ECONOMIC CONSIDERATIONS AND A LOOK AT KEY SHALE PLAYS

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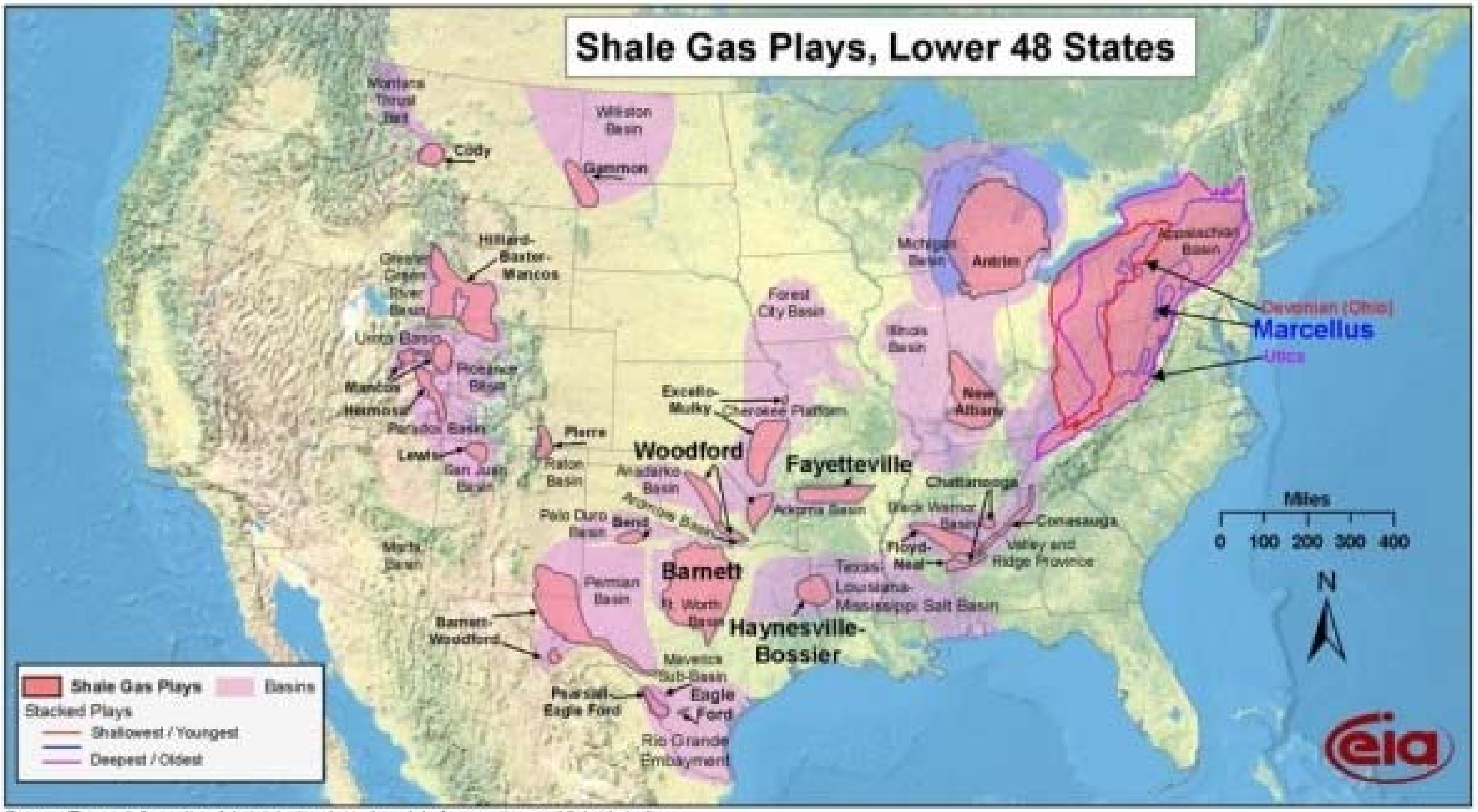
INTRODUCTION

Technically recoverable shale oil resources, is 23.9 billion barrels in the onshore Lower 48 States.

The largest shale oil formation is the Monterey/Santos play in southern California, which is estimated to hold 15.4 billion barrels or 64 percent of the total shale oil resources.

INTRODUCTION



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

INTRODUCTION

The Monterey shale play is the primary source rock for the conventional oil reservoirs found in the Santa Maria and San Joaquin Basins in southern California.

The next largest shale oil plays are the Bakken and Eagle Ford, which are assessed to hold approximately 3.6 billion barrels and 3.4 billion barrels of oil, respectively." (INTEK shale report).

INTRODUCTION

The Energy Information Agency expects U.S. oil demand to continue falling, natural gas production to keep rising, and North America to likely transition to a net energy exporter by 2025.

INTRODUCTION

Beyond Keystone XL, oil and gas industry analysts and leaders have been predicting new pipelines will be constructed and old ones will be adapted to meet today's supply and demand picture.

The current labyrinth of North American pipelines was built decades before the current drilling boom, with much of the grid flowing to the north and east.

INTRODUCTION

Oil drilling in North Dakota, natural gas production in the Northeast and the zeal for natural gas liquids on the Gulf Coast have dramatically changed the dynamic.

Shipments of crude from the Gulf to the Midwest dropped 500,000 barrels per day from 2008 to 2013, while shipments in the opposite direction, from the Midwest to the Gulf, jumped by 33,000 barrels per day."

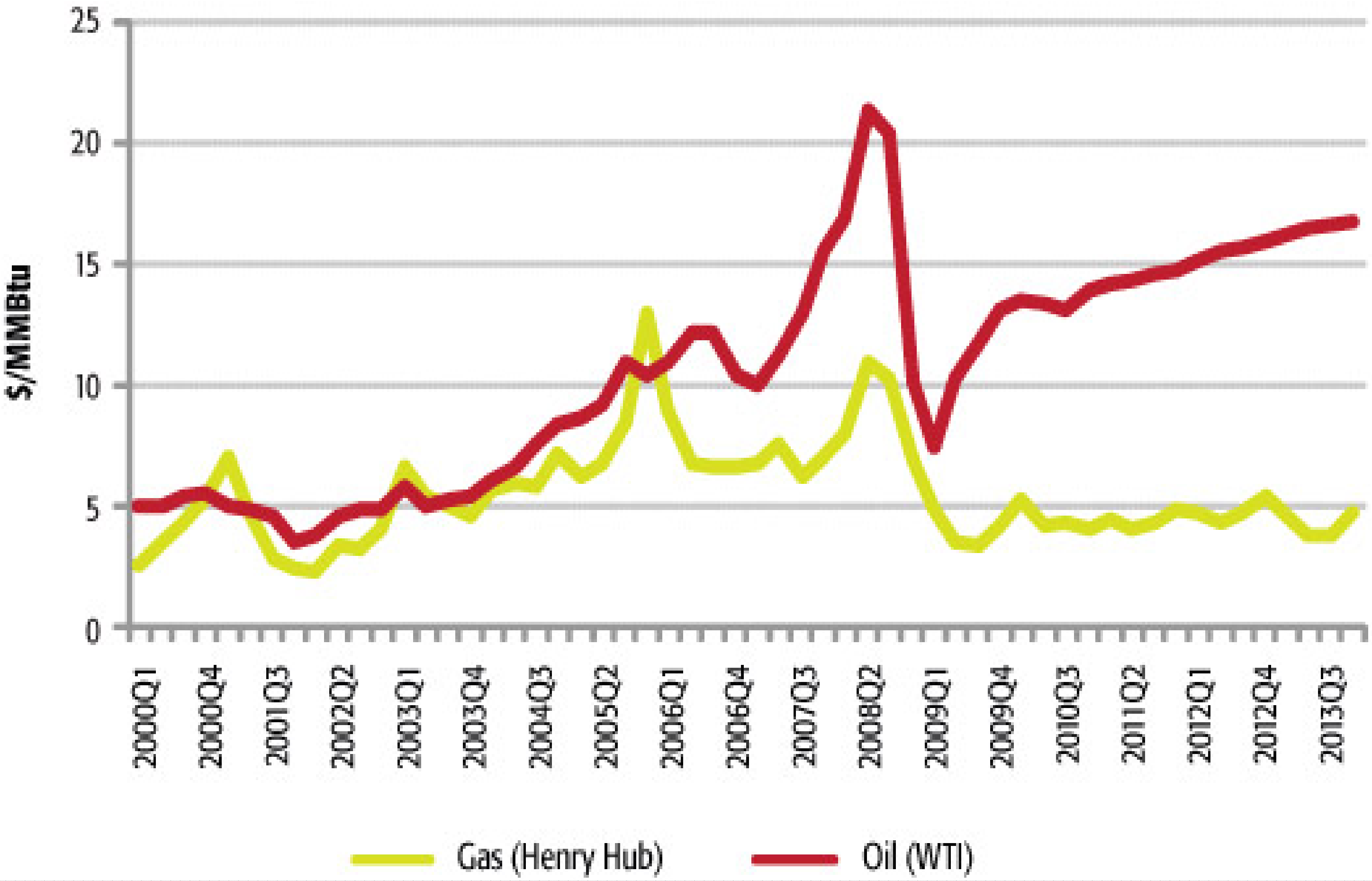
INTRODUCTION

Historically, there was a correlation between natural gas and oil prices.

Since early 2009, prices have moved independently, on paths that diverge.

Many believe that this disconnect between oil and gas prices has significant implications.

INTRODUCTION



INTRODUCTION

A surge in U.S. oil production has in just a few short years propelled the United States from a country largely dependent on oil imports to one that soon could become the world's top oil producer.

INTRODUCTION

In the past five years we have seen the amount of crude oil produced in the United States shoot up 40 percent, after declining every year for the previous 20.

INTRODUCTION

The International Energy Agency predicts the United States will overtake Saudi Arabia as the world's top oil producer by the year 2015. America already has become the largest producer of natural gas.

In October the United States started producing more oil than it imports for the first time since 1995.

INTRODUCTION

Questions remain about how quickly the U.S. fields will decline and whether the boom can last.

Much of the increase has been due to increased technology, e.g. horizontal drilling and fracking with all their difficulties.

INTRODUCTION

Benefits include resurgence in American manufacturing and a reshaping of U.S. relationships around the world, where America's thirst for oil has long been blamed for interventionist policies in the Middle East and elsewhere.

INTRODUCTION

For the first time since 1949, the U.S. sends more of its refined petroleum products such as diesel, heating fuel and gasoline to other nations than it is bringing in.

INTRODUCTION

The energy revolution has been a boon to American manufacturing.

Natural gas prices in the U.S. are at near record lows, far cheaper than in Europe and Asia.

INTRODUCTION

Natural gas is used for manufacturing and electrical generation, and the cheap price is convincing utilities to switch to it from the more polluting coal.

The German industrial trade group BDI warned last year that America's cheap natural gas could put European firms at a serious economic disadvantage.

INTRODUCTION

"This is now issue No. 1 for German industry, this fear of loss of competiveness against the United States," said Pulitzer Prize-winning oil historian, author and analyst Daniel Yergin.

INTRODUCTION

Other countries have their own worries. Saudi Arabian Prince Alwaleed bin Talal wrote an open letter in July to his country's oil minister, saying that the Saudi economy is vulnerable to the threat of surging U.S. oil.

The Organization of Petroleum Exporting Countries, which includes Saudi Arabia, is bracing itself for a drop in U.S. demand. In September, China overtook the U.S. as the world's largest importer of oil.

INTRODUCTION

The United States isn’t the only country with oil and natural gas locked in shale rock, but it’s the only country currently in a position to take advantage of it, analysts say.

INTRODUCTION

In Europe, the environmental opposition to fracturing is deeply held and widespread. Elsewhere, most countries simply don't have the technology or the infrastructure to exploit deposits that require fracturing.

INTRODUCTION

America is even helped by its property laws, which allow most landowners to hold onto subsoil mineral rights, giving hopes of cashing in, unlike in many countries where oil and gas activity just means problems without any hope of economic reward.

INTRODUCTION

Drilling and fracturing are expensive, and shale wells tend to decline quickly, so new drilling is constant, according to a Harvard University study..”

INTRODUCTION

Only the United States, with 60 percent of the world's supply of drilling rigs, most of which can do the horizontal drilling fracturing requires, has the wherewithal to maintain the pace.

The Harvard study noted, the U.S. completed 45,468 oil and gas wells last year; the rest of the world outside of Canada completed just 3,921.

INTRODUCTION

"We are the only country in the world where individuals own the property rights down to the center of the Earth on land they sit on," said Joseph Stanislaw, who helped found the consultancy Cambridge Energy Research Associates.

"It's an economic advantage that doesn't exist anywhere else."

TEXAS

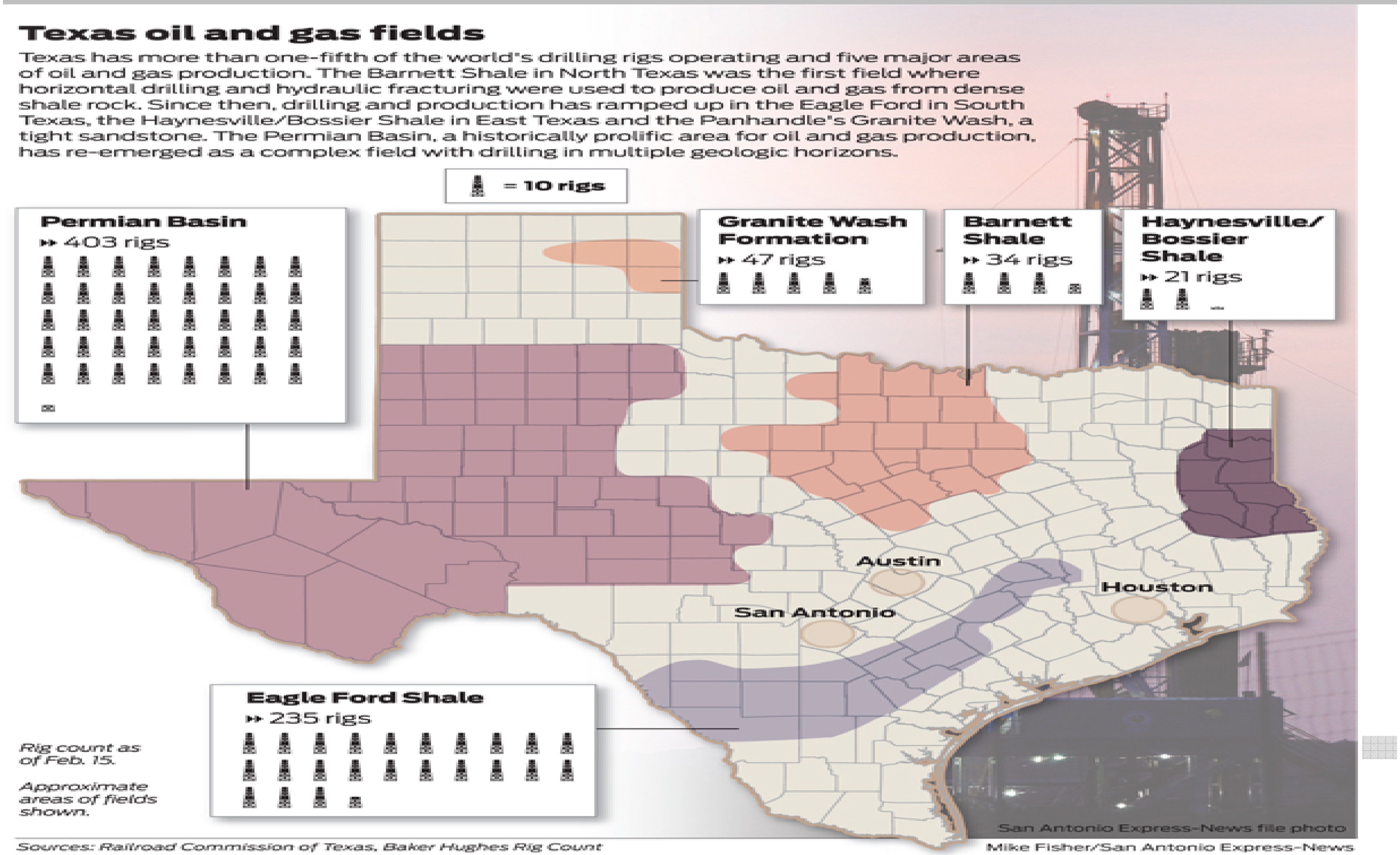
But the state appears awash again in oil and gas, with drilling in fields across the state, including one West Texas shale formation that could dwarf both the Eagle Ford Shale in South Texas and North Dakota's famous Bakken Shale.

Texas recently had 839 drilling rigs operating — nearly half of all rigs in the U.S. and 22.7 percent of rigs worldwide, according to the Feb. 15 Baker Hughes Rig Count.

TEXAS

Most of those rigs were working in five regions of the state: the Permian Basin in West Texas, the Eagle Ford Shale in South Texas, the Granite Wash in the Panhandle, the Barnett Shale in North Texas and the Haynesville Shale in East Texas.

TEXAS



Texas oil and gas fields
Texas has more than one-fifth of the world's drilling rigs operating and five major areas of oil and gas production. The Barnett Shale in North Texas was the first field where horizontal drilling and hydraulic fracturing were used to produce oil and gas from dense shale rock. Since then, drilling and production has ramped up in the Eagle Ford in South Texas, the Haynesville/Bossier Shale in East Texas and the Panhandle's Granite Wash, a tight sandstone. The Permian Basin, a historically prolific area for oil and gas production, has re-emerged as a complex field with drilling in multiple geologic horizons.
= 10 rigs
Permian Basin
403 rigs
Granite Wash Formation
47 rigs
Barnett Shale
34 rigs
Haynesville/ Bossier Shale
21 rigs
Austin
Houston
San Antonio
Eagle Ford Shale
235 rigs
Rig count as of Feb. 15.
Approximate areas of fields shown.
San Antonio Express-News file photo
Sources: Railroad Commission of Texas, Baker Hughes Rig Count
Mike Fisher/San Antonio Express-News

TEXAS

Texas has doubled its oil output since 2005. Even with the surge in output in North Dakota's Bakken region, Texas produces as much oil as the four next largest producing states combined.

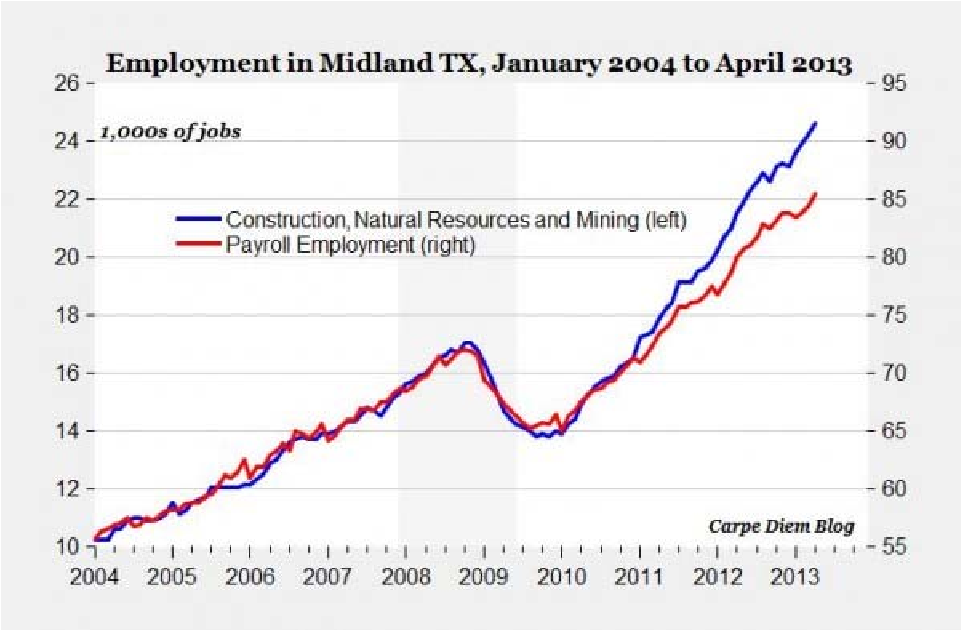
Texas now pumps nearly two million barrels a day, and Texas Railroad Commissioner Barry Smitherman (who is also oil commissioner) says "total production could double by 2016 and triple by the early 2020s." The entire U.S. now produces about seven million barrels a day.

TEXAS

The two richest fields are the Eagle Ford shale formation in South Texas, where production is up 50% in the last year alone, and the 250-square mile Permian Basin.

Midland-Odessa in the Permian is one of America's fastest-growing metro areas.

TEXAS



Employment in Midland TX, January 2004 to April 2013
1,000s of jobs
Construction, Natural Resources and Mining (left)
Payroll Employment (right)
Carpe Diem Blog
26
24
22
20
18
16
14
12
10
95
90
85
80
75
70
65
60
55
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

TEXAS

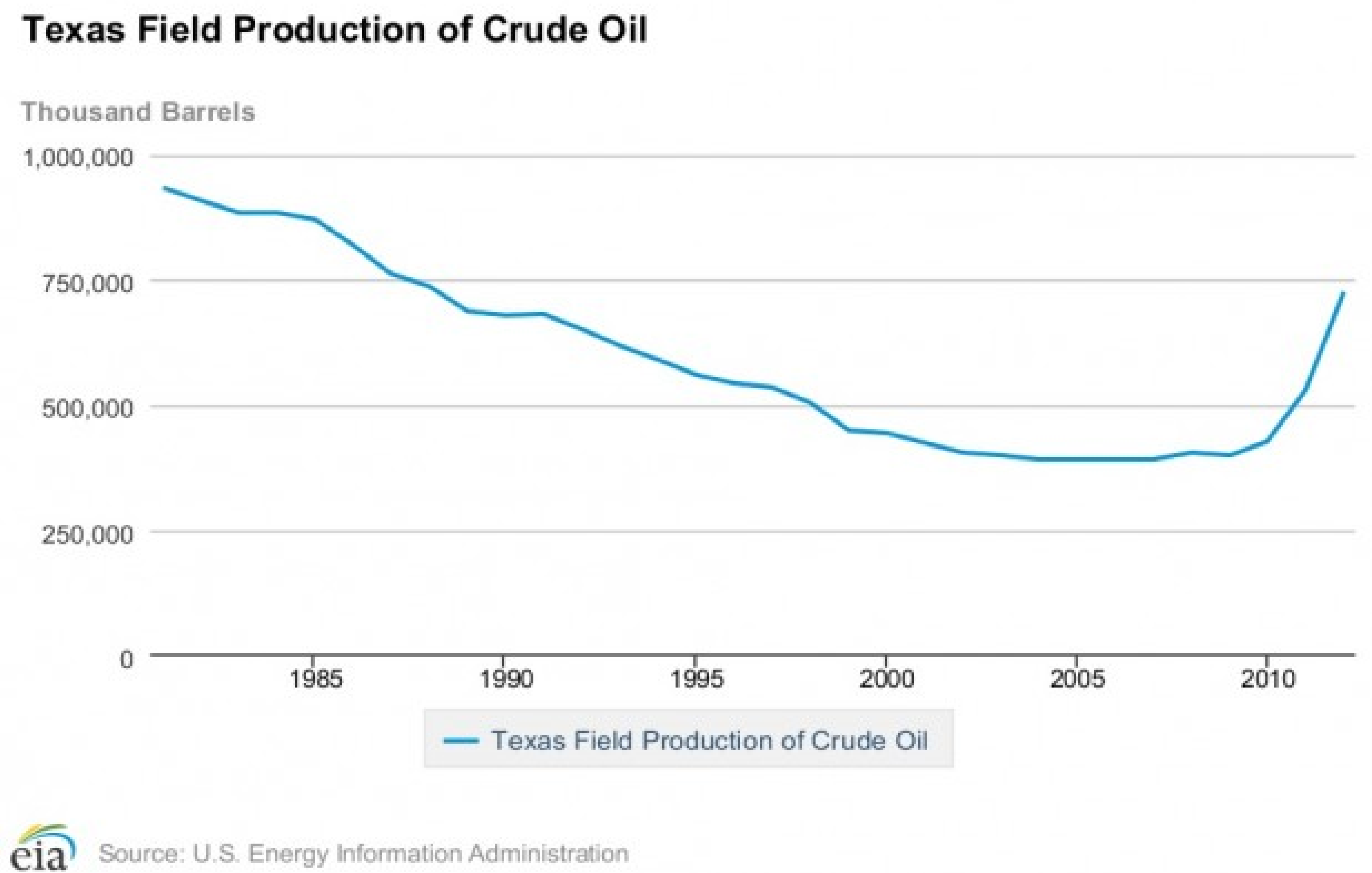
Barry Smitherman, chairman of the Railroad Commission of Texas, the state's oil and gas regulatory agency, has said that oil production in Texas could roughly double by 2020.

TEXAS

Much of Texas' production in the near future is likely to come from well-known formations like the Eagle Ford Shale of South Texas and the shales of the Permian Basin of West Texas.

Figures from the Railroad Commission show that oil production in the Eagle Ford Shale nearly tripled between 2011 and 2012.

TEXAS


Texas Field Production of Crude Oil
Thousand Barrels
1,000,000
750,000
500,000
250,000
0
1985
1990
1995
2000
2005
2010
Texas Field Production of Crude Oil
Source: U.S. Energy Information Administration

PERMIAN BASIN

What began a decade ago as a modest revival is now a full-fledged boom in the Permian basin.

The play extends across hundreds of square miles of West Texas and into New Mexico, from Mentone east to El Dorado, and it is reviving long dormant backwaters.

PERMIAN BASIN

Environmental concerns about fracking and water use could slow the pace of development, but analysts believe the technology could help the Permian Basin produce more than 2 million barrels of oil a day in the next four years, which would be a historic high.

Some of that is geology: the bulk of the Permian's hydrocarbons are oil, as opposed to less valued natural gas.

PERMIAN BASIN

The attraction lies in an unusual geological feature known as “stacked plays,” horizontal bands of oil- and gas-bearing stones laid down tens of millions of years ago when much of the U.S. Southwest was an inland sea.

PERMIAN BASIN

Peggy Williams, editorial director with Hart Energy, said the Permian Basin, with more than 400 drilling rigs operating, is the most complex field in the state, with both horizontal and vertical drilling in multiple geologic horizons.

"It's a very prolific conventional basin that produces in many, many zones," Williams said.

PERMIAN BASIN

Hart Energy estimates the Permian Basin could produce 1.65 million barrels of oil equivalent per day by 2020, just from unconventional drilling that uses hydraulic fracturing.

The company estimates South Texas' Eagle Ford Shale could produce 2.4 million barrels of oil equivalent per day by 2020

PERMIAN BASIN

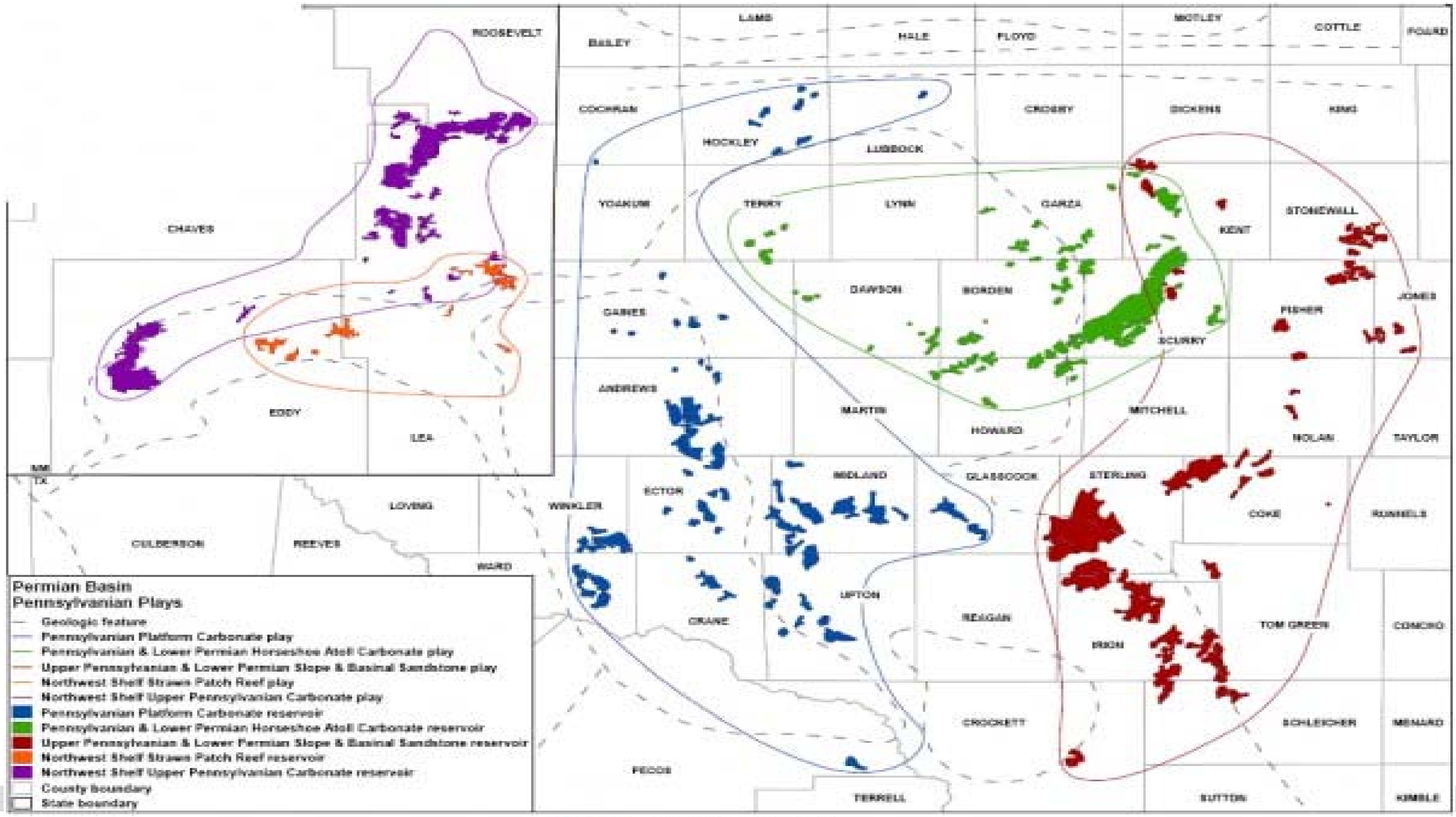
But expertise and infrastructure play a role too. There have been commercial oil wells in the Permian since 1921, and Midland, Texas, may have more expert drillers per capita than any other city on earth.

PERMIAN BASIN

The Permian Basin produced more than 270 million barrels of oil in 2010, over 280 million barrels in 2011, and 312 million in 2012. In percentages, production increased 10% in 2011 and 35% in 2012.

Texas' oil production represents about 25% of the U.S. oil production, with the Permian housing 57% of Texas' oil production, according to the Texas Railroad Commission.

PERMIAN BASIN



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PERMIAN BASIN

Pioneer Natural Resources is one of the leading advocates for the Permian Basin's future potential.

It sees the Spraberry/Wolfcamp formations of the Permian Basin representing the world's second-largest oil field. Pioneer Natural Resources believes producers can recover 50 billion barrels of oil equivalent from this part of the Permian.

PERMIAN BASIN

That is nearly twice the amount of oil and gas than can be recovered from the Eagle Ford Shale.

Pioneer Natural Resources has one of the best positions in the play at 900,000 acres, from which it believes it can draw 7 billion barrels of oil equivalent.

PERMIAN BASIN

Concho Resources has a leading pure-play position in the Permian Basin, with 630,000 net acres.

Concho recently announced that it is accelerating its growth plan and now expects to double production by 2016.

PERMIAN BASIN

While Apache isn't as focused on the Permian Basin as others on this list, it is the No. 1 driller in the play and certainly worthy of attention.

Apache has been refocusing its portfolio in order to pursue its rich North American liquids position, which is led by its massive 1.6 million net acres in the Permian Basin.

PERMIAN BASIN

Apache has more than 30,000 known locations that it can drill in the region and believes it has nearly 3.8 billion barrels of oil equivalent potential in the play.

PERMIAN BASIN

Apache has identified at least 35 potential zones in its Permian holdings, and it has tested about 20 so far, said John Polasek, exploration and new ventures manager for the Permian region.

The Houston-based company’s employee count in the Permian was estimated to surge to 896 by year-end 2013, from 345 in 2010.

PERMIAN BASIN

The Permian Basin is the top producer of crude oil and natural gas in the Texas, with twice as many rigs and permits producing about 30 percent more crude than the Eagle Ford Shale daily.

THE CLINE SHALE

The formation has the potential to make a huge impact on the Permian Basin.

It spans from Midland to Big Spring and from Lubbock down to Big Lake.

THE CLINE SHALE

Midland Energy Industry Expert Morris Burns, "This is a huge shale formation and only in the last 15 to 20 years have we been able to get oil and gas out of it.

The Wolfberry shale has increased the permian basin's production by about 25 to 30 percent in the last few years. The Cline shale has the potential to increase it by another 50 to 60 percent."

THE CLINE SHALE

About a year ago, talk began circulating in this West Texas town about a huge oil producing formation called the Cline Shale, east of the traditional drilling areas around Midland.

THE CLINE SHALE

The Cline Shale, thousands of feet underground in a roughly 10-county swath, is just one of many little-tapped shale formations in Texas and across the nation, geologists say.

That means the potential for oil and gas discoveries is theoretically huge, and the reason is technology.

THE CLINE SHALE

Within Texas, shales besides the Cline that are not household names include the Midway Shale, which is closer to the coast than the Eagle Ford in South Texas, and deeper layers beneath well-known formations in the Permian Basin.

There is also shale under Austin, geologists say.

THE CLINE SHALE

Devon Energy, an Oklahoma City-based drilling company known for pioneering work in the Barnett Shale, has opened offices in the past 18 months in San Angelo and Abilene, in addition to the planned Sweetwater location.

It has nine rigs operating in the Cline and in the nearby Wolfcamp Shale.

THE CLINE SHALE

Energy producers on average need oil prices around $96 a barrel to break even on wells drilled in Permian layers known as the Cline Shale and the Northern Mississippian Lime, according to Mike Kelly, an analyst at Global Hunter Securities LLC.

THE CLINE SHALE

That compares to average break-even prices of around $78 a barrel in the Eagle Ford Shale a few hundred miles east of the Permian, and $84 in the Bakken of North Dakota. Some areas of the Permian need a price of just $70-$74, Kelly said.

THE CLINE SHALE

West Texas has a multitude of overlapping oil fields, but the Cline Shale has created a stir. The formation runs about 140 miles north to south and about 70 miles wide through Howard, Glasscock, Reagan and Sterling counties.

THE CLINE SHALE

Early estimates for the Cline, based on Devon Energy's exploration in the area, put the estimated recoverable reserves at 30 billion barrels of oil.

By comparison, the U.S. Geological Survey estimates the Eagle Ford holds up to 7 billion to 10 billion in recoverable reserves, while the Bakken Shale could hold as much as 4.3 billion barrels of recoverable oil.

THE BARNETT SHALE

In the Fort Worth area, the Barnett Shale is the grandfather of unconventional drilling — the place where operators first used both horizontal drilling and hydraulic fracturing.

THE BARNETT SHALE

Although drilling has declined, with most of the recent business activity coming in the form of asset sales, Chris Robertson, an analyst with Wood Mackenzie, said it's still the third most productive U.S. gas field behind the Marcellus in Pennsylvania and the Haynesville in Louisiana.

THE BARNETT SHALE

The Barnett has been well studied and provides good, predictable cash flow.

As natural gas prices have started to rise a bit from historic lows, driving a slight uptick in drilling in the Barnett.

HAYNESVILLE/BOSSIER SHALE

In East Texas, there were 21 drilling rigs targeting the Haynesville/Bossier Shale as of Feb. 15, 2013.

The formation is more productive and lucrative in Louisiana, but it primarily produces natural gas, so operators are largely drilling because they must if they want to hold onto their mineral leases.

HAYNESVILLE/BOSSIER SHALE

There is one area of the field, the Cotton Valley formation in Rusk, Panola and Harrison counties, where companies have been able to produce a higher proportion of the more profitable crude oil and natural gas liquids.

THE GRANITE WASH

In the Texas Panhandle, 47 drilling rigs were recently targeting the Granite Wash, a tight sandstone that extends into Oklahoma.

The Granite Wash is primarily natural gas.

THE GRANITE WASH

Most Texas drilling is focused on finding crude oil because dry natural gas is selling near historic lows.

But the heat content of the Granite Wash gas is so great that it sells at a premium of 30 percent to 50 percent over standard prices.

EAGLEFORD SHALE

The Eagleford Shale is a shale rock formation located in multiple counties in South Texas.

The Eagle Ford Shale Formation has been one of the hottest shale plays because several companies are finding huge pools of oil & natural gas.

EAGLEFORD SHALE

Oil can be found in McMullen County, Texas while Natural Gas has been found in the Eagle Ford Shale located in La Salle County, TX.

EAGLEFORD SHALE

EAGLEFORD SHALE

The Eagle Ford Shale is located directly below the Austin Chalk Formation and is estimated in some spots to be as deep as 11,300 feet.

While the Eagle Ford Shale has mainly been tested in many counties located in South Texas, the Eagle Ford Shale extends up toward Dallas County and has an average thickness of 475 feet.

EAGLEFORD SHALE

The Eagle Ford formation was named after exposures around the small settlement of Eagle Ford, which is situated on the south side of the Trinity north of Arcadia Park

CALIFORNIA

Texas and California have been competing for years as U.S. growth models, and one of the less discussed comparisons is on energy.

California has long been one of America's big three oil producing states, along with Texas and Alaska, but last year North Dakota surpassed it. This isn't a matter of geological luck but of good and bad policy choices.

CALIFORNIA

California's oil output is down 21% since 2001, according to Energy Department data, even as the price of oil has soared and now trades in the neighborhood of $95 a barrel.

CALIFORNIA

California has huge reservoirs offshore and even more in the Monterey shale, which stretches 200 miles south and southeast from San Francisco.

The Department of Energy estimates that the Monterey shale contains about 15 billion barrels of oil, which is about double the estimated supply in the Bakken.

CALIFORNIA

Running from Los Angeles to San Francisco, California's Monterey Shale is thought to contain more oil than North Dakota’s Bakken and Texas's Eagle Ford.

CALIFORNIA

ILLUSTRATION: EMILY CARTER/CNNMONEY

CALIFORNIA

Occidental Petroleum, the big oil player in California, has recently purchased leases from the Interior Department to drill in the Monterey shale, but in April 2013 a federal judge blocked hydraulic fracturing, or "fracking," in the state.

The judge ordered an environmental review.

CALIFORNIA

California has also passed cap-and-trade legislation that adds substantially to the costs of conventional energy production and refining.

The politicians in Sacramento and their Silicon Valley financiers have made multibillion-dollar and mostly wrong bets on biofuels and other green energy. Texas has invested heavily in wind power but not at the expense of oil production.

CALIFORNIA

Another contrast is that most Texas oil is on private lands, which owners are willing to lease at a price.

In California much of the oil-rich areas are state or federally owned, and leasing doesn't happen because of political constraints.

CALIFORNIA

As a result of the San Andres fault, California's geologic layers are folded like an accordion rather than simply stacked on top of each other like they are in other Shale states.

The folds have naturally cracked the shale rock, and much of California's current "conventional" oil production -- the third largest in the nation -- is thought to come from the Monterey.

CALIFORNIA

But the folds mean recent advancements that have made shale oil and gas profitable to extract -- horizontal drilling combined with hydraulic fracturing -- don't work as well in California.

It's hard to drill horizontally if the shale is not flat.

CALIFORNIA

Occidental has had some success using a technology known as deep acid injection.

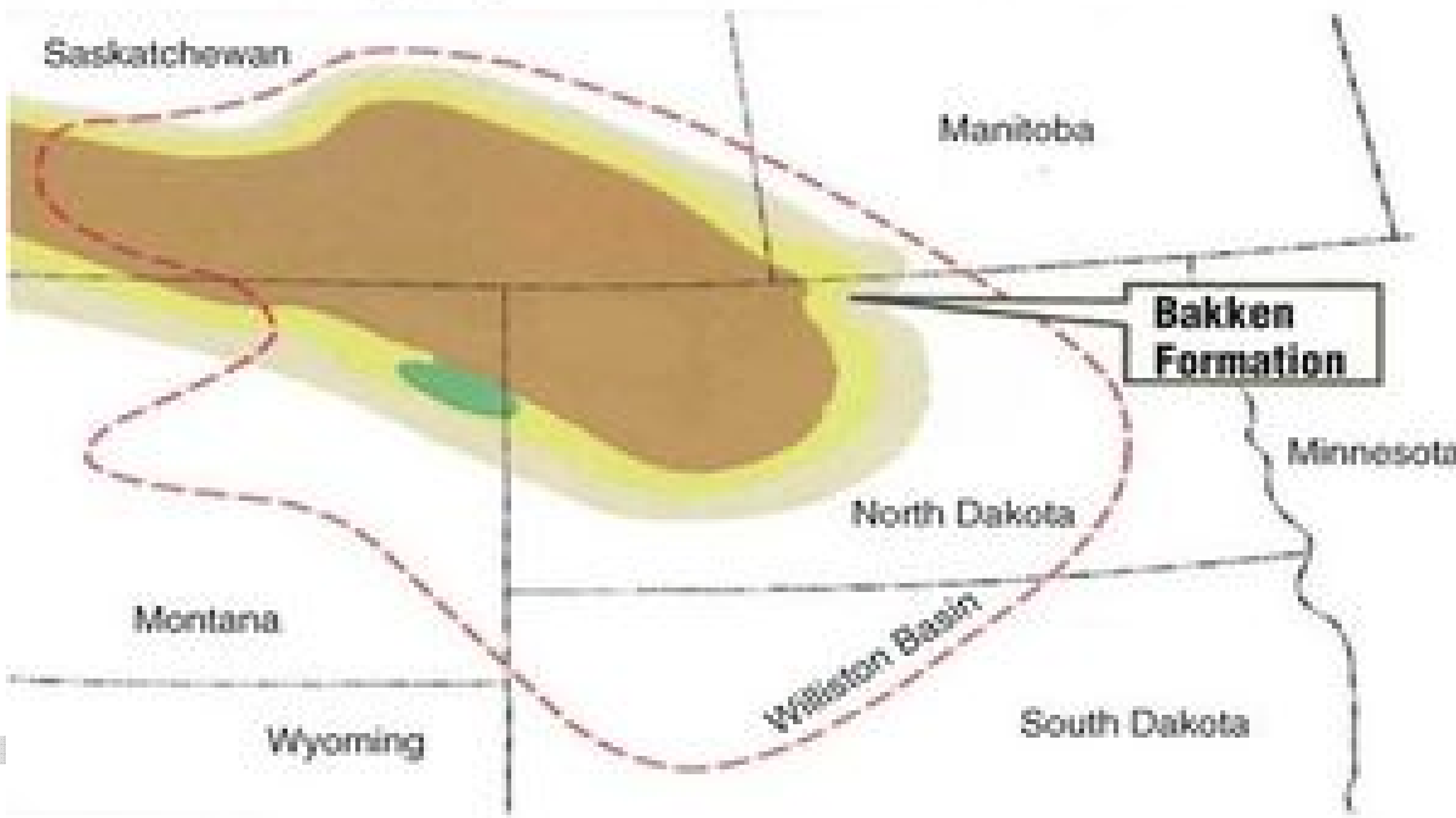
The process involves injecting hydrofluoric or other acids deep underground, where they eat away at the shale rock and allow the oil to flow. It's cheaper than fracking.

THE BAKKEN

The Bakken formation is a rock unit from the Late Devonian to Early Mississippian age occupying about 200,000 square miles (520,000 km2) of the subsurface of the Williston Basin, underlying parts of Montana, North Dakota, and Saskatchewan.

THE BAKKEN

The Bakken Formation was deposited in the more central and deeper portion of the Williston Basin.



Source: USGS

THE BAKKEN

The Bakken was discovered in the 1950's. However, it has only been through new technologies like hydraulic fracturing and horizontal drilling that we have been able to unlock the field's bounty.

Over the past five years, Bakken production has grown more than ten-fold to almost one million barrels per day, or bpd. This has catapulted North Dakota to the second largest energy producing state in the nation.

Source: United States Geologic Survey

THE BAKKEN

In May 2013 the USGS updated its oil reserves assessment, saying the Bakken play has an estimated 3.65 billion barrels of undiscovered, technically recoverable oil, and the Three Forks formation an estimated 3.73 billion barrels of undiscovered, technically recoverable oil.

For natural gas, the plays had a mean estimate of 6.7 trillion cubic feet of as-yet undiscovered natural gas and 530 million barrels of natural gas liquids.

THE BAKKEN

In November 2013, the US Energy Information Administration projected that Bakken production in North Dakota and Montana would exceed one million barrels per day in December 2013.

As a result of the Bakken, North Dakota as of 2013 is the second largest oil-producing state in the US, behind only Texas in volume of oil produced.

THE BAKKEN

The number of rigs drilling new wells in North Dakota’s part of the basin reached a record 218 last May.

It has now leveled off at around 200, as thousands of wells have been completed under deadline pressure to secure expiring mineral leases.

THE BAKKEN

And then around seven years ago — driven by technological refinements that have made North Dakota a premier laboratory for coaxing oil from stingy rocks — the state's Bakken boom began in Mountrail County.

THE BAKKEN

At the time, North Dakota was ranked ninth among U.S. oil-producing states. By 2010 it had climbed to fourth.

In July 2012, monthly oil output reached 20.97 million barrels, and North Dakota was the largest oil producer in the country after Texas.

THE BAKKEN

North Dakota's oil boom now accounts for 11 percent of U.S. oil production, and it is the main reason the state government currently has a $3.8 billion surplus.

THE BAKKEN

Of the 20 oil-producing geological formations in the Williston Basin — including some like the Madison that have yielded large volumes of oil for decades — the Bakken Formation now accounts for 91 percent of North Dakota’s oil production.

THE BAKKEN

The formation, named for Henry O. Bakken, a farmer who leased his land for an early well, consists of three layers, sandwiched, in a commonly used analogy, like an Oreo cookie.

THE BAKKEN

The Middle Bakken layer, a band of grayish dolomitic sandstone and siltstone from 30 to 70 feet thick, sits between the Upper and Lower Bakken intervals, carbon-rich beds of black shale between 20 and 50 feet thick.

THE BAKKEN

Significant amounts of Bakken oil were produced from conventional vertical wells beginning in 1961, but for many years the formation was considered problematic: you had to be lucky or skillful enough to find an area of the shale that was naturally fractured.

Generally the formation was too thin to provide a worthwhile pay zone for a vertical well.

THE BAKKEN

What made people rethink the viability of the Bakken was horizontal drilling. The first horizontal well in the Bakken was spudded by Meridian Oil in 1987, long before the current boom.

Meridian engineers went down more than 10,000 feet and then burrowed sideways into a bed of Upper Bakken shale that was only eight feet thick.

THE BAKKEN

The Bakken today contains some of the longest horizontal wells in the world, “laterals” that extend as far as three miles from the drill pad to otherwise unreachable oil under Lake Sakakawea or beneath the Williston airport.

THE BAKKEN

The current recovery rates for Bakken reserves typically range from 1 to 6 percent, but recovery rates are a function of both technology and market prices.

“With the best technology, we can recover 4 to 8 out of every 100 barrels of oil in the Bakken,” says Ron Ness, president of the North Dakota Petroleum Council. “

Every 1 percent increase in the rate of recovery means another billion barrels.”

THE BAKKEN

Production from a typical Bakken well declines rapidly but on average produces modest amounts of oil for 45 years and earns a profit of $20 million.

But as the volume of oil in the Bakken shale is still a moving target, and recovery techniques are increasingly sophisticated, some estimates put the life of the Bakken play, and the attendant upheaval it is causing in North Dakota, at upward of a hundred years.

THE BAKKEN

Shale fields like the Bakken are the steep well decline rates.

Over its 45-year lifespan, the typical Bakken well will produce 665,000 barrels of oil.

Almost all of that output occurs during the first year after the well has been drilled.

As this chart from Kodiak Oil & Gas shows, production from the average Bakken well falls over 90% less than four years after its drilled.

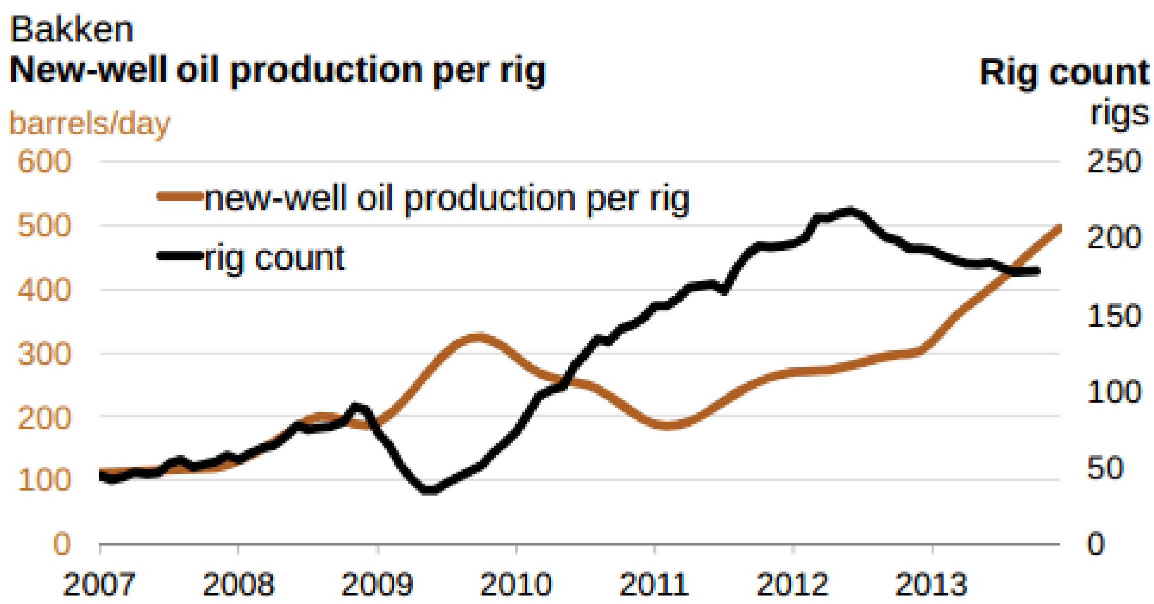
THE BAKKEN

This is actually a good thing from an investor's perspective. That's because cash flows generated sooner have a greater net present value than cash flows generated later in a well's life.

That's why Bakken wells have such high internal rates of returns and short payback periods.

THE BAKKEN

While production is growing, the number of wells operating in the region is actually declining.



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THE BAKKEN

This can be mostly credited to the shift to pad drilling.

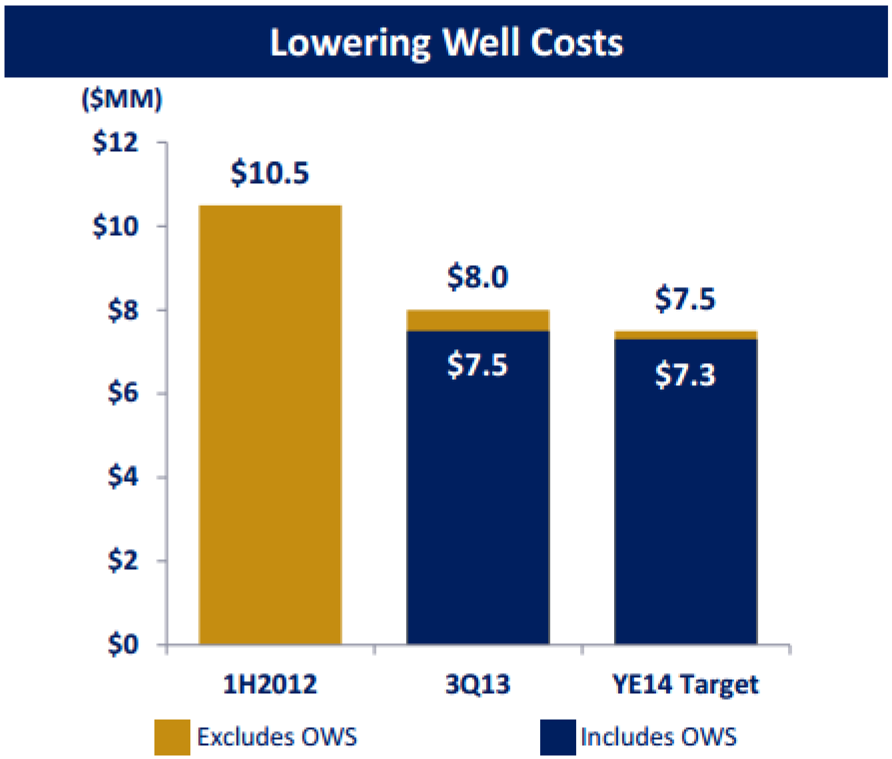
This new technique allows operators to drill multiple wells from a single site, or pad, greatly employing efficiency and reducing surface disturbance.

THE BAKKEN

Pad drilling, in combination with the falling cost of hydraulic fracturing services and other operation efficiencies, has significantly reduced the cost of doing business in the Bakken.

Oasis Petroleum, one of the leading operators in the region, has seen its average well completion costs fall 25% to $8 million per well over the past two years.

THE BAKKEN



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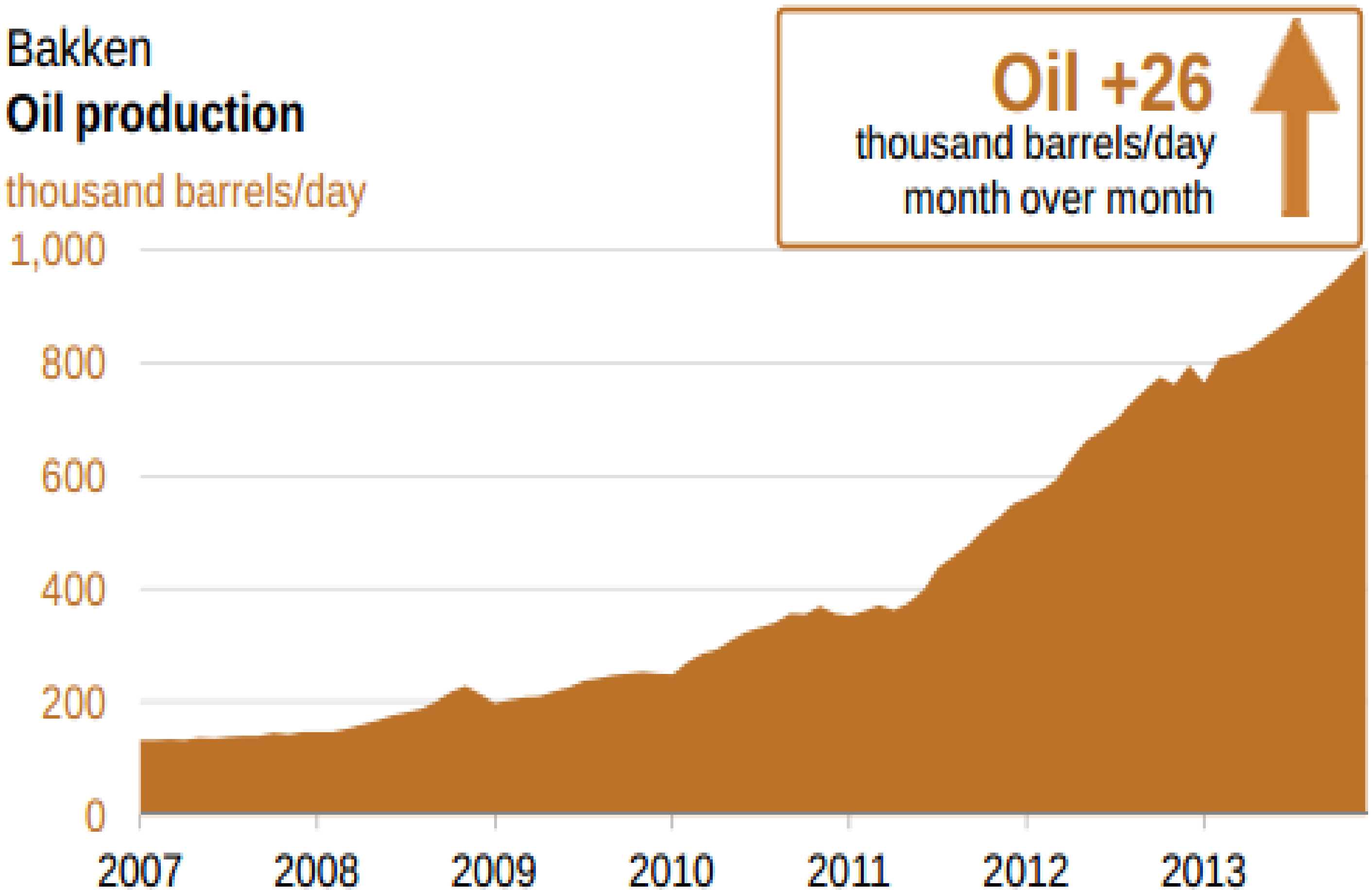
THE BAKKEN



Bakken
Oil production
thousand barrels/day
Oil +26
thousand barrels/day
month over month
1,000
800
600
400
200
0
2007
2008
2009
2010
2011
2012
2013

THE BAKKEN

North Dakota's energy infrastructure has struggled to keep up with surging production.

Due to transportation constraints, Bakken oil trades at a discount to other crude benchmarks.

THE BAKKEN

Enbridge, one of the largest shippers in the area, is rushing to catch up.

Earlier this year the company announced plans to nearly double its Bakken capacity over the next two years to 725,000 bpd.

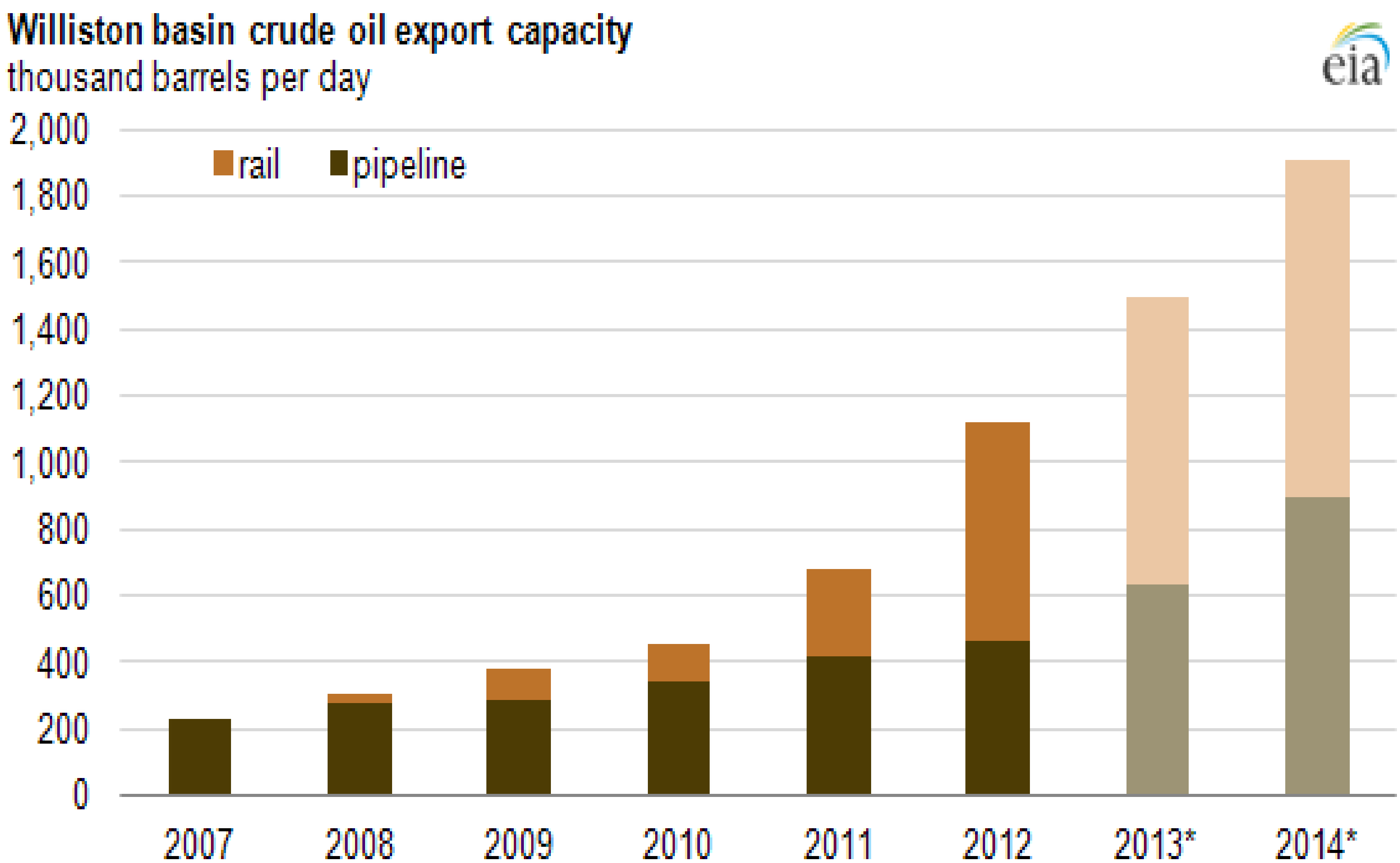
THE BAKKEN

Pipelines continue to lose market share.

Three years ago, over three quarters of Williston crude was shipped by pipeline.

Today, rail now accounts for almost 70% of Bakken shipments.

THE BAKKEN



Williston basin crude oil export capacity
thousand barrels per day
eia
rail
pipeline
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
2007
2008
2009
2010
2011
2012
2013*
2014*

THE BAKKEN

Crude-by-rail has become an increasingly important marketing option for Bakken operators.

EOG Resources, for example, now ships nearly all of its Bakken production via rail.

The move has allowed the company to take advantage of price differences across the United States.

THE NIOBRARA SHALE

The Niobrara shale formation extends across northeastern Colorado, northwestern Kansas, southwestern Nebraska and southeastern Wyoming.

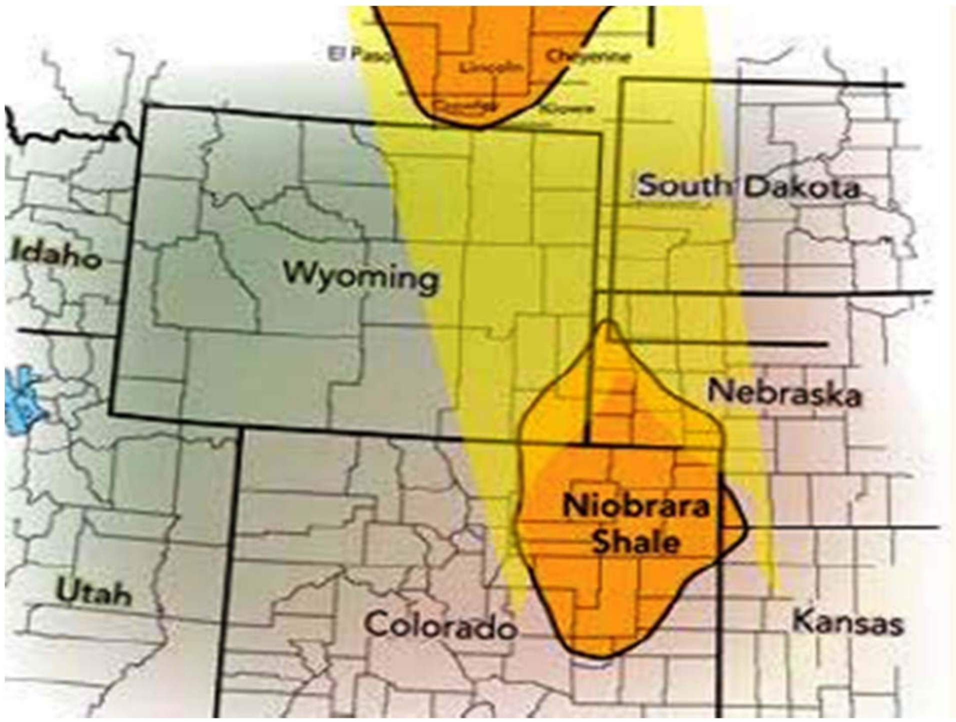
Most of the Niobrara can be found in Colorado, Wyoming, and western Nebraska.

Portions of it extend as far south as the Raton Basin of northern New Mexico and as far north as north-central Montana.

THE NIOBRARA SHALE

The play ranges in thickness from 275-400 feet deep, with three primary carbonate-rich benches that average 10-25 feet thick with 5-10% porosity

THE NIOBRARA SHALE



THE NIOBRARA SHALE

Many plays are strong in one particular area: gas, oil or natural gas liquids.

The Niobrara has all three, sitting in a traditionally strong gas field.

THE NIOBRARA SHALE

The Niobrara formation, sometimes called the Niobrara Chalk, has emerged as the second-hottest liquids-rich play in the Rockies after the Bakken shale.

THE NIOBRARA SHALE

Although the Niobrara is **not a shale play**, operators are using similar techniques (horizontal drilling, multi-stage hydraulic fracturing, etc.) as are used in shale resources to optimize production in the formation.

THE NIOBRARA SHALE

Most of the Niobrara's O&G development focuses on the Denver-Julesburg Basin ("DJ Basin"), with hot spots in the Wattenberg field of Weld County, Colorado, and (to a much lesser degree) Wyoming's Silo field.

THE NIOBRARA SHALE

Houston-based Noble Energy Corp. got in early and is the largest producer.

Niobrara operators face unique challenges in this formation, but remain hopeful because of new estimates on overall production expectations over the next few years.

THE NIOBRARA SHALE

Niobrara's geological characteristics can impede effective, economical drilling.

The formation transitions from limestone to chalk to calcareous shale to sandstone, each with differing depth and thickness.

Navigating drills in the thin layers is difficult, and high clay content of the formation makes it less permeable than other areas and complicates extraction.

THE NIOBRARA SHALE

The variable natural fracturing occurrence that results from the geological variety also impacts successful drilling.

Operators seek sections that experience high natural fracture density, which are likely more productive and easier to tap, versus reservoirs with lower fracture density that yields higher water cuts and lower productivity.

THE NIOBRARA SHALE

Early interest has yielded select highly explored drilling areas; however operators face challenges finding suitable locations for new horizontal wells that won’t interfere with existing vertical wellbores.

THE NIOBRARA SHALE

Water has proved an additional impediment in the Niobrara, from industry and environmental standpoints. The hydraulic fracturing process that revolutionized shale drilling requires high volumes of water.

Summer 2012's severe drought and rampant wildfires in Colorado rendered water scarce and forced O&G operators to spend more on securing access to water from the Colorado River.

THE NIOBRARA SHALE

Estimates show that almost 2 billion barrels of oil equivalent have been produced from the Wattenberg field alone.

EOG Resources' "Jake 2-01h" drilled its first well in 2009 in northern Colorado, producing 50,000 barrels of crude oil in the first 90 days and maintaining outputs of 50,000 barrels per month.

THE NIOBRARA SHALE

Noble Energy's "Gemini" entered Weld County in 2010 and produced 1,100 barrels per day at its peak.

New estimates now say that the play is a third bigger than first thought, capable of producing as much as 3.6 billion barrels of oil over the next several years.

THE NIOBRARA SHALE

The main barrier to entry for new producers is acreage acquisition, which, to some extent, can be surmounted by acquisitions and joint ventures.

Once entry barriers are overcome, the outlook for economic feasibility should be positive.

THE NIOBRARA SHALE

In the Piceance Basin, natural gas is the dominant resource exploited, whereas exploration and production activities are focused more on liquids and oil in the Greater Green River Basin, and even more so in the D-J Basin.

THE NIOBRARA SHALE

During the past three decades, hundreds of vertical wells have been drilled in these old basins and even through the Niobrara formation, which spans depths from 4,000 to a little over 10,000 feet.

Two key factors have helped make the play a household name in the industry: technology and economics.

THE NIOBRARA SHALE

A combination of horizontal drilling and enhanced stimulation techniques (multistage fracking) at affordable costs and oil prices relative to natural gas prices (20-to-1) have created an inadvertent shift and renewed focus on shale-oil development.

THE NIOBRARA SHALE

The Niobrara shale play is no longer associated with natural gas, but rather is perceived as an oil play.

THE NIOBRARA SHALE

Corporate strategic shifts to focus on oil in the Niobrara by companies that have historically exploited natural gas are due to the disappointing outlook for natural gas prices; and confidence that oil prices will stay above minimum levels for individual project-finance viability, providing an overwhelmingly better return than natural gas.

THE NIOBRARA SHALE

Substantial gathering and processing infrastructure is in place to accommodate additional gas volumes from the area, as is take-away capacity from the basin.

Gas produced from the Niobrara and Mancos shales can be processed without modification to existing gas treatment facilities.

THE NIOBRARA SHALE

Drilling costs vary throughout the play, according to the depth drilled and the number of frac stages required for an optimal initial production (IP) rate.

For example, the Niobrara's formation depth within Wattenberg Field of the D-J Basin is about 7,000 feet, whereas it can measure as deep as 12,000 feet in Silo Field.

THE NIOBRARA SHALE

This non-uniformity also affects well economics, due to the varying liquids-gas production mix.

The play gets oilier and less gassy as one transitions from Wattenberg Field to Silo Field.

THE NIOBRARA SHALE

Compared to other shale plays, such as the Haynesville and Eagle Ford, where overall well costs can be on the order of $7 million and $5.5 million, respectively, horizontal well expenditures in the Niobrara are much more economical at roughly $3.5 million, depending on the extent of completion services contracted. Vertical wells in the area cost about 75% less.

THE NIOBRARA SHALE

Reported IP rates for horizontal wells have been impressive, although results have varied widely.

The highest rate reported was from EOG Resources Inc.'s famed Jake 2-01H, which flowed a maximum unrestricted rate of 1,558 barrels of oil per day.

THE NIOBRARA SHALE

On average, wells are expected to average around 800 barrels daily in the D-J Basin. Estimated ultimate recoveries (EURs) for horizontal wells are anticipated to be in the range of 300,000 to 400,000 barrels equivalent, depending on field characteristics, with less gas production than traditional vertical wells.

THE NIOBRARA SHALE

Wattenberg Field vertical wells typically have an ultimate recovery of 40,000 barrels, with about 60% natural gas.

Despite steeper declines the tenfold increase in production from horizontal drilling proves the efficacy of revolutionary stimulation techniques and more than justifies the extra capital outlay.

THE NIOBRARA SHALE

Recovery results are based on 320-acre spacing. Existing vertical wells within the play will affect future down-spacing and could further influence horizontal decline rates.

THE NIOBRARA SHALE

Although the horizontal-well IP rates are far superior to those of vertical wells, it is not yet fully understood how fast they will decline.

While most predict a gentle slope, others are a little less optimistic.

THE NIOBRARA SHALE

Carrizo Oil & Gas Inc. anticipates an IP rate of 600 barrels of oil per day with a gradual decline to about 80 barrels per day in 24 months.

Rex Energy Corp.'s Silo Field type curve has an IP rate of 400 barrels per day with a 24-month decline to around 80 barrels.

THE NIOBRARA SHALE

The Wattenberg is an oil- and gas-rich field that blankets the southern part of Weld County up north to Greeley. Within that field, the Niobrara shale, 7,000 feet below, is at its most productive so far.

It's been questionable on the outskirts, but emerging technologies are only getting better at extracting the hydrocarbons that 10 years ago seemed impossible to extract.

THE NIOBRARA SHALE

A Credit Suisse report in January put the Niobrara at No. 3 among the top plays with a 49 percent return on investment.

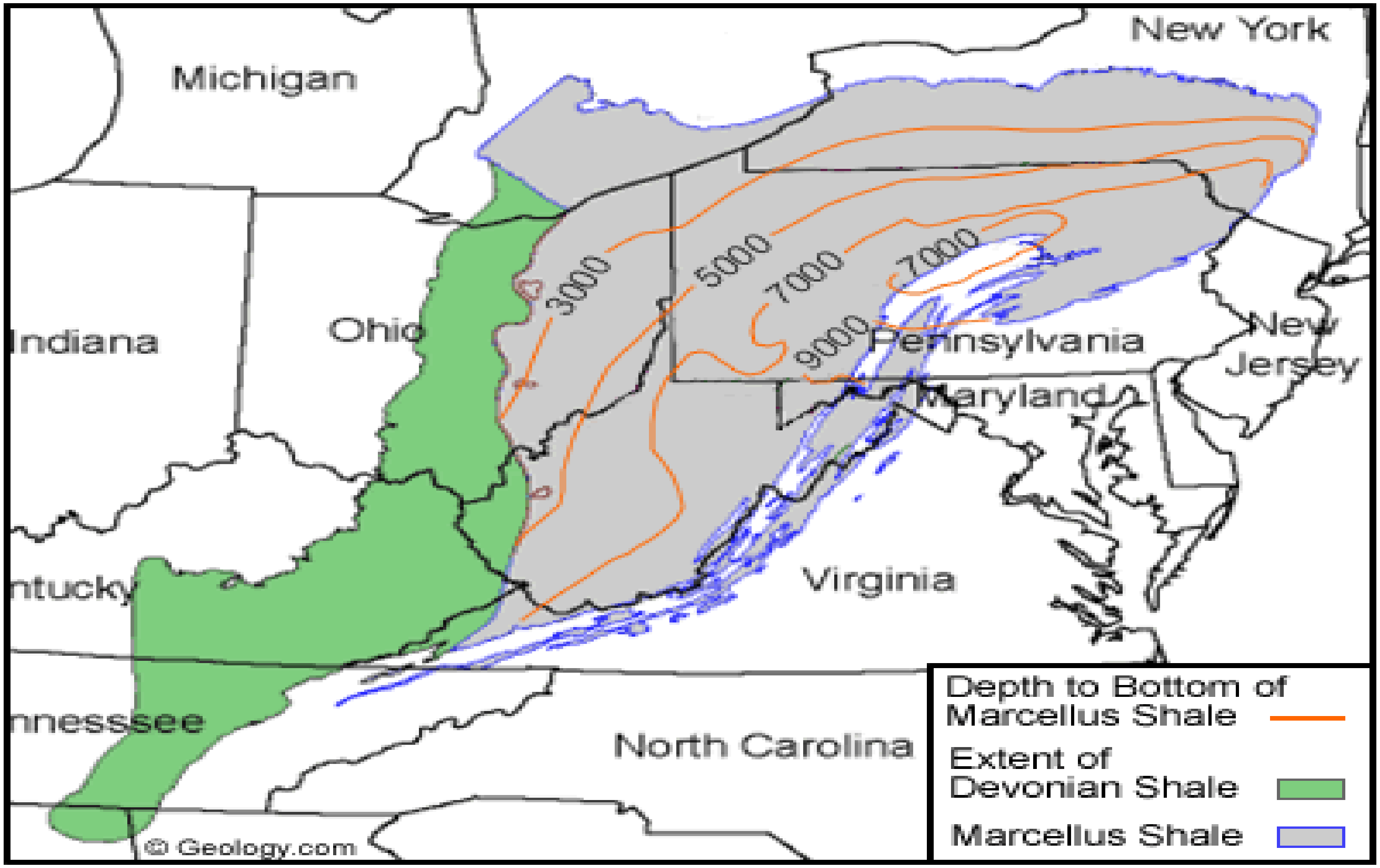
The Eagle Ford topped the list at a 56 percent return.

Returns on the high-producing Bakken, according to the report, were at 33 percent .

THE MARCELLUS SHALE

The Marcellus Shale Natural Gas Field Formation, which extends through Pennsylvania, New York, Ohio, and West Virginia, is a part of the Devonian Black Shale Field.

THE MARCELLUS SHALE



DANIELS
COLLEGE OF BUSINESS
UNIVERSITY of DENVER

THE MARCELLUS SHALE

This shale rock formation was named after the town of Marcellus, New York due to the outcrop formation in the shale. The Marcellus shale extends over 575 miles and has a thickness of up to 900 feet.

Also known as the Pennsylvania Shale (or New York Shale, West Virginia Shale, Ohio Shale) this geologic natural gas shale was reported to hold more then 1.9 trillion cubic feet back in 2002.

THE MARCELLUS SHALE

This did not cause much excitement because the amount that could actually be extracted was low. Combined with the fact that natural gas prices were very low, drilling in the Marcellus Shale was not economical.

Range Resources, showed up to Marcellus Shale back in 2003 in hopes to extract natural gas. Range drilled a well in Washington County, PA and found that this natural gas well was very promising.

THE MARCELLUS SHALE

Like many companies, today, Range Resources used techniques and experience from the Barnett Shale in Texas for the Marcellus Shale natural gas field. The first well that produced gas in Marcellus Shale for Range was hit in 2005.

Range Resources (RRC) now has drilled over 100 natural gas wells on their 900,000 acres in the Marcellus Shale play.

THE MARCELLUS SHALE

During 2012, the Marcellus Shale fell victim to low natural gas prices due to the ramp up in drilling.

The drilling companies below really cut back on the number of active drilling rigs but we are seeing a tick up in natural gas prices as we head into 2014.

THE MARCELLUS SHALE

Marcellus shale is named after the town in upstate New York, where outcrops were first discovered.

Marcellus shale breaks apart when struck. Interestingly, it breaks along horizontal planes, leaving flat plate like fragments that are less than one-half inch thick. Geologists use the term “fissile” to refer to the ability of shale to break apart.

THE MARCELLUS SHALE

Over most of its range, Marcellus rock is buried under more recent layers of rock. In central New York state, it forms outcrops – meaning that it is found at the surface.

In most places in northeastern Pennsylvania it is found at depths of 5000’ in the northern part of Pennsylvania to over 7000’ in Luzerne and Lackawanna Counties

THE MARCELLUS SHALE

Many factors typically influence the production life of a natural gas well. The initial production rate and the amount of natural gas present are the biggest determinants of a well's life span.

Other factors include the decline rate of the natural gas in a particular spot, unpredictable prices, and the production cost versus the return of natural gas.

THE MARCELLUS SHALE

A company is unlikely to continue investing time and money if a well is not producing enough gas to make a profit. Based on studies of the decline in rate of production of natural gas wells in Texas, it is estimated that some wells can be active for 20 to 30 years.

Some sources even estimate that wells can remain active for up to 40 years. New studies are trying to predict the potential life of the Marcellus gas wells in Pennsylvania.

THE MARCELLUS SHALE

The introduction of new technologies, such as horizontal drilling and hydraulic fracturing, may increase the production of a natural gas well, while also potentially shortening the life of the well.

When new technologies are used, they often cause the well to produce more gas over a shorter period of time.

THE MARCELLUS SHALE

Using new technology may actually produce more gas than a traditionally drilled well, and over a shorter period of time.

Long-term data regarding the Marcellus Shale is not yet available to assess the potential actual lifetime of a natural gas well drilled in the Marcellus Formation in Pennsylvania.

CONCLUSION

Thanks for coming!