Texas in the Permian Basin some 7,300 feet below the surface, the Cline Shale is said to produce a similar type of light, easy-to-refine oil as that found in the Eagle Ford^{43,44}. If the Cline Shale play pans out, industry experts predict it could generate in excess of \$30 billion annually in total economic impact across an 11-county region.⁴⁵

Meanwhile, West Texas is also home to the **Wolfcamp**, where operators have discovered ideal conditions for horizontal drilling: Large volumes of oil are sealed in thick pockets at high pressures that enable high production with slower rates declines. It's still in early stages of development, but producers here are already a leg up, thanks to infrastructure in place from explorations dating back to the 1950s. Initial production rates average 580 barrels of oil equivalent per day since inception in 2009, and continually enhanced recovery techniques and increased lateral drilling lengths bring solid increases over time. Daily average production neared 700 barrels of oil equivalent at the end of 2012, with estimated ultimate recoveries (EURs) of 450,000-500,000 barrels.⁴⁶ Analysts have yet to speculate on its productive limits, but estimates exceed 1 billion barrels.

Not wanting to be left out, activity on the other side of the state in East Texas is also picking up. After being labeled the largest natural gas field in the U.S five years ago, production steadily declined in the **Haynesville** due to natural gas prices plummeting, but now, the region is back on the rise. As natural gas prices continue to climb back up, the Haynesville has started to once again attract the attention of oil and gas companies who are now returning rigs to the region. The good news is that the Haynesville is still expected to contain a wealth of resources. Despite the fact that more than 2,400 wells have been drilled across the Haynesville—which stretches from Northeast Texas to Northwest Louisiana—it's still believed that 75% of its resources still haven't been recovered.⁴⁷

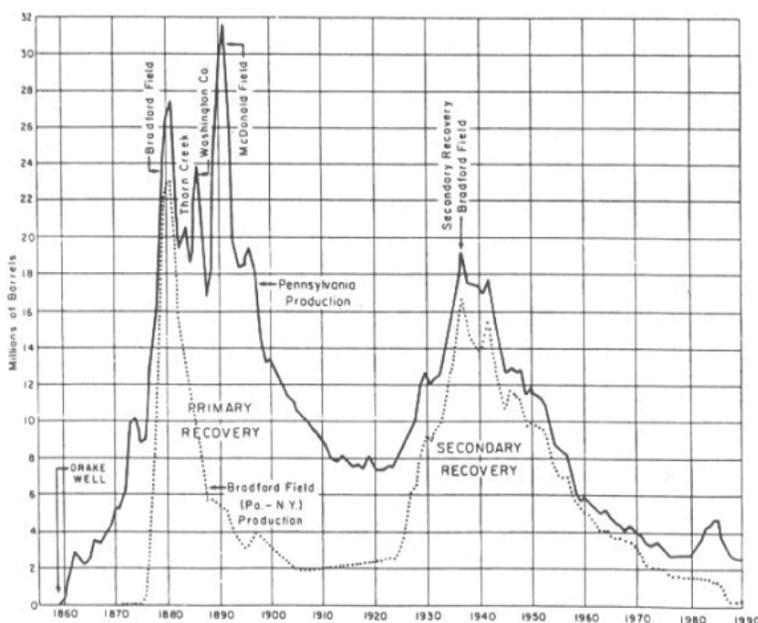
(Read more about the Haynesville formation on page 27)

That's just the latest piece of good news in the unbelievable oil renaissance ongoing in Texas, a state that could very soon eclipse Venezuela, Mexico, Kuwait, and Iraq to become the ninth-largest oil producer in the world.⁴⁸

SHALE BOOM REVIVES PENNSYLVANIA'S LAGGING ENERGY INDUSTRY

When you think of top oil and gas producing US states, Pennsylvania probably doesn't immediately come to mind. But the state's ties to petroleum go back 150 years. And today, Pennsylvania once again finds itself as a key production hub thanks to a remarkable shale boom.

Way back in 1859, the world's first commercial oil well was drilled in Pennsylvania under the supervision of Colonel Edwin Drake. When the well struck oil, a boom hit the area. For two decades, the state was the world's leading producer of crude oil.⁴⁹ Since that time, more than 350,000 oil and natural gas wells have been drilled across the state.⁵⁰



Source: www.econbrowser.com/archives/2010/11/peak_oil_in_pen.html

Unfortunately, the state's oil production peaked in 1891 at nearly 32 billion barrels⁵¹ and spent the better part of the following century on a steady decline to the point that it no longer warranted a major focus from the oil and gas industry.

But the focus has returned, due to an expansive geologic formation a mile beneath the surface of most of the state. The Marcellus shale is, quite literally, pumping new life into the state's oil and gas industry and its economy. Spanning across Pennsylvania, West Virginia, New York, Ohio, and Maryland, the Marcellus is among the largest shale regions in the country, and it's estimated to be the second biggest natural gas play on earth.⁵²

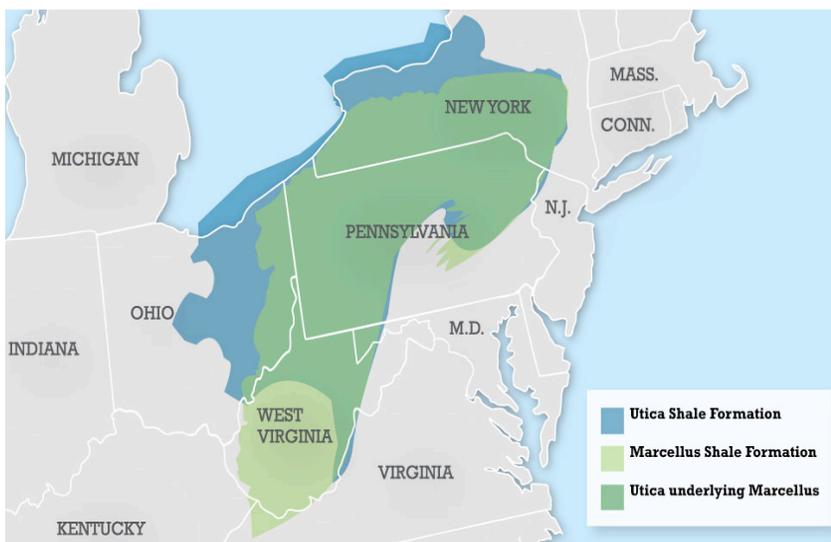
BOOMING BENEFITS

The abundance of natural gas in the Marcellus is having a significant economic impact on the state. A big winner is Pennsylvania's job market. Of all new jobs created between 2005 and 2012, a whopping 90% were created by the drilling industry. In 2009 alone, 44,000 new shale jobs were created in Pennsylvania, adding nearly \$4 billion in value to the state's economy.⁵³ As of the second quarter of 2013, new shale jobs increased

35% compared to three years earlier.⁵⁴ By 2020, it's expected that the Marcellus could support more than 211,000 fracking jobs across the state.⁵⁵ And it's not just the fracking engineers, construction workers, and equipment operators who are being hired (at average salaries up to \$25,000 a year more than the state average) – plenty of companies seek employees to fill professional services and support positions.

All over the state, landowners are also profiting big-time. Before 2006, lease offers from drilling companies were insignificant, typically bringing in a few bucks an acres. Not so today... common signing bonuses are now a few grand per acre.⁵⁶ What's more, sales tax collections – an indication of retail sales activity – show the economic significance of the state's gas development. State sales tax in counties with significant Marcellus activity increased by an average of 11% between 2007 and 2010, compared with an average 6% decrease in counties with no Marcellus activity.⁵⁷

But the Marcellus doesn't limit itself to helping one state. In the first half of 2013 alone, the Marcellus in Pennsylvania produced about 1.5 trillion cubic feet of gas, with year-end projections totaling about 3.2 trillion cubic feet, the equivalent of roughly 550 million barrels of oil. This bounty is a boon to the entire nation. Marcellus now supplies a majority of the gas for the eastern US, and gas from the Gulf Coast and western Canada that once shipped east is now fueling the Midwest and West Coast.⁵⁸ This is important for a number of reasons. Not only does it help put the United States on the path to energy independence, but it's a clean-burning energy source that serves as a bridge fuel between high-carbon coal and other future renewable energy sources, like cheap solar power.⁵⁹ And because natural gas has about half the carbon footprint of coal, it's providing remarkable environmental benefits, contributing to helping reduce CO2 emissions and improving air quality in major cities that are relying more heavily on natural gas^{60,61,62}.



Source: marcelluscoalition.org/pa-map/

(Read more about the Marcellus formations on page 26)

DIGGING DEEPER: UTICA SHALE SHOWS PROMISE

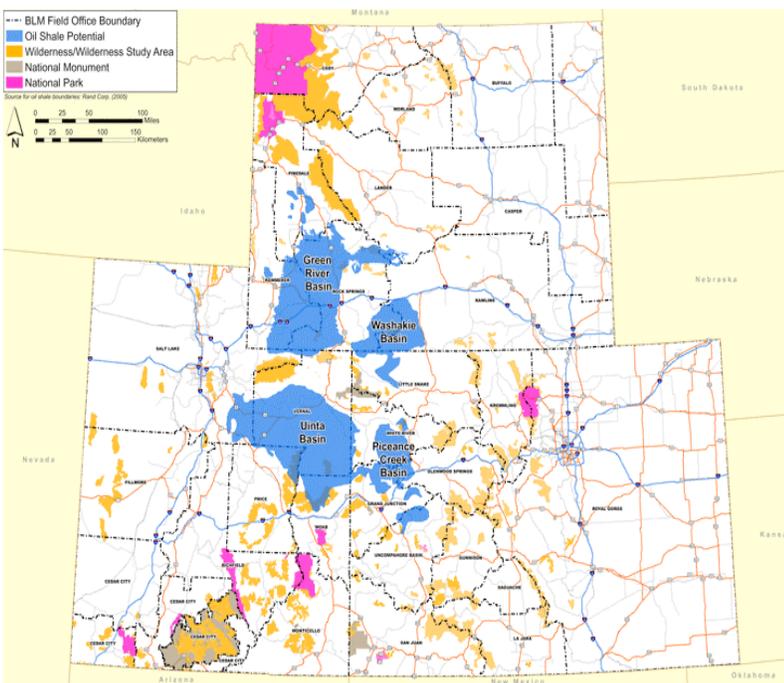
But why stop there? Beneath the Marcellus is yet another layer of hydrocarbon-rich rock that runs all the way from Tennessee to Quebec. It's the Utica shale, and some believe that it too is an oil and gas giant. Early predictions estimate that the Utica could contain as much as 55 billion barrels of oil and 16 trillion cubic feet of natural gas. The play would become another large energy resource for Pennsylvania, although neighboring Ohio could end up with the lion's share of that treasure.⁶³

For the moment, it's mostly speculation about the Utica's potential. Because of its great depth and inconsistent composition (it's expected to contain many dead zones), drillers still question if it will be possible to extract the resources in an economically viable way. Regardless of how things play out with the Utica Shale, one thing is clear: The shale boom has brought new life to a slumping oil and gas industry in Pennsylvania. As a result, the state and the entire nation are prospering.

COLORADO ENERGY PRODUCTION SKYROCKETS, THANKS TO SHALE

For decades, petroleum engineers have known of vast quantities of oil trapped under the ground in Colorado's oil shale rock. And for decades, oil companies have been struggling to find an economically viable way to release that oil from the underground rock.

The most abundant oil shale beds in the world lie in the Green River formation, located along the border of Colorado, Wyoming, and Utah. Expert estimates of the oil contained in the Green River Formation are in the trillions of barrels. Although not all of the oil will be recoverable, it's still estimated that about 800 billion barrels could be extracted – three times as much as Saudi Arabia's proven reserves and enough to satisfy current US demand for more than a century.⁶⁴



Source: www.eccos.us/oil-shale-in-co-ut-wy

BUT THERE'S A CATCH:

Engineers in Colorado are discovering that the Green River oil can't be recovered via fracking.

Green River oil is actually oil shale, a much different prospect than the tight oil of other shale plays in, say, North Dakota and Texas. Oil shale is an inorganic rock containing kerogen, a precursor in the production of petroleum. In order to produce oil, the oil shale and its kerogen need to be heated. When superheated to 5,000 degrees Fahrenheit, kerogen undergoes various chemical reactions, resulting in a vapor containing a mixture of hydrocarbons and other organic compounds. When this vapor condenses, it becomes oil that can be refined to produce liquid fuels and lubricants.

Producing oil from oil shale has been done in one of two ways: a.) The oil shale is brought to the surface and cooked; or b.) An electric heater is placed deep beneath the surface at the base of the rocks to heat the shale, convert it into liquid oil and gas, and then bring it to the surface.⁶⁵ Unfortunately, neither method has proven economically viable to this point. In recent years, both Shell and Chevron have abandoned their respective oil shale efforts in Colorado, after investing tens of millions of dollars into finding profitable extraction methods.⁶⁶

And so, for now, these alluring deposits of oil remain out of reach.

FRACKING ACTIVITY PICKS UP ELSEWHERE IN COLORADO

But Colorado's fracking tale isn't completely full of woes. Quite the contrary: outside of the Green River formation, it has been used quite successfully in other parts of the state.

Take the Niobrara play in the northern part of the state. Kicked off in August 2009 with the wildcat oil well "Jake" from EOG Resources, the Niobrara has proven particularly lucrative: It produced 50,000 barrels of crude oil in its first 90 days, signaling the beginning of the region's shale boom.⁶⁷ From 2009 to 2012, as fracking has increased in the Niobrara, Colorado's total oil production has increased 46%, from 32.7 million barrels to 47.9 million barrels. This marks the highest levels of oil production in Colorado in over 50 years.⁶⁸

(Read more about the Niobrara formation on page 27)

The economic benefits of fracking the Niobrara are undeniable. In 2012, the oil and gas industry contributed \$29.6 billion into the state's economy and supported more than 110,000 high-paying jobs.⁶⁹ Collectively, the industry contributed just over \$3.8 billion in employee income to Colorado households in 2012.

SOURCE	EMPLOYMENT	EMPLOYEE COMPENSATION (MILLIONS)	VALUE ADDED (MILLIONS)	OUTPUT (MILLIONS)
Drilling	4,935	\$319.17	\$1,054.36	\$1,556.59
Extraction and Support Activities	67,572	\$3,942.23	\$9,580.08	\$18,701.75
Petroleum Refineries	4,746	\$245.89	\$1,133.73	\$4,789.86
Transportation	2,889	\$178.85	\$263.18	\$791.88
Gas Stations	18,646	\$466.24	\$1,000.47	\$1,649.90
All Other	12,688	\$687.31	\$1,194.55	\$2,078.18
TOTAL	111,476	\$5,839.68	\$14,226.37	\$29,568.16

Source: www.coga.org/pdf_studies/UniversityofColorado_LeedsSchoolofBusiness_Oil&NaturalGasIndustry_EconomicStudy2012.pdf

Furthermore, fracking is more efficient, producing greater output with fewer permits. With 37% fewer permits approved by the state between 2010 and 2012, production still increased to its highest levels in more than 50 years.^{70,71} The fracking-spurred spike in natural gas production has also resulted in lower energy costs for Coloradans. With marketed natural gas production increasing 27% from 2007 to 2011, the state's natural gas prices are historically low, dropping average Colorado household energy costs to 23% less than the national average.⁷²

In short, the state is seeing a new oil boom - centered on oil produced from shale formations, not oil shale.

CONTINUED BOOM? OR IMPENDING BUST?

COULD A LETDOWN BE LOOMING ON THE HORIZON OF COLORADO'S CURRENT SHALE BOOM?

As Niobrara's Jake well indicates, production declines are all-too-common. After its first 90 days recovering 50,000 barrels of crude, its annual production in 2012 was just 22,300 barrels. And many other wells are also seeing production dips throughout the Niobrara. Within a typical Niobrara well's first year, oil production declines more than 65%.⁷³ More wells have to drill and frack to recoup the difference, and this has some questioning the long-term sustainability of Colorado's major shale play.

The other challenge facing the industry is a bit trickier to handle: Colorado has been ground zero in the fracking debate in 2013, with so-called "fracktivists" citing environmental concerns and calling for a moratorium⁷⁴ despite numerous studies refuting the environmental risk arguments. (Even the EPA has ruled out contamination from fracking because its activity takes place thousands of feet away from the groundwater.⁷⁵) Fracktivists pose a very real threat to the future of fracking in Colorado: some believe that their influence could lead to a statewide fracking ban referendum on the ballot in the near future.⁷⁶

BOLD PROJECTIONS GIVE REASON FOR OPTIMISM

How all this political debate will affect Colorado's fracking activity remains to be seen. In the meantime, however, work continues in the Niobrara - and some industry executives believe the best is yet to come.

Noble Energy, among the largest energy companies working in the Niobrara, recently announced its bold projections for the next few years. Company's chairman Charles Davidson expects its production to more than triple within the next five years. He spoke highly of the region's potential, calling it a "top tier play" that is on par "with any of the unconventional oil plays in the U.S."⁷⁷

For now, cautious optimism in Colorado's current shale boom remains.

CALIFORNIA SHALE OIL: BIG ON HYPE, SMALL ON RESULTS?

It's been called "an opportunity we can't miss."

It's been promised to be the thing that will "single-handedly"⁷⁸ turn California's economy around, increasing state and local tax revenue by \$4.5 billion and bringing in some 2.8 million jobs by 2020.

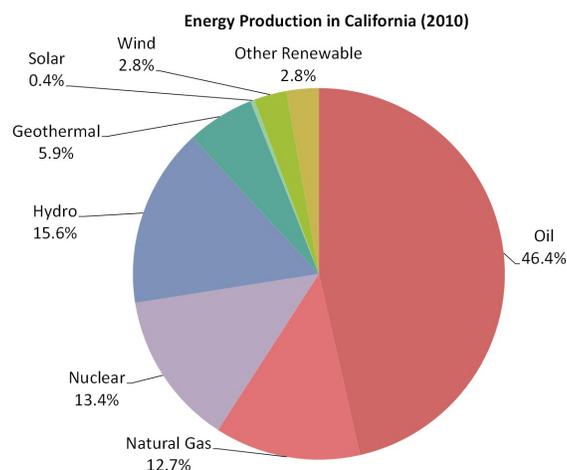
It's the much-hyped California shale oil boom, and it has arrested the nation with its allure. Seeing current examples of the benefits of shale in other states across the country, many hope that California can produce similar, if not even better, results with its Monterey shale formation.

We have ooh'd and ahh'd over the tantalizing descriptions of this expansive geological formation, encompassing 1,750 square miles from Los Angeles to San Francisco and promising as much as 15.4 billion barrels of oil. To put that quantity into perspective, it's more than double the amount estimated in the Bakken and more than five times the amount in the Eagle Ford of Texas. All told, the Monterey could hold more than half of the undeveloped, technically recoverable shale oil resources of the continental United States.⁷⁹

This, the President says, could be what finally helps put our country in "control of our own energy future" and reduces our dependence on foreign oil.⁸⁰ Unfortunately, to date, the California shale oil boom has been all hype and no results. Between strict environmental regulations, disappointing drilling results, and a technological shortfall, the shale revolution in California seems stalled.



Source: money.cnn.com/2013/01/14/news/economy/california-oil-boom/



Source: Energy Information Administration

STATE FORTUNES LONG TIED TO OIL

Some would say that California's greatness was achieved thanks to oil. For more than 100 years, the state has consistently been one of the top producers of oil. All the way back in the late 1800s, the state became a worldwide oil producer with its oil fields spread throughout the Los Angeles Basin, necessitating the development of the Port of Los Angeles to ship crude oil overseas.

Since 1861, about 96 oil and gas fields have been discovered across the state, with 66 of these fields having an ultimate recovery greater than 1 million barrels of oil.⁸¹ In fact, Southern California has produced more oil per acre than any other place in the whole world – including Saudi Arabia.

During the 1960s, California's oil production was at its peak, and the state's economy was thriving. Even though its production today is half what it once was, oil still significantly impacts the state's economy.⁸²

CONTROVERSIAL POLICIES HANDCUFF DRILLERS

Many blame California's political policies for the state's sharp decline in oil production. "California has very challenging environmental regulations," explains Dr. Andrew N. Kleit, Professor of Energy and Environmental Economics at Penn State University. "You simply can't build new things."⁸³

Those energy regulations are likely tightening even further, and the impact is making it very difficult for producers to recover oil from shale formations. Some of California's politicians and environmental groups aggressively oppose the shale oil technological breakthrough of hydraulic fracturing (or "fracking" as it's often called), the technique that has driven the shale boom across the country by blasting a mixture of water, sand, and chemicals at a high pressure to release the trapped resources and significantly boost production.

The anti-fracking crowd calls for a statewide ban on the technique. It makes several arguments against the use of this technique in California – including the potential to trigger earthquakes, the strain on the state's already-dwindling water supply, and the risk of contaminating drinking water – all of which have been refuted time and time again by noted experts:

- Seismologist Peggy Hellweg of UC Berkeley knows a thing or two about major earthquakes. She doesn't connect fracking with destructive tremors: "I'm not expecting the Big One to be triggered by this kind of thing."⁸⁴
- The state's geology itself, say developers, prevents fracking from sucking the state's water supply dry. They argue that geological conditions require *much less* water for California wells than other sites around the country, noting that the average 100,000 gallons that fracking wells in California use is a fraction of others.⁸⁵

- And as for the argument that fracking could poison the water, multiple studies – including three by President Obama’s EPA, have proven that contamination simply isn’t possible because fracking occurs thousands of feet from the groundwater.⁸⁶ As former EPA administrator Lisa Jackson said, there is no “proven case where the fracking process itself has affected water.”⁸⁷

Unfortunately, the anti-fracking contingent’s arguments, based on misinformation and fear-mongering, have earned them a lot of press and quite a public following. Perhaps Stanford University economics professor Frank Wolak summed it up best when he said that environmental concerns over fracking are “not based on experience or scientific evidence, but emotion.”⁸⁸

Despite the evidence, California recently proposed new fracking regulations that officials hail as the “strongest” in the nation.⁸⁹ The new regulations would require developers to get state permits, test groundwater supplies, and notify neighbors before conducting fracking and related techniques. Developers and fracking proponents worry that these strict requirements will hold California back and prevent the state from experiencing its own shale boom.

NEXT GREAT TECHNOLOGICAL ADVANCE, PLEASE!

While activity in the Monterey is still in its early stages, one thing that’s been lost in the argument over environmental regulations is the fact that oil and gas companies have reported disappointing drilling results to date.

Chevron’s Kurt Glaubitz expressed the company’s displeasure with its findings: “Based on our drilling results, our view is that the oil has migrated out of the formation and is now found in pockets outside of the Monterey shale... We don’t believe it’s going to compete for our investment.”⁹⁰

Venoco, an independent that held the second-highest amount of acreage in the Monterey Shale formation, experienced similar disappointment. The company found its early wells to be “uneconomic”⁹¹ and it moved to sell off its holdings⁹² in the early part of 2013.

Jason Marshall, the California Conservation Department’s chief deputy director, believes that the fallout from earthquakes over time has left the Monterey disjointed and unpredictable. “It may take an advancement in technology or methodology to unlock the oil production potential of the formation,” Marshall said.⁹³

Analysts agree. The oil is still there, they contend, but it will come down to finding an economically feasible way to extract it. “Here’s this obviously well-known, very rich source rock,” said Pete Stark of the consultancy IHS Energy. “If we can crack the code on getting into new and unconventional parts of the Monterey, maybe we have a huge new bonanza on hand.”⁹⁴

SHALE BOOM STILL EXPECTED

Despite early disappointments over limited recovery, many oil and gas analysts caution that it's still too early to write off the Monterey. "It's not conclusive that the emperor has no clothes," Oppenheimer senior energy analyst Fadel Gheit acknowledged.⁹⁵

Several oil companies are banking on an enriching future of California shale, gobbling up acreage across the Monterey and intensifying their exploration efforts within the region. Private landowners are also getting caught up in excitement, with visions of signing bonuses and royalties in their futures.

California oil is still a very prominent player in the energy marketplace. It retains its place in the top-5 oil producing states, currently ranking 4th behind Texas, North Dakota, and Alaska.⁹⁶ For now, the state's shale boom is little more than a wait-and-see promise – but the trajectory of advancements in drilling technology could be an indicator that this promise can be kept. "There are some pretty creative people in this industry," said Stephen Trammel, energy research director at HIS. "I'd say they are going to figure it out."⁹⁷

SHALE TO THE KING: COULD THE SHALE REVOLUTION

Pump New Life into Alaska's Oil and Gas Industry?

For the past 40 years, Alaska's economy has been supported almost exclusively by its oil and gas industry. As a matter of fact, about 93% of the state's general fund revenues come from oil production, and about one-third of its jobs are oil-related. To put it in perspective just how important oil is to the state's economy, a study released by the University of Alaska's Institute for Social and Economic Research (ISER) found that, without oil, the state's economy would be only half its current size.⁹⁸

Alaska has always been a top US oil producer, with more than 17 billion barrels of oil under its belt since becoming a state in 1959.⁹⁹ At times, the state has accounted for 20% to 25% of the nation's entire domestic production.

But the times they are a-changin': Recent declining production and falling oil prices are fostering a bleak outlook for Alaska's economy. Since Alaska's oil peak in 1988, when 2.1 million barrels were produced per day, production has dwindled down steadily, reaching its lowest point of just 536,000 barrels per day in 2012.¹⁰⁰

For the first time in nearly a decade, Alaska's budget has been forced into deficit spending as its oil revenues sag. Over the course of just three years, the state has seen a radical change, from billion-dollar surpluses to billion-dollar deficits.¹⁰¹ Because around 90% of the state's public budget is provided by oil-related revenues, the state has no income or sales tax. In other words: if the oil industry fails, the state fails.

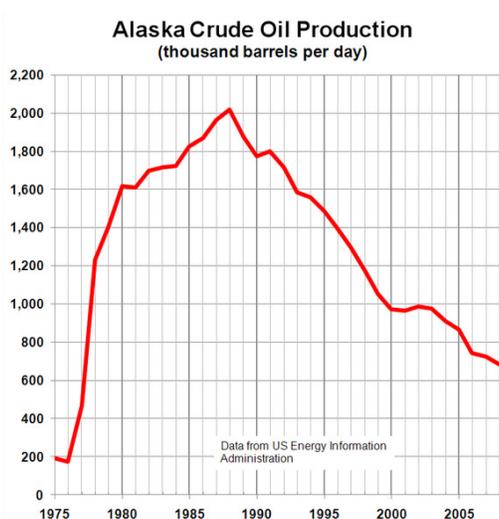
Why this dramatic decline in Alaska's oil production? Experts cite many reasons, both political and geological, but the one thing everyone seems to agree upon is that at least part of the decline is due to the fact that 40 years of drilling has simply reduced the supply of easy-to-attain oil.

THE OIL KING GETS DETHRONED

Alaska's economic and oil production struggles are compounded by the fact that many of the key players in the industry are turning their attention south to the lower 48. Thanks to a boom in shale production – driven mainly by the technological advances of horizontal drilling and hydraulic fracturing (a technique that involves blasting a mixture of water, sand, and chemicals at a high pressure to release trapped oil and gas) – US oil production has skyrocketed in recent years.

According to the Congressional Research Service, US annual crude oil production rose by 1.5 million barrels per day between 2008 and 2012.¹⁰² About 92% of the increase came from shale and tight oil formations in Texas and North Dakota.

The “Shale Revolution” in the lower 48 has proven incredibly beneficial to the US on multiple fronts. Not only has this modern-day oil boom led to solid job growth, but it's also reducing the nation's dependence on foreign oil, a vulnerability the US has struggled with for decades.



And the positive economic impact of domestic shale oil and gas isn't expected to go away any time soon. According to a report by Purdue University energy economists, the nation's gross domestic product is expected to increase by an average of 3.5% annually through 2035.¹⁰³ The US is also on track to become the world's top oil producer and net exporter of natural gas by 2020.¹⁰⁴

But while this boom – which many scholars refer to as “a game changer for the US economy” – is great for states like Texas and North Dakota, it's been a bust for the former leader of the US pack. A peak at the numbers shows just how far Alaska's crude oil production has fallen.

HOME OF THE NEXT GREAT SHALE BOOM?

With its oil fields waning and its position as the top oil producer stripped away, it's not surprising that Alaska is exploring its own unconventional oil opportunities. Taking inspiration from the increased shale activity in North Dakota, Texas, Pennsylvania, and other lower-48 siblings, Alaska is now pursuing its own shale oil development. If things go as expected, the state could once again take its place atop the nation's oil production ranks.

As with shale developments across the lower 48, speculations in Alaska point to combining the technologies of hydraulic fracturing (“fracking”) and horizontal drilling, two innovations that have greatly improved the efficiency of oil and gas recovery and ushered in the shale boom.

Most industry experts are pinning their hopes on Alaska's North Slope. While the region's supply of easy-to-recover oil has dwindled in recent years, many believe that much more oil remains trapped in its shale rock.

The US Geological Survey estimated that the North Slope's shale rock, which spans from the Chukchi Sea on the west all the way to the Arctic National Wildlife Refuge on the east, could hold as much as 2 billion barrels of recoverable oil. That would make it the second-biggest deposit of unconventional crude after North Dakota's Bakken and more than Texas' Eagle Ford. The North Slope region could also contain as much as 80 trillion cubic feet of natural gas, which would make it the fourth-largest gas-shale deposit in the country.¹⁰⁵

Of course, no one knows for sure how much of the oil can be recovered from the North Slope's source rock, or if it can be recovered at an economically viable rate. Regardless, petroleum geologist Ed Duncan, president and CEO of Great Bear Petroleum LLC, has wasted no time in going all-in on Alaska's North Slope shale fields. In 2010, his company leased 500,000 acres of land in the region, believing it to be America's next huge shale play. The company plans to begin its shale development program in 2014.

O&G CHALLENGES: ALASKA-UNIQUE?

If Alaska hopes to see its own shale oil boom, it will have to overcome a few unique – and not inconsequential – obstacles along the way.

While the North Slope boasts an abundant water and sand supply for fracking, a lack of rigs and other drilling/completion equipment combined with a shortage of trained workers is stalling development in the area. Due to supply chain issues, getting rigs to the North Slope has proven difficult. According to Duncan, “You don't have a lot of materials. You have companies competing for few rigs. The rig rates are high. Labor costs are high. Material costs are high on the North Slope.”¹⁰⁶

Another obstacle that Alaska may need to overcome if it hopes to reverse its economy's downward spiral is its own legislation. In April 2013, the state legislature approved a huge tax cut for top oil producers. Supporters of the legislation believe it will incentivize oil companies to kick lagging production into full gear, helping the state get its economy back on track.

But not everyone sees the new legislation in such a positive light. Critics argue that the tax cut won't do much to spur production, and, in the process, it will cause the state to lose billions of dollars in tax revenue from the oil and gas industry.

Policy aside, one thing is for certain: the production lag needs to be remedied soon, or else the state's economy will continue to weaken. If, on the other hand, Alaskan shale can indeed revolutionize the state's oil & gas industry, locals and the nation as a whole stand to gain. As Interior Secretary Ken Salazar put it, “Alaska's energy resources hold great promise and economic opportunity for the American people.”¹⁰⁷

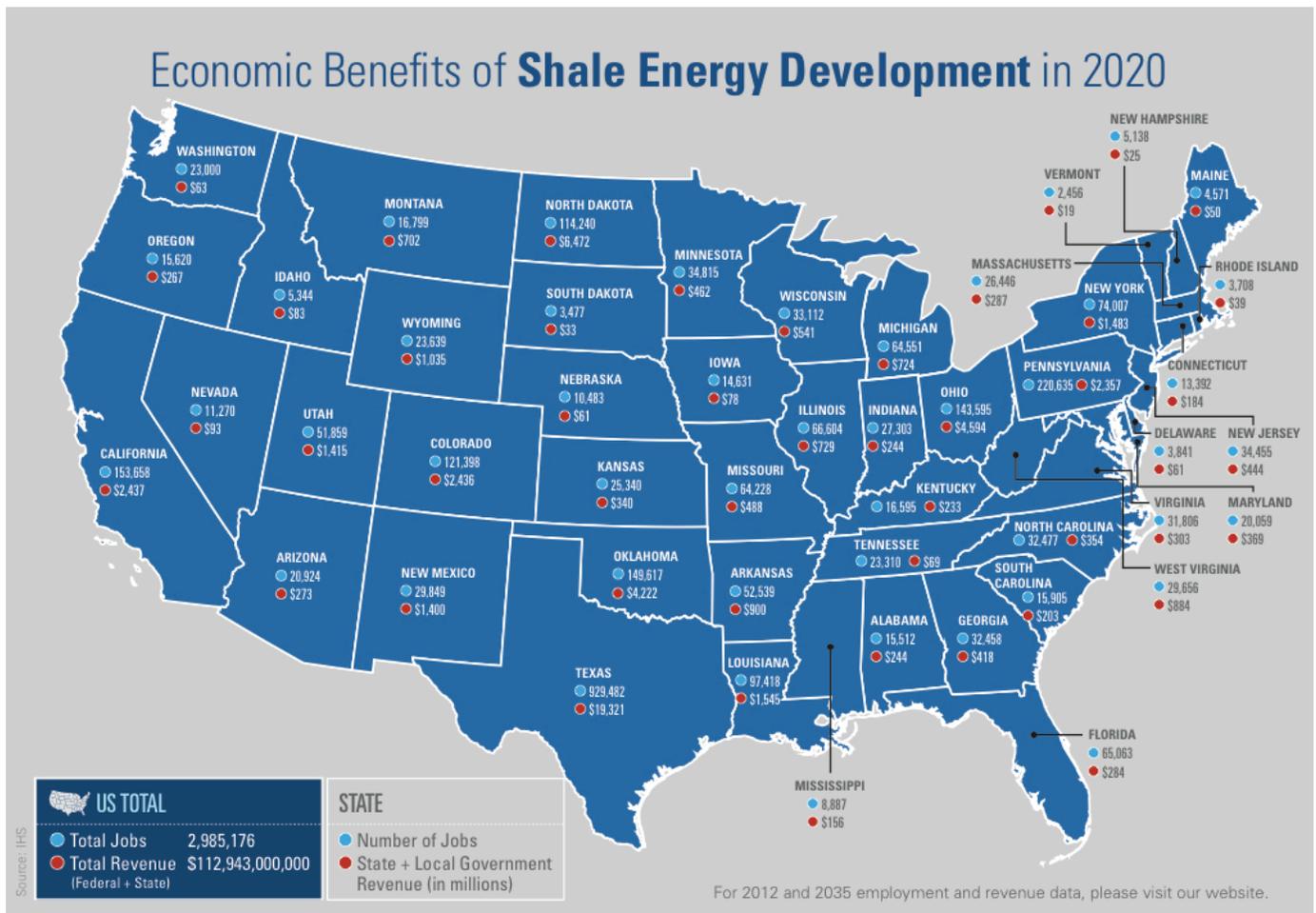
That's a lot of pressure. Can Alaska replicate the shale oil revolution currently taking place across the lower 48? It's still too early to tell, but many have their fingers crossed.

SHALE AROUND THE COUNTRY

Even in leaner areas of shale production, states are benefiting from increased energy activity. Petroleum engineers have discovered pockets of lucrative shale across the country, with resulting benefits to the local state economies.

(See our summary table on the following page)

This eye-opening graphic from the US Chamber of Commerce forecasts some amazing statistics for the coming decade. Their projections show that *every single state in the Union* will realize benefits from the shale boom:



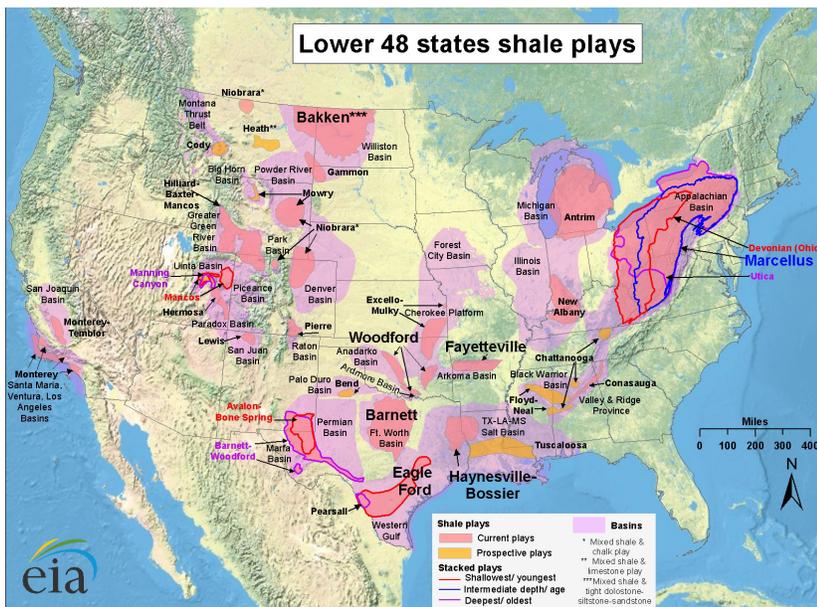
www.shaleworksforus.com

STATE	MAIN SHALE PLAYS	PRODUCTION (AS OF 8/13)	LOCAL BENEFITS
Alabama	Floyd-Neal / Conasauga	890,000 barrels oil and 195,581 million cubic feet gas	Alabama's energy prices are 5% lower than the national average, due to its considerable conventional and unconventional natural gas reserves, numerous oil refineries within the state lines, and proximity the Gulf of Mexico. Its three refineries increased the state's oil production by 35% in the last 2 years.
Arkansas	Fayetteville	574,000 barrels oil and 1,072,212 million cubic feet gas	O&G jobs in the state rose 120% from 2004 to 2008 and pay better than average. The 36,000 unconventional sector jobs in Arkansas created in 2010 will swell to 54,000 by 2015 and 80,000 by 2035.
Illinois	New Albany	843,000 barrels oil and 2,121 million cubic feet gas	A range of economic outcomes could benefit Illinois through expanded natural gas production, with the most conservative estimates of 1,000+ jobs and \$1+ billion in economic impact.
Indiana	New Albany	203,000 barrels oil and 9,075 million cubic feet gas	Indiana could host 10+ new chemical industry projects due to current competitive prices of natural gas.
Kansas	Excello-Mulky, Mississippian Lime	4,027,000 barrels oil and 309,124 million cubic feet gas	Unconventionals amount to just 3.8% of the state total, but their proliferation could bring investments into the \$billions and thousands of jobs to Kansas over the next 20-30 years.
Kentucky	Big Sandy, New Albany	336,000 barrels oil and 124,243 million cubic feet gas	Proposed transportation fuel projects such as the Bluegrass Pipeline, opening in 2015 with a capacity of 200,000 barrels a day, will stimulate Kentucky's centrally located economy and encourage more investments through shale-friendly policies.
Louisiana	Haynesville	6,233,000 barrels and 3,029,206 million cubic feet gas	Energy activities brought in \$7 billion to the state and created 57,000 jobs in 2009 alone, and the state announced \$50 billion capital investment in 2012-13. The 81,000 jobs created in 2010 should increase to 125,000 jobs by 2015 and 200,000 jobs by 2035.
Michigan	Antrim	656,000 barrels oil and 138,162 million cubic feet gas	In 2010, the Antrim was the 13th largest natural gas producer in the US, with an average EUR of 0.28 Bcf per well and 19.9 Tcf of technically recoverable gas.
Mississippi	Floyd-Neal / Conasauga, Tuscaloosa Marine	2,083,000 barrels oil and 81,487 million cubic feet gas	Although much is unproven, the state has prospects for economic quantities of shale oil as recovery techniques continue to improve. Shale-friendly legislation has encouraged many major drillers to set up operations.
Montana	Bakken	2,449,000 barrels oil and 74,624 million cubic feet gas	Montana is the only other state (besides North Dakota) with a budget surplus.
Nebraska	Niobrara	240,000 barrels oil and 1,959 million cubic feet gas	Horizontal drilling interest in Nebraska has increased over the past 5 years due to the state's flexible permitting process and less restrictive regulatory environment than its neighbors.
New Mexico	Avalon / Bone Springs, Lewis	8,425,000 barrels oil and 1,237,303 million cubic feet gas	Energy operations grew from >1% of total state employment in 2000 to 4% in 2011. O&G extraction's share in the state GDP was 5.1% in 2010
New York	Marcellus	30,000 barrels oil and 31,124 million cubic feet gas	Current regulations prohibit fracking, but the state benefits from shale production.
Ohio	Marcellus, Utica	413,000 barrels oil and 78,858 million cubic feet gas	Shale development has generated \$900 million in state and local government revenue. In 2012 alone, shale added \$4.1 billion to Ohio's gross state product, produced \$2.5 billion of labor income, and saw 20% higher sales tax revenues in the shale regions than in 2011. By 2020, O&G companies will spend \$34 billion in the state and bring in 200,000 new jobs.
Oklahoma	Fayetteville, Woodford	9,810,000 barrels oil and 1,888,870 million cubic feet gas	Oklahoma's unconventional energy sector generated 28,000 jobs in 2010. This number will likely hit 42,000 jobs by 2015 and 69,000 jobs by 2035.
South Dakota	Bakken	152,000 barrels oil and 1,848 million cubic feet gas	South Dakota manufacturing, modular home construction, and professional services industries benefit substantially from the Bakken boom, filling in the gaps where North Dakota firms are overwhelmed.
Utah	Mancos	2,816,000 barrels oil and 457,525 million cubic feet gas	Utah should see substantial expansion that will bring in \$10 billion in capital investments and \$5 billion in taxes and royalties over the next decade, as well as 36,500 new jobs by 2015 and 51,000 jobs by 2035.
Virginia	Big Sandy, Marcellus	151,094 million cubic feet gas	Although Virginia produces relatively small amounts of shale gas, its proximity to high-producing neighbors has boosted its energy economy.
West Virginia	Marcellus, Utica	378,000 barrels oil and 394,125 million cubic feet gas	Average income for Wheeling residents rose by 3.1% over the past year. 1% job growth and 2% per-capita income growth are likely each year until 2018. West Virginia shale energy development has already supported 12,000 extraction jobs and generated \$280 million in state and local revenue. In 2012 alone, shale added \$1.6 billion to the gross state product and \$794 million in labor income.
Wyoming	Hilliard-Baxter-Mancos, Niobrara	5,819,000 barrels oil and 2,159,422 million cubic feet gas	Unconventional energy development in Wyoming generated 35,000 jobs in 2010, and should reach 48,000 jobs by 2015 and 79,000 jobs by 2035.

THE MAJOR PLAYS FUELING THE SHALE REVOLUTION

There are nearly 40 known shale plays across the United States.¹⁰⁸ But owing to shale's natural characteristics, each formation offers unique properties that require equally unique treatment. Some plays hold more resources – or enable their resources to be tapped more easily – than others.

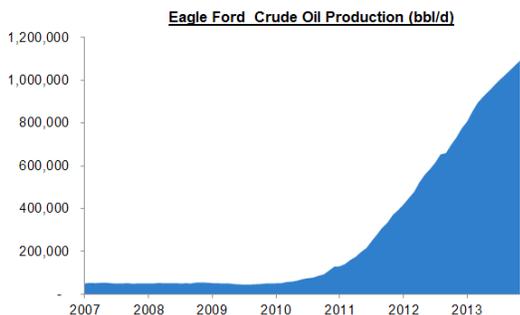
The fact is that the majority of production comes from just a handful of these plays. For their overall importance to the shale revolution, the US Energy Information Administration has designated six formations responsible for the bulk of recent production growth in domestic shale: Eagle Ford, Bakken, Permian Basin, Marcellus, Niobrara, and Haynesville.



Source: Energy Information Administration based on data from various published studies. Updated: May 9, 2011

1. Eagle Ford:

While it's only been tapped for about 5 years, the Eagle Ford has quickly become one of the most important US shale plays. In fact, it is the world's fastest growing shale play with a 160-fold increase in permits in just a 4-year span. Stretching across 20,000 square miles in southern Texas, the Eagle Ford could contain up to 10 billion barrels of recoverable oil.



Source: EIA, Oilpro

Experts believe the true potential of the Eagle Ford might be greater than anything ever before seen on US soil. The U.S. Geological Survey estimates the field holds up to 10 billion barrels of oil – which would make it the most massive onshore oil reserve ever discovered in the continental US.¹⁰⁹

Source: oilpro.com/post/648/top-5-unconventional-oil-plays-in-the-us

But what makes the Eagle Ford truly special isn't just the *quantity* of oil it's pumping out, it's the *quality*. Eagle Ford oil is some of the most valuable crude in the world. Characterized as "exceptionally light and sweet," this crude is inexpensive to refine. And because the play is near metropolitan hubs in Houston and Corpus Christi, transporting it is quite economical.¹¹⁰

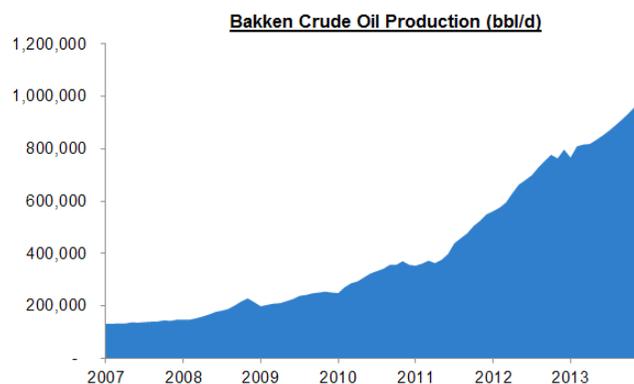
Furthermore, the Eagle Ford beats other traditional shale plays in both oil and gas production. The formation's high percentage of carbonate shale is largely to thank as it is more brittle and allows for easier fracking.¹¹¹ Combine all of this with declining drilling costs, and it's no wonder the Eagle Ford tops the list of major shale plays in the US.¹¹²

2. Bakken:

The Bakken was named after the North Dakota farmer who owned the land where the formation was originally discovered back in 1951. Back then, the technology didn't exist to tap the resources in the formation, but as unconventional technologies have emerged, the region has become ground zero for the shale revolution.

In April 2013, a USGS survey estimated that the Bakken would produce a total recovery of 7.4 billion barrels of oil. The formation's remarkable production has helped North Dakota become the second-largest oil production state, behind only Texas.

Source: oilpro.com/post/648/top-5-unconventional-oil-plays-in-the-us



Source: EIA, Oilpro

What makes the Bakken such a bonanza is its highly-pressurized source rocks. The formation's high pressure contributes to high initial production rates for drills. It also suggests that the oil is contained tightly within the source rock itself. As of early 2013, the Bakken was producing about 779,000 barrels of oil per day, accounting for 11% of total U.S. production.¹¹³ It's expected to soon eclipse 1 million barrels of oil per day in production.¹¹⁴

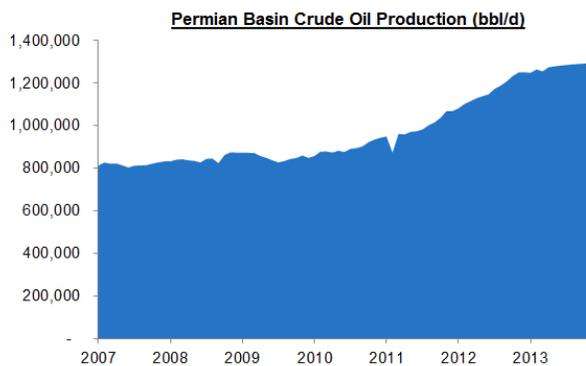
3. Permian Basin:

The Permian Basin is home to numerous promising shale plays, including the Cline, Wolfcamp, and Spraberry. The region currently produces about 900,000 barrels of oil per day, and that number is only growing.¹¹⁵ Within the next 5 years, the Permian Basin is projected to pump out a jaw-dropping 2 million barrels of oil per day.¹¹⁶

The Permian's most appealing characteristic is its "stacked pay potential." Imagine having 6 Eagle Ford formations stacked on top of one another. That's what the Permian Basin offers.

With a pay zone up to 1,800 feet thick in some locations (compared to about 250 feet thick in the Eagle Ford), drillers are able to target multiple areas with a single vertical well. When it's all said and done, the Permian Basin could be the world's largest oil and gas discovery.¹¹⁷

Source: oilpro.com/post/648/top-5-unconventional-oil-plays-in-the-us

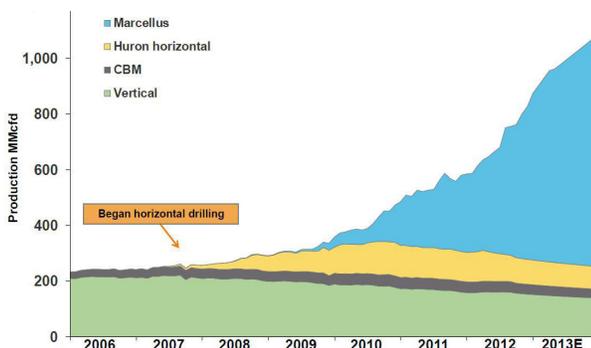


Source: EIA, Oilpro

4. Marcellus:

With about 80% of wells in the region focused on natural gas production, the Marcellus Shale produces about 20% of the nation's daily gas supply.^{118,119} The formation, located primarily in Pennsylvania, is expected to contain more than 500 trillion cubic feet of natural gas. If only 10% of this gas is recovered, it would still be enough to supply the entire country with natural gas for about two years.¹²⁰

Experts attribute the formation's massive natural gas resources to its depth and thickness. The Marcellus is located 4,000-8,500 feet beneath the earth's surface, and thickness ranges between 50 feet to 200 feet. A rich organic composition from plants and animals compressed over the course of millions of years has helped trap natural gas in the formation's fractures.



With such abundant resources and its nearness to large Northeastern US energy markets, the Marcellus is attracting developers and has a bright outlook for years to come.¹²¹

Source: seekingalpha.com/article/1137011-eqt-corp-operating-analysis-marcellus-shale-production-growth-to-continue-unabated-in-2013

Source: www.eqt.com

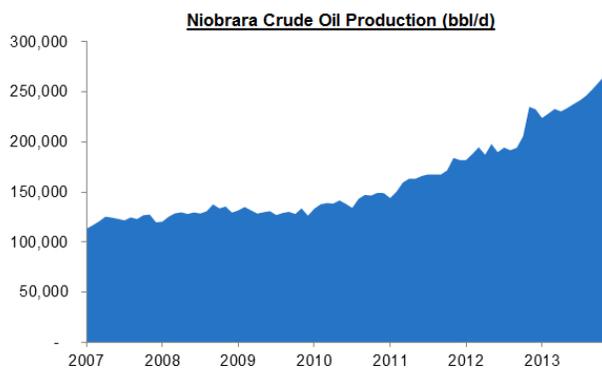
5. Niobrara:

From day one, the Niobrara play showed enormous potential. When the wildcat oil well “Jake” was first drilled in August 2009, it produced 50,000 barrels of crude oil in just 90 days.¹²² This signaled the beginning of an oil boom, one that today is still in its earliest stages. Thanks to the Niobrara, the state of Colorado is seeing its highest levels of oil production in more than 50 years, with a 46% increase in total production from 2009 to 2012.¹²³

Because development in the Niobrara is still in its infancy stage, analysts are still struggling to assess just how much recoverable oil lies beneath the surface.

After a strong start, output has been less than predicted. In Weld County, for example, the first half of 2012 produced 11.5 million barrels of oil and 101.4 million cubic feet of gas – compared to 26.5 million barrels and 238.4 million cubic feet, respectively, in 2011. Despite lower outputs than expected, strong interest in the play remains. Estimates now say that the play is a third bigger than first thought. Some believe it could hold about 2 billion barrels of recoverable oil – and the promises a bright future for the region.¹²⁴

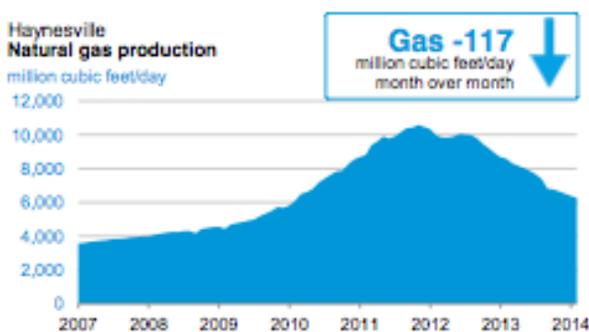
Source: oilpro.com/post/648/top-5-unconventional-oil-plays-in-the-us



Source: EIA, Oilpro

6. Haynesville:

The play that stretches from Northeast Texas to Northwest Louisiana is expected to contain a wealth of resources. Five years ago, the Haynesville earned the label as the largest gas field in the US. In early 2011, the Haynesville actually surpassed the Barnett as the nation’s highest-producing shale gas play.¹²⁵



Source: www.eia.gov/petroleum/drilling/pdf/haynesville.pdf

And while production has since gone down, it’s still believed that 75% of its resources still haven’t been recovered. More than 2,400 wells have been drilled across the play to date.

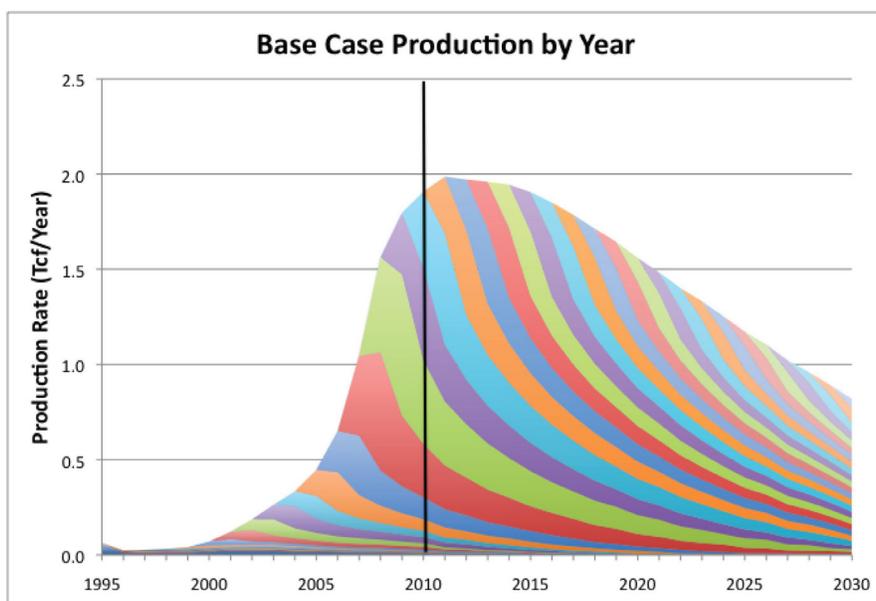
Plummeting natural gas prices led to a decline production from this formation. But as natural gas prices climb back up, the Haynesville is once again attracting the attention of oil and gas companies who are returning rigs to the region.¹²⁶

OTHER IMPORTANT PLAYS KEEP SHALE HOT

Don't Forget "Grandpa Barnett"

Considered "the grandfather" of all shale plays, the Barnett of north-central Texas' Fort Worth Basin contains one of North America's largest onshore natural gas fields. Since 1993, the play has yielded more than 13 trillion cubic feet of natural gas¹²⁷, exceeding an average 3 billion cubic feet daily - and speculation promises that more than 24 trillion cubic feet more is technically recoverable. A typical Barnett well is very productive for extended periods and enjoys fairly level production after an initial decline over the first few years.¹²⁸

Production Outlook for the Barnett Shale through 2030



Source: Bureau of Economic Geology/Univ. of Texas at Austin

Like the wise old grandfather, the Barnett has influenced E&P practices for other fields. Years of experience and innumerable successes have made drilling here an education for its younger, less mature counterparts around the country. It's even a trend-setter for recent technological advances like urban "pad drilling" (with multiple wells from a single location) and frac water recycling methods.

Age has its drawbacks, too: Some analysts predict that the Barnett has already reached its production apex. Drilling is down overall in the Barnett, leading some to question the play's lifespan. Despite this tapered activity, though, production increased to its September 2011 peak of 6 million cubic feet of gas per day.¹²⁹ So even though the Barnett didn't make the EIA's "Top 6" list, Granddaddy still has a few tricks up his sleeve!

SMALLER PRODUCTION VOLUME DOESN'T RULE OUT IMPORTANCE

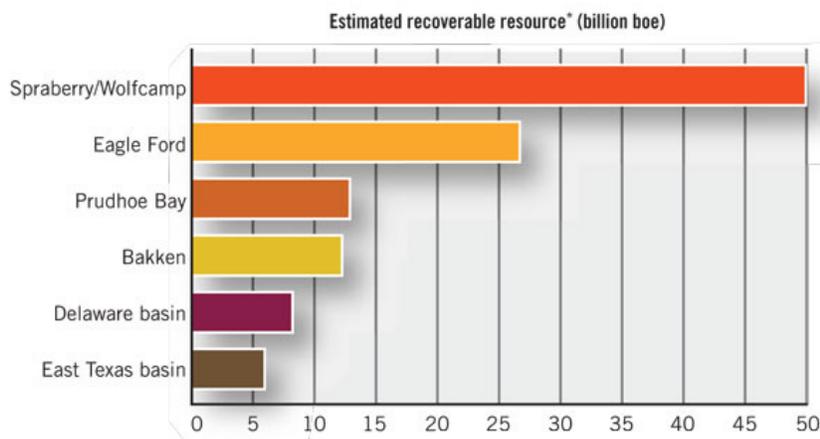
Of course, the domestic shale revolution isn't limited solely to the huge plays in the media spotlight. There are many more very important shale plays that, while not as prolific as the major plays detailed above, still play a very important role in the nation's quest for energy independence.

Fayetteville: With an estimated 38 trillion cubic feet of technically recoverable gas reserves, this northern Arkansas formation is one of the most productive shale gas basins in the country.¹³⁰ Despite declining production in recent years, the formation still holds a lot of gas.¹³¹ A 2014 study from the Bureau of Economic Geology (BEG) at The University of Texas at Austin predicts that the Fayetteville will continue to be a key contributor to US natural gas supplies for many years to come.¹³² The forecast calls for a total of 18 trillion cubic feet of economically recoverable reserves by 2050.¹³³

Utica: Spanning parts of Ohio, Pennsylvania, New York, West Virginia, and Quebec, the Utica is located underneath the Marcellus. The Utica's potential, for the moment, is mostly speculation: Its great depth and inconsistent composition give geologists reason to expect many dead zones, and some drillers question if it will be economically feasible to extract the formation's vast resources.¹³⁴ But early predictions have caught the attention of developers, who see tremendous potential in estimates that the Utica could contain as much as 940 million barrels of oil and 38 trillion cubic feet of natural gas.¹³⁵

Woodford: The gigantic formation underlying much of Oklahoma has catapulted the state into prominence as a key player in the shale revolution. In fact, production in Oklahoma is growing faster than in any other state besides Texas and North Dakota.¹³⁶ This diverse play holds a lot of potential: With estimates that the Woodford could contain as much as 4 trillion cubic feet of gas and 400 million barrels of recoverable oil, numerous oil and gas companies have filed in to try to strike it big.¹³⁷ One developer called the Woodford "one of the thickest, best quality resource shale reservoirs in the country."¹³⁸ Because the formation is so widespread, its characteristics change significantly based on location. The western portion, for example, tends to be gas-rich, while the eastern area is much more oil-rich and condensate-rich.

LARGEST US OIL FIELDS



*Cumulative production and estimated recoverable reserves.

Source: Pioneer Natural Resources Co.

MERGING PLAYS SHOW PROMISE

The oil and gas landscape seems to change almost by the day. While the major shale plays will likely continue to hold their place atop the production charts, budding plays are also capturing the attention of the industry.

Wolfcamp: As emerging shale plays go, the Wolfcamp could be the Permian Basin's shining star. With some industry experts saying it could become "the largest oil and gas discovery in the world," the buzz surrounding this hot play is deafening. Based on estimated recoverable resources, the Wolfcamp is the largest onshore play in the US and second in the world to only Saudi Arabia's Ghawar Field.¹³⁹

While developers have known about the Wolfcamp since the early 1920s, it had always been nonproductive shale that simply didn't allow for commercially viable drilling. Of course, that was before the advancement of horizontal drilling and fracking technologies made tapping the Wolfcamp's vast resources a real possibility. As operators continue to explore and develop the Wolfcamp, it will become clearer if this play will become the largest the country has ever seen.

Source: www.ogj.com/articles/uogr/print/volume-1/issue-3/urtec-wolfcamp/wolfcamp-shale-graduates-to-world-class-play.html

Buda: While the Eagle Ford is the most successful South Texas shale formation, other important rock layers that are producing oil or gas sit adjacent to it. One such promising formation is the Buda Limestone, which lies below the Eagle Ford. Developers have long known of the formation, but it wasn't until a "sweet spot" was recently discovered that the play piqued serious interest.

The Buda's sweet spot, found in northern Dimmit and southern Zavala Counties, has started producing surprisingly economical results for three different oil companies. In fact, the wells located in the Buda hot spot could have better drilling economics than Eagle Ford wells. An average Eagle Ford well costs between \$7 million to \$8 million to produce results. A Buda well, on the other hand, costs under \$4 million. The reason? It doesn't have to be fracked because the limestone formation is naturally fractured.¹⁴⁰ It's these simple economics that have developers excited about the Buda's remarkable potential.

Tuscaloosa: So far, not a lot of people have heard of the Tuscaloosa Marine Shale, but that doesn't diminish the potential of this emerging play. Extending from central Louisiana into southwestern Mississippi, this 6.6 million-acre shale play is said to hold upwards of 7 billion barrels of oil in place deep beneath the surface (estimated depth ranges from 10,000 feet to 15,000 feet).

The formation's soft rock, clay-like materials and incredible depth (about two times deeper than the Eagle Ford) initially scared off many drillers. But some stalwarts active in the Tuscaloosa have started to see promising results through the use of sand, clay stabilizers, and proppant.¹⁴¹ As operators continue to find ways to reduce drilling costs in the region while recovering decent resources, there is hope that the Tuscaloosa Marine could become an important play. DrillingInfo CEO Allen Gilmer recently said the play looks like "the real deal."¹⁴²

A BRIGHT FUTURE IN AN EVER-CHANGING LANDSCAPE

The shale revolution is still young. As it continues to progress, it's a safe bet that the landscape of major shale plays will continue to change with time.

Our journey toward energy self-sufficiency is underway. We have already shocked the world with the massive amounts of oil and gas we've been able to produce in just a short time. Regardless of the changes, the foreseeable future is bright for US shale plays. While unconventional gas plays accounted for 42% of total US gas production in 2007, experts project it will account for nearly 65% in 2020.¹⁴³ Domestic oil production is likewise expected to continue increasing, hitting 11.6 million barrels per day in 2020, compared to 9.2 million per day in 2012.¹⁴⁴

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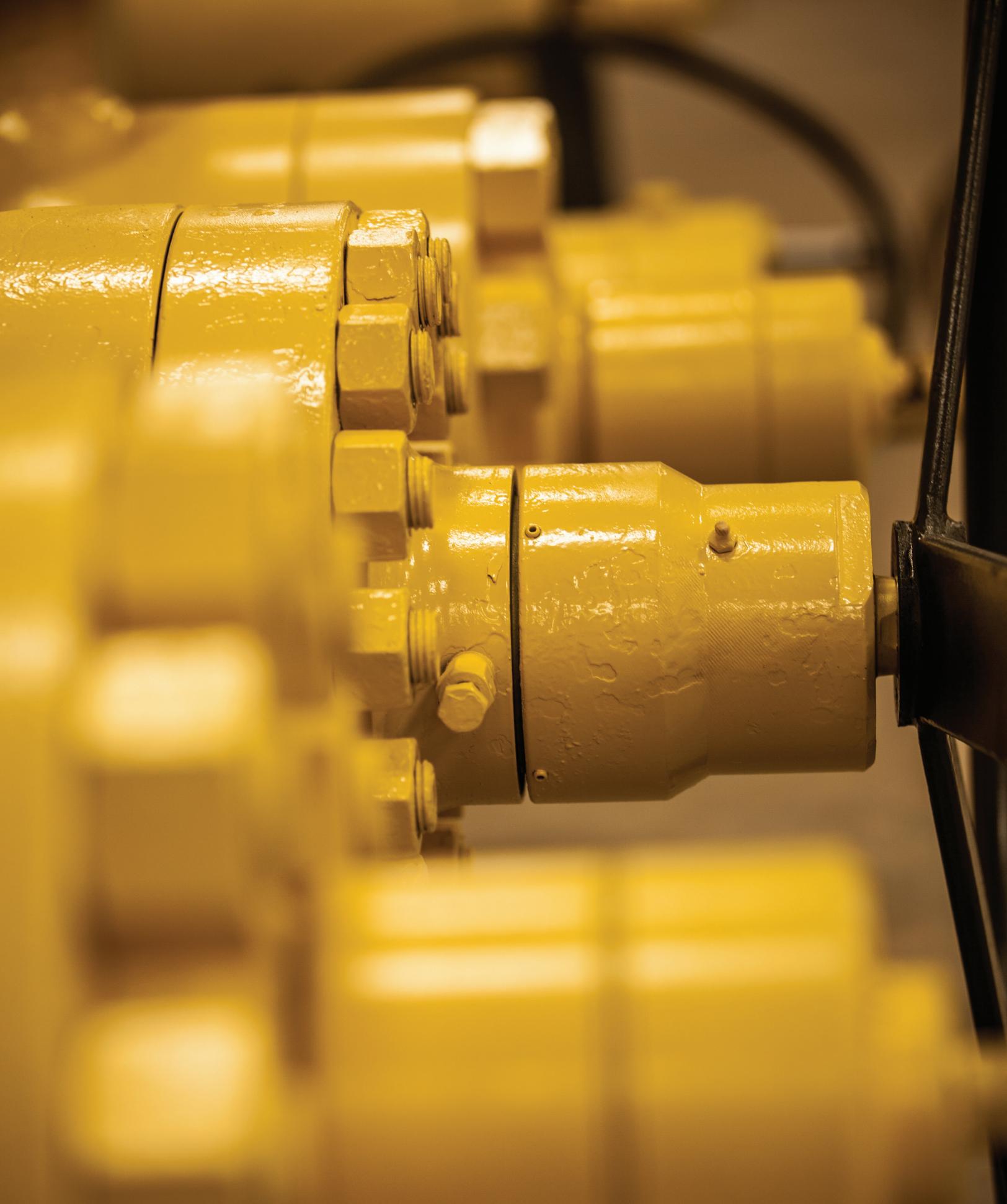
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