
MUSINGS FROM THE OIL PATCH

January 9, 2018

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Note: *Musings from the Oil Patch* reflects an eclectic collection of stories and analyses dealing with issues and developments within the energy industry that I feel have potentially significant implications for executives operating and planning for the future. The newsletter is published every two weeks, but periodically events and travel may alter that schedule. As always, I welcome your comments and observations. Allen Brooks

Seeking The Future For Oil & Gas In A Challenging World

Not only would the kingdom not support prices, it was preparing to ramp up production in order to reclaim the market share it had lost

Three years ago, at this time, the oil and gas industry was in absolute chaos! The nice, neat energy world marked by high oil prices, exciting new technologies, expanding output, healthy share prices, and investors throwing money at companies was coming unglued. Barely 30 days before year-end, ironically on America's 2014 Thanksgiving Day, Saudi Arabia's oil minister announced that his country would no longer support the price target of the Organization of Petroleum Exporting Countries. Not only would the kingdom not support prices, it was preparing to ramp up production in order to reclaim the market share it had lost over the prior few years by adhering to its price-support commitment.

Oil industry executives who had been around in the 1980s realized that a repeat of that era was unfolding in front of their eyes. That earlier era witnessed global oil prices collapsing from \$34 a barrel to below \$10. Companies born during the 1970s boom in response to dramatic two oil price jumps were soon destined for the trash heap. What the industry didn't understand was that it was facing an extended period of oil, equipment and personnel oversupply. Before the devastation was over, Houston, and other oil patch cities, saw their populations fall, homes abandoned, weeds growing in the streets and bankruptcy courts chocked full of cases – mostly liquidations.

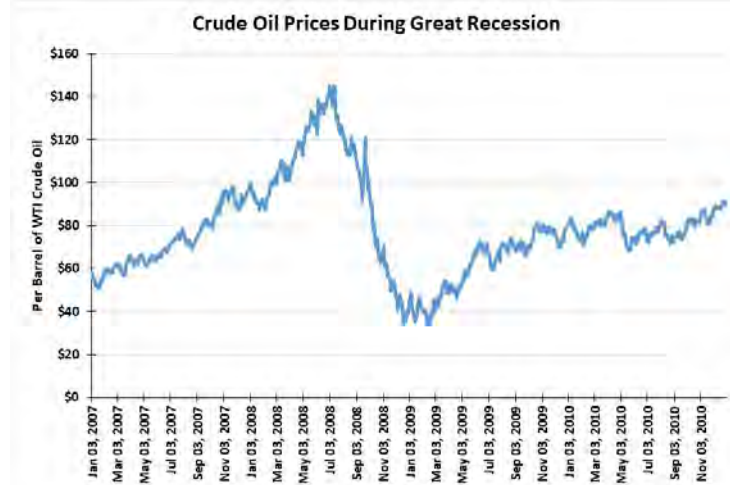
He wanted his people to understand that the future they would be confronting would be radically different

Those memories helped spawn BP plc (BP-NYSE) CEO Robert Dudley's famous expression – "we are preparing for lower for longer." His guiding philosophy for managing BP reflected both an understanding that the underpinnings of the oil business had been destroyed, but for how long and to what ultimate outcome he didn't yet know. More importantly, he wanted his people to understand that the future they would be confronting would be radically different

Mr. Dudley wanted his people to be thinking about what actions BP would need to take to survive in a U-shaped oil price recovery

from that which they experienced during the industry's previous downturn in 2008-2009. In that event, oil prices fell from \$145 to \$34 per barrel, before subsequently rebounding to \$70 in a matter of 12 months. In contrast to that V-shaped recession and recovery, Mr. Dudley wanted his people to be thinking about what actions BP would need to take to survive in a U-shaped oil price recovery scenario. What Mr. Dudley feared, however, was that this recovery would be more like the extended 1980s downturn and subsequent recovery in which oil prices followed an L-shape pattern that lasted for over a decade.

Exhibit 1. Oil Execs Hoped For A 2008-like Price Recovery



Source: EIA, PPHB

The prospect of oil closing the year at \$60 had the bulls snorting and pawing, ready to charge ahead into 2018

As we contemplate the future for the oil and gas industry at 2017's year-end, the WTI oil price was flirting with \$60 a barrel, a level it has not seen since June 2015, nearly 30 months ago. The prospect of oil closing the year at \$60 had the bulls snorting and pawing, ready to charge ahead into 2018. Whether oil prices climb higher, retreat to more modest levels, or possibly soar like an eagle in 2018 depends on a number of factors, which we have grouped into four broad areas of focus. They are:

1. OPEC/Russia production solidarity,
2. U.S. oil output/capital discipline adherence,
3. Global GDP growth and energy demand, and
4. Geopolitical developments.

Three of these four factors are directly tied to the trend for oil prices. The higher they go, especially in the near-term, the greater the risk the price trajectory will be impacted, limiting how prices might go. That doesn't mean oil prices can't rise to higher levels than people currently anticipate, but it likely means they won't be able to sustain the higher levels. Remember, market trends are heavily

We could see oil prices quickly tumble to lower levels, undoing the current updraft in prices

influenced by the news flow surrounding the factors that impact oil prices. Therefore, if the media surveys report any weakness in the resolve of OPEC members and/or its non-OPEC supporters, principally Russia, to sustain high compliance with the production cuts agreed to in Vienna last November, we could see oil prices quickly tumble to lower levels, undoing the current updraft in prices. Equally important is that significantly lower oil prices are not sustainable given the sharp drawdowns in global oil inventories. Of course, oil traders would begin to factor in higher oil output, and how that would act to slow, or potentially reverse, the trend in global oil inventory drawdowns, and drive oil prices lower.

Our guess is that capital discipline will be embraced, at least for some period of time, in order for producers to assess the sustainability of higher oil prices, and at what level they are sustained

A key consideration in how oil traders would interpret the weakening of OPEC/non-OPEC's production cut resolve will be shaped by how U.S. oil producers respond to higher oil prices. Will producers fully embrace the recent push by institutional investors demanding greater capital discipline, including returning a larger portion of company cash flows to investors, or will they begin cheering, and rewarding, managements who focus on growing reserves and output? Our guess is that capital discipline will be embraced, at least for some period of time, in order for producers to assess the sustainability of higher oil prices, and at what level they are sustained. Thus, any aggressive increase in oil industry capital spending compared to current budget expectations for about a 7%-8% increase in 2018 following the expected 4% gain in 2017, is not likely to happen until the second half of next year. That doesn't mean U.S. oil production won't be growing handsomely during the first part of the year. However, oil traders will be closely watching to see if trends fall into place that would sustain the first half of 2018's year-over-year output gains in the second half.

The other dynamic that will influence oil prices is global economic growth. At the present time, it appears that the U.S. and most world economies are meshing into a synchronized global upswing, something that has not happened for a while. That means increased demand for oil and gas, although the push by many large and mature economies to shift their car fleets away from fossil fuel burning will blunt some of the expected oil use increase. How strong that push is, and how widely it is adopted, will determine the magnitude and timing of the impact on oil's use in the transportation sector.

The recent acceleration in global economic growth has come partly in response to lower oil, gas and coal prices

It is also important to note that the recent acceleration in global economic growth has come partly in response to lower oil, gas and coal prices. Those lower prices have provided the equivalent of a tax reduction for consumers who are responding with increased spending. Higher fossil fuel prices will act as a drag on economic growth, although the recently enacted U.S. tax reduction, which will prompt other governments to consider tax rate reductions, should provide an offsetting stimulus to economic growth.

The improving Russian economy and the determined growth plans of China may work at cross-purposes for global oil markets in 2018

The final issue of geopolitical considerations remains the proverbial wildcard. While 2017 had its share of monumental geopolitical events and issues, the oil industry was only minimally impacted. That can always change, and given the tensions in the Middle East and the continuing deterioration in the Venezuelan economy, we could see geopolitical shocks that might impact OPEC oil output. On the other hand, the improving Russian economy and the determined growth plans of China may work at cross-purposes for global oil markets in 2018. Lastly, while we cannot rule out some sort of conflict between North Korea and the U.S. and its allies, we think this year will be characterized by a continuation of diplomatic torment.

On balance, we see 2018 as a year in which oil prices trade from the mid-\$50s a barrel to as much as \$70, with the off-chance they soar to the mid-\$70s if the OPEC/non-OPEC resolve, U.S. capital discipline and global economic growth variables all combine to tighten the world's oil market more than currently anticipated. In other words, higher than anticipated oil prices could be the surprise of 2018!

2018 may be the first year of the last bull market for oil

Healthy oil prices in 2018, at least in the context of the long-term history of oil prices, will help improve the financial health of the global oil industry. At some point, executives will conclude that their balance sheets are sufficiently improved that they can redirect more of their outsized cash flows to doing what they have been trained to do – grow their businesses, e.g., more reserves and output. The push to become more efficient in exploiting shale resources will remain a dictum, so even in the face of higher oilfield costs, oil profitability will be enhanced next year, and possibly grossly enhanced. As a result, 2018 may be the first year of the last bull market for oil. The oil industry's history is one of cycles lasting 5-7 years generally. This last bull market will be fraught with the industry confronting long-term trends unfriendly to the business, but not sufficiently strong enough to kill the business. They will only sap it of its long-term growth dynamics.

The forces at work that may extract this dynamism for the industry include:

1. Transitioning energy to cleaner fuels,
2. An economic cycle downturn,
3. Capital discipline in the face of capital adequacy needs, and
4. The health of the Middle East/Saudi Arabia/Russia/China.

Regardless of one's belief about the efficacy of actions to control climate change, governments around the world have embraced the belief that their actions will alter current conditions. Those actions

Government actions will ensure that the transition will prove more disruptive and costly than if it took its normal course

are detrimental to the long-term future of the oil business, by speeding up what would eventually happen anyway – transitioning to new and better energy sources. Unfortunately, government actions will ensure that the transition will prove more disruptive and costly than if it took its normal course. However, politicians and bureaucrats believe that their primary role in life is to act! As they order their citizens to increase their use of renewable fuels, albeit often more expensive and less consumer-friendly, demand for fossil fuels, especially coal and oil will decline.

The changed environment for energy may translate into lower valuations for energy companies

The pace of this energy transition will be influenced by the economic cycle, which is enjoying a remarkably long period of prosperity without a meaningful downturn, such as 2008-2009. History teaches us that prosperity doesn't last forever. At some point, economic activity will contract, which will exacerbate the financial pain the energy transition may inflict on people. Will the pain be sufficient to cause a revolt among the public against the costly energy shift underway, or will the transition merely be slowed? The latter scenario would provide longevity for the fossil fuel industry.

The energy business may find that over-achieving financial performance in 2018 does not restore the industry's prior "darling" status among investors. Under the pressure for increased capital discipline, the reduced need to drive output growth will cause a shift in how managers approach running their enterprises. The changed environment for energy may translate into lower valuations for energy companies. Companies will strive to re-orient their businesses away from the "boom and bust" history of the industry, into being a more balanced provider of a service – power – to consumers. That will translate into a push to generate healthy and stable profit margins, and to become more flexible with regards to what power and how it is delivered to consumers. It won't be a case of "green" energy versus "dirty" energy. Rather, it will be a case of delivering environmentally-sound power to meet customers' needs at a reasonable and stable price. Rethinking how to organize and manage energy businesses will occupy a greater proportion of executives' time.

"If Saudi Arabia is selling its oil company, what does that say about their view of the long-term future for the oil business?"

The global alignment in energy is shifting, also. A sign of the shift was demonstrated with Saudi Arabia's Vision 2030 economic overhaul and the government's planned initial public offering of Saudi Aramco, its national oil company. As one money manager put it last fall: "If Saudi Arabia is selling its oil company, what does that say about their view of the long-term future for the oil business?" Given his view of the answer, he was staying away from energy investments. While probably an overstatement of the significance of the IPO, it is a recognition that an energy transition is underway, and for Saudi Arabia it means an economic transition is necessary. This view is also a statement about how energy is currently being viewed by the stock market, which is understandable following the industry's dismal financial performance over the past few years.

We are left with the middle period of a \$70 a barrel average as potentially our template for the future

2014 oil price collapse, we have seen prices fluctuating around \$50-\$55 a barrel, closing out 2017 at \$60.42 a barrel. If we treat the pre-collapse high prices and the early years' low prices as extremes, we are left with the middle period of a \$70 a barrel average as potentially our template for the future.

Given greater price volatility in the future than experienced in recent years, possibly oil trades between \$50 and \$80 a barrel over the next five years - creating heartburn at the low end and euphoria at the top. One might describe this scenario as a "Goldilocks" period – not too high and not too low, so everyone survives and benefits. All the while, the energy policies of governments erode the industry's foundation, eventually sending it on a downward trajectory by the mid-2020s.

Oil industry executives should be focused on 2025 as a point when the upcoming change in their companies' fortunes may become more visible

The demise of the oil business won't happen as fast as the environmentalists hope for, while the better days won't last as long as the industry would like. Given this outlook, oil industry executives should be focused on 2025 as a point when the upcoming change in their companies' fortunes may become more visible. One should not await that date before beginning to plan alternate business strategies. The greatest risk for the industry is that a much-better-than-expected 2018 may dull people's thinking into believing that the industry's future will continue to improve, maybe even suggesting a repeat of the 2010-2014 era and thus negate the need to make business adjustments. Sensing a need to pressure his management team into realizing that they had to think very differently about the future was what drove BP's Mr. Dudley to make his oft-quoted expression: lower for longer. That mindset is still necessary, and possibly critical, although oil prices are higher than Mr. Dudley expected.

The Green Movement Is Alive And Well In Europe

France's parliament approved a law banning all exploration and production of oil and natural gas by 2040

Just prior to Christmas, France's parliament approved a law banning all exploration and production of oil and natural gas by 2040 within the country and its overseas territories. Mechanically, it means that existing drilling permits will not be renewed and no new exploration licenses will be granted. French President Emmanuel Macron Tweeted after the parliament's vote: "Very proud that France has become the first country in the world today to ban any new oil exploration licenses with immediate effect and all oil extraction by 2040."

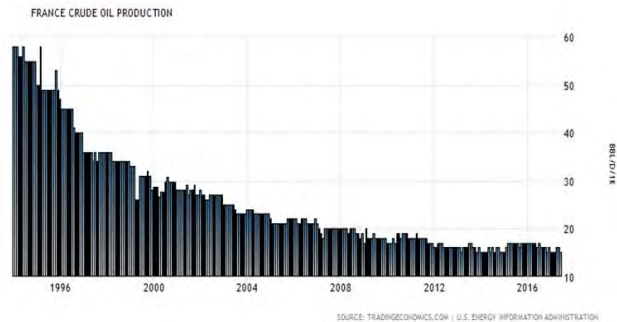
We were curious about the extent of the ban. The territories are referred to collectively as the Overseas Departments and Regions – Overseas Collectives (DROM-COM), and encompass all the land under French sovereignty outside of mainland France. This includes the islands of the French Overseas Territories, which includes the islands of Guadeloupe, Martinique, Saint-Martin, Saint-Barthélemy,

At the present time, France’s domestic oil production is averaging about 16,000 barrels per day (b/d), down from an average of about 58,000 b/d in 1995

Saint Pierre and Miquelon, all in the Atlantic Ocean. In the Indian Ocean are the islands of Reunion, Mayotte, and the French Southern and Antarctic Lands, while in the Pacific Ocean are French Polynesia, New Caledonia, Wallis and Futuna. This extraterritorial area covers almost 120,000 square kilometers (46,322 sq. miles), and is home to more than 2.5 million people. We thought about showing pictures of the islands, but that would constitute “cruel and unusual” punishment, since the petroleum industry virtually never finds hydrocarbons in such idyllic settings. If so, the industry would be swamped with employees volunteering for ex-pat duty.

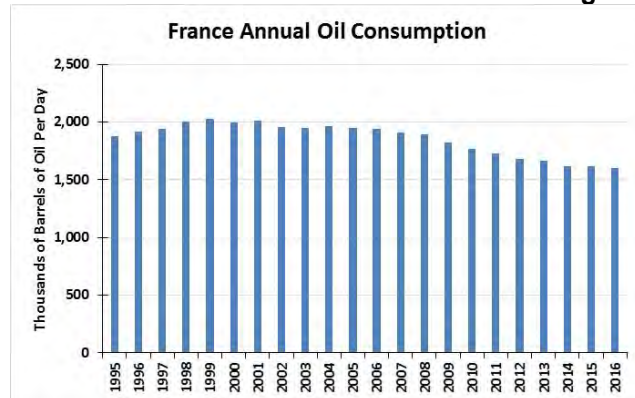
While the extraterritorial areas don’t possess any oil and gas reserves, we wondered what the significance of the ban will be for the country of France. Not much. At the present time, France’s domestic oil production is averaging about 16,000 barrels per day (b/d), down from an average of about 58,000 b/d in 1995. Given the production decline rate, unless it has slowed dramatically, it is possible by the time the exploration ban goes into effect, there may not be much if any domestic oil production. At the same time, France’s consumption in 2016 was 1.6 million b/d. So, the absence of domestic production will have virtually no impact on France’s import bill.

Exhibit 3. French Oil Production Barely 1% Of Use



Source: *Tradingeconomics.com*

Exhibit 4. L-T France Oil Use Decline Leveling Off



Source: *BP, PPHB*

Currently, the share of cars in France that are hybrid or are powered by electricity and other alternative fuels is about 4%

According to Eurostat statistics, in 2015, France derived 0.8% of its total energy consumption from crude oil, while 15.7% came from renewable energy sources and 82.5% from nuclear power. Even though oil plays a miniscule role in France's total energy supply, it is targeted to be completely phased out at some point after 2040 when the country mandates all new highway vehicles be powered by electricity or other clean renewable fuels. Hybrid cars will also be permitted, giving oil some residual market. Currently, the share of cars in France that are hybrid or are powered by electricity and other alternative fuels is about 4%, but with sales of electric vehicles growing rapidly. Through October, France had sold 23% more EVs than during the same 2016 period, but the total number of cars sold was only 29,000.

France was also a leader on the continent in banning the use of hydraulic fracturing to produce shale oil and gas resources

France was also a leader on the continent in banning the use of hydraulic fracturing to produce shale oil and gas resources. It banned the technology in July 2011, due to health concerns, leading to the Ministry of Ecology revoking drilling permits held by Schuepbach Energy and Total SA (TOT-NYSE) because it was assumed they would use fracking in their exploration activities. The ban and the permit revocations were upheld in October 2013 by France's constitutional court. Both companies appealed the permit revocations. Schuepbach's appeal was rejected by an administrative court in December 2015, but it subsequently issued a favorable ruling with respect to Total's appeal in January 2016. The French government said it would appeal the decision, and we cannot find any recent news on the status of the appeal.

According to the most recent (2013) Energy Information Administration (EIA) report on shale resources globally, France has 137 trillion cubic feet of technically recoverable shale gas resources. That puts France second behind Poland in terms of shale gas potential resources on the European continent.

More sane energy executives explained that it was virtually impossible to know how the natural gas molecules were produced

In 2016, the French government became even more zealous in its fight against fossil fuels by considering a ban on imported hydraulically fractured natural gas. The government's rationale was that it seemed hypocritical to ban exploring for shale gas using fracturing while allowing the importation of equivalent gas from abroad. More sane energy executives explained that it was virtually impossible to know how the natural gas molecules were produced. That is also true for those claiming they are only using green electricity. That claim can only be true if 100% of the electricity comes from a renewable facility.

Reading about the hoopla surrounding the French ban on oil and gas exploration, we were reminded of similar episodes regarding the banning of hydraulic fracturing in various U.S. states. While Maryland and New York actually have oil and gas reserves and production, Vermont does not, yet it was the first state to ban the use of the technology in 2011.

A review of Vermont's oil and gas business showed that in its history there have been six wells drilled in the state

A review of Vermont's oil and gas business showed that in its history there have been six wells drilled in the state, with five during 1957-1964, and one in 1984. The state's geologic map also shows that there have been seven water wells with shows of natural gas. Given this exploration history, Vermont acknowledges that it does not have any oil and gas resources. Thus, the state's effort to ban hydraulic fracturing was a publicity stunt.

Exhibit 5. Vermont's Non-existent O&G Industry



Source: Vermont Geological Survey

Potentially more successful have been efforts to block the approval of new and expanded pipelines

The anti-hydraulic fracturing movement nationwide seemed to lose steam last year. That may be because environmentalists have found that battling the financial community (institutional shareholders) and the pipeline industry have proven to be more successful. If you can cut off the funding for oil and gas exploration and development, or pressure the companies to return more of their cash flow to investors rather than spending it on growing production, you can begin to permanently stop the fracturing of wells. Potentially more successful have been efforts to block the approval of new and expanded pipelines. If you can't get the oil and gas to market, it has little value, so why drill and fracture new wells.

We are sure that 2018 will witness new twists and turns in the environmental battle over fossil fuels. We won't speculate on what those twists and turns might be, but we will be watching and commenting on them as the year unfolds.

New York Governor Wants To Lead Offshore Wind Parade

The reality is that divestment of fossil fuel investments and no longer investing in energy stocks will have little to no impact on the volume of carbon emissions released or the use of fossil fuels in the future

Last week, New York Governor Andrew Cuomo (Dem) delivered his 2018 State of the State speech in which he outlined 22 proposals for what he and his administration hope to see the state's legislature and bureaucracy deliver to the residents. As he prepares to run for a third term this November, and hoping to keep his name in the pool for Democratic candidates for president in 2020, Gov. Cuomo's speech and its proposals touched on all the traditional Democratic rallying points. One such point (9th) was to call on the New York State Common Fund (the state pension fund) to cease all new investments in entities engaged in significant fossil fuel-related activities and to develop a plan for divesting from current fossil fuel investments. While a popular selling point for the environmental vote, the reality is that divestment of fossil fuel investments and no longer investing in energy stocks will have little to no impact on the volume of carbon emissions released or the use of fossil fuels in the future. But, by adapting this policy, the residents of New York State will certainly feel better.

Gov. Cuomo announced that his administration would issue solicitations in 2018 and 2019 to develop at least 800 megawatts (MW) of offshore wind projects

The more significant energy-related proposal made by Gov. Cuomo was to unveil New York's Clean Energy Jobs and Climate Agenda. A key aspect of the agenda is moving forward in the development of offshore wind energy. Gov. Cuomo announced that his administration would issue solicitations in 2018 and 2019 to develop at least 800 megawatts (MW) of offshore wind projects. This is also part of a plan to foster the development of an offshore wind energy industry and a skilled wind workforce. Like every other New England and Middle Atlantic state, governors foresee the development of their offshore wind resources as the key to creating a new industry to help the states address unemployment.

In his 2017 State of the State speech, Gov. Cuomo announced an agreement to shutter the Indian Point Energy Center's two nuclear

The state has yet to determine how it will meet the power needs of New York City and Westchester County that are provided by the 2,083 MW plant

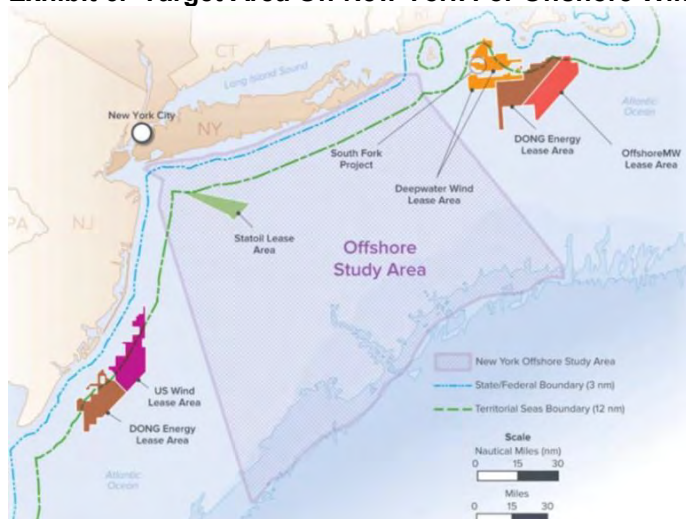
power units earlier than under their federal re-licensing terms. The units, owned by Entergy Corp. (ETR-NYSE), will close in 2020 and 2021, respectively, some 13 and 14 years ahead of schedule. This had been a long-term goal of Gov. Cuomo, but the state has yet to determine how it will meet the power needs of New York City and Westchester County that are provided by the 2,083 MW plant. These units provide roughly 25% of the region’s power. The Governor suggested that offshore wind, and maybe some additional Canadian hydropower, would fill the supply hole.

We now are seeing concrete efforts by Gov. Cuomo to address the potential shutdown of the Indian Point nuclear units, but it will certainly be a race against time to fill the hole, although we are sure Gov. Cuomo, or his successor would be willing to negotiate an extension of the plants’ lives to prevent a power disaster. What the governor wants is a sea full of wind turbines, sitting in the middle of some of the best squid and scallop fisheries along the Eastern Seaboard.

The power authority authorized a 16-cent per kilowatt-hour (kWh) price, reportedly in line with the price paid to other renewable power projects, but 8-cents/kWh below what Block Island residents are paying for power

New York has already embarked on one offshore wind effort off the tip of Long Island. Early last year, the Long Island Power Authority approved plans for the South Fork Project to erect 15 wind turbines, 600 feet tall, with 6-MW capacity at a cost of about \$750 million. The wind farm will be built by Deepwater Wind, the developer of the Block Island Wind Farm in Rhode Island state waters. The power will be brought to a substation on the tip of Long Island via a 50-mile subsea cable. The power authority authorized a 16-cent per kilowatt-hour (kWh) price, reportedly in line with the price paid to other renewable power projects, but 8-cents/kWh below what Block Island residents are paying for power. Interestingly, the current power price for customers on Long Island is 7.6-cents/kWh.

Exhibit 6. Target Area Off New York For Offshore Wind



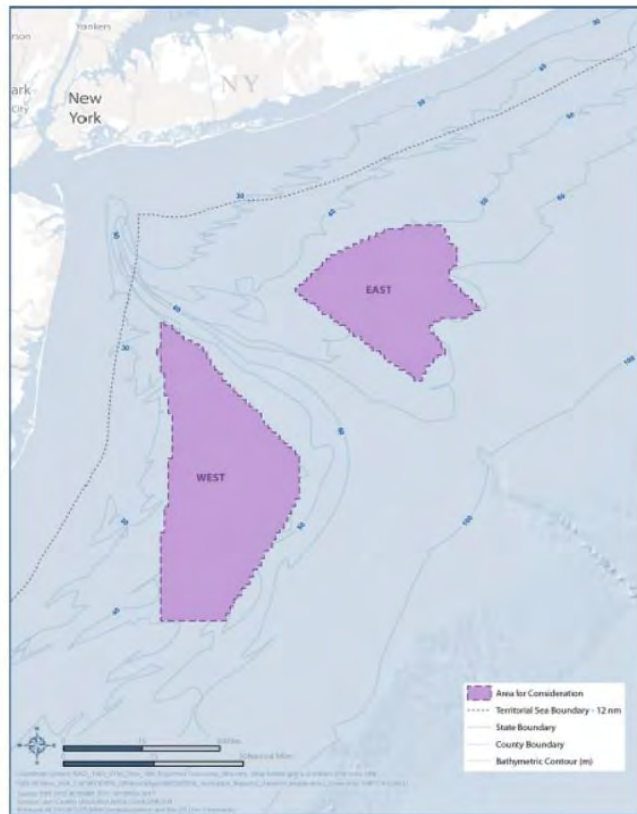
Source: New York State

New York is asking BOEM to identify and lease at least four new Wind Energy Areas, each capable of supporting at least 800 MW

In October, the State of New York submitted an identified offshore area for consideration to the Bureau of Ocean Energy Management (BOEM) for the development of wind resources. The state began with a study area of 16,000 square miles, but narrowed its focus in the submission. Exhibit 6 (prior page) shows the offshore study area for New York waters, along with those offshore lease areas that already exist and where companies such as DONG Energy (DNGY-Nasdaq), Statoil ASA (STO-NYSE) and Deepwater Wind hold wind energy leases.

The state provided extensive data and analyses for the target areas, guided by stakeholder feedback, which was designed to maximize the benefits while minimizing the conflicts to ocean users, including both people and marine wildlife. New York is asking BOEM to identify and lease at least four new Wind Energy Areas, each capable of supporting at least 800 MW, which would be located within the two broad offshore areas identified.

Exhibit 7. Where New York Wants Wind Farms



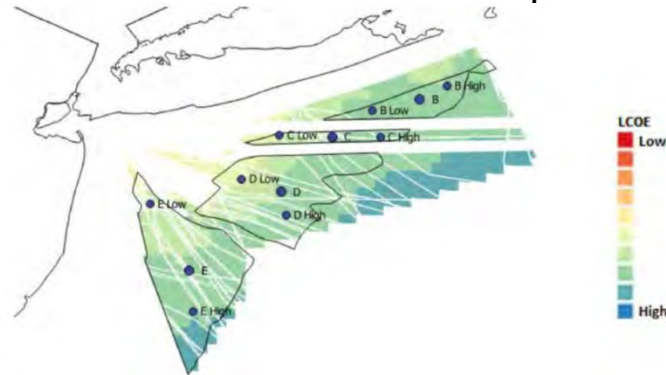
Source: New York State

While the primary lease areas are outside of the main shipping lanes, they do cover a portion of the squid and scallop fisheries and where offshore cables run. Although there were many charts

Only the edges (closest to shore) of the areas of interest are considered "low" cost

dealing with various aspects of the research conducted by the state, we were intrigued by Exhibit 8 that shows the cost of offshore wind developed within the areas. Only the edges (closest to shore) of the areas of interest are considered "low" cost, which is largely a function of reduced water depth.

Exhibit 8. Offshore Wind Will Not Be Cheap

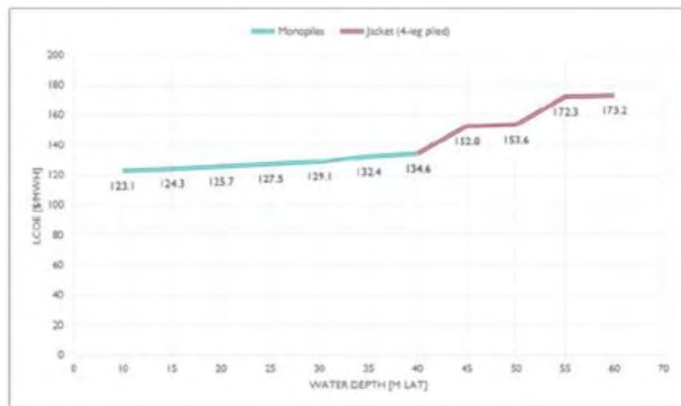


Source: New York State

The analysis assumes that at 40 meters (131 feet) of water depth, there is a cross-over from a single pile structure to a four-legged platform

In New York's report, it included a series of charts about offshore wind farms globally, along with a chart showing the state's estimated cost per megawatt-hour for offshore wind based on water depth. (Poor chart quality in the report.) What it shows is the average levelized cost of energy (LCOE) for a wind farm of 504 MW using 8-MW wind turbines, or 63 units total. The analysis assumes that at 40 meters (131 feet) of water depth, there is a cross-over from a single pile structure to a four-legged platform, which obviously will cost more due to the increased water depth and the additional steel necessary in the larger structure. The figures also assume a 50% utilization rate for the turbines.

Exhibit 9. Offshore Wind Will Be Expensive Power



Source: New York State

Based on the 2017 Annual Energy Report, the U.S. Energy Information Administration (EIA) calculates that the minimum and

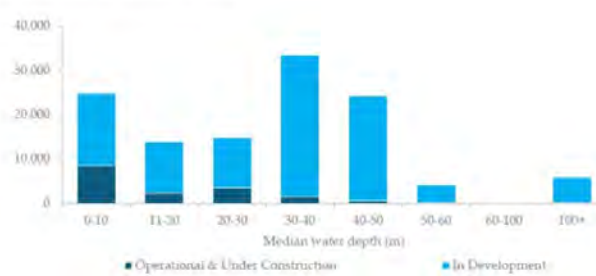
The EIA uses a 45% utilization factor, below the 50% estimate used by New York, and more in line with the actual performance of large offshore wind farms in Europe

maximum cost for a total offshore wind system entering service in 2022, without any tax credits, on a LCOE basis, ranges between \$136.60/mega-watt hour (MWh) and \$212.90/MWh, with a non-weighted average of \$157.40/MWh. This compares with onshore wind costs ranging from \$43.40 to \$75.60 MWh, with an average of \$63.70/MWh. The EIA average for a combined cycle natural gas power plant is \$57.30/MWh. The EIA uses a 45% utilization factor, below the 50% estimate used by New York, and more in line with the actual performance of large offshore wind farms in Europe.

The other two charts the New York report contained related to the global portfolio of wind farms by water depth. It is interesting to see the number of operating wind farms compared to the number under development, assuming all of the latter wind farms are eventually constructed.

Exhibit 10. Offshore Wind Target Shallow Water

Global Portfolio by Water Depth (m)



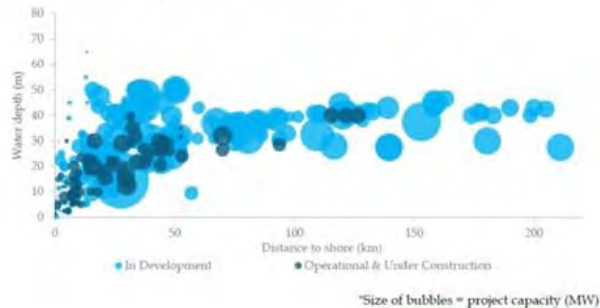
Source: New York State

The desire to locate them where they are less costly to build and operate

The second chart relates to the number of wind farms, with the bubbles demonstrating the size of the wind farm, and their distance from shore. Again, just as with water depth, most wind farms are located close to shore. This is not surprising, as it relates to the technology for building offshore wind farms and the desire to locate them where they are less costly to build and operate. Of course, that also means the wind farms have a greater chance of being visible from shore, thereby reaping the scorn of residents.

Exhibit 11. Most Offshore Wind Is Close To Shore

Global Portfolio - Water Depth (m) vs Distance to Shore (km)



Source: New York State

Mr. Gordon targeted locating his \$2.6 billion, 130 wind turbines in Nantucket Sound, surrounded by the homes of wealthy and politically-powerful residents who fought, and eventually defeated, the project

These last two charts confirm observations about two high-profile wind farm projects. First was the announcement by Jim Gordon a few weeks ago that he was officially declaring the Cape Wind Farm Project dead. This declaration came 10 years after he launched the effort, in which he battled many wealthy residents of high-profile Martha's Vineyard, Nantucket and Cape Cod. Mr. Gordon targeted locating his \$2.6 billion, 130 wind turbines in Nantucket Sound, surrounded by the homes of wealthy and politically-powerful residents who fought, and eventually defeated, the project. While the media made the battle over Cape Wind an issue due to its location and visibility from shore, many local officials, business owners, fishermen, Indian tribes and residents were opposed because of the high cost of the power, and the navigational hazards and threats to the environment the turbines created.

Exhibit 12. Putting Cape Wind In The Wrong Place



Source: Clean Technica

Reflecting the bitterness of the battle, when the Massachusetts Legislature enacted its mandate for local utilities to purchase large amounts of offshore wind, it excluded Cape Wind from the bidding process, allowing only wind farms located at least 10 miles from shore to compete.

The shallowness of the area means it will need less sand to construct the island, which will support thousands of wind turbines needing to be tethered to the sea floor

This brings us to the latest wind farm announcement from Europe. TenneT, the operator of the Netherlands' electric grid, announced plans to build an artificial island in a region in the North Sea called the Dogger Bank, about 100 km (60 miles) off the coast of Yorkshire in the UK. In the last Ice Age, 20,000 years ago, when sea levels were 100 meters (328 feet) lower than today, Dogger Bank was actually a landmass called Doggerland, which connected mainland Europe to the British Isles. The shallowness of the area means it will need less sand to construct the island, which will support thousands of wind turbines needing to be tethered to the sea floor. Dogger Bank's location puts the electricity supply within reach of five countries.

Exhibit 13. Here Come The North Sea Wind Mills

Source: TenneT

TenneT plans to take the alternating current generated by the wind farm and convert it to direct current, which can be transported over longer distances

Because wind turbines are a less dense form of electricity generation compared to fossil fuel-powered or nuclear power, operators need locations close to shore. A nuclear power plant can generate 400 times as much energy per unit of area compared to wind. TenneT plans to take the alternating current generated by the wind farm and convert it to direct current, which can be transported over longer distances, such as to the UK, the Netherlands, and later to Belgium, Denmark, and Germany, at which point it can be converted back to alternating current for use. This adds complexity and cost to the project.

Twice the amount of total offshore wind power installed across Europe today

The Dogger Bank wind farm will be capable of producing 30 gigawatts (GW) of power over about 6,000 square kilometers (2,300 sq. miles). That's about twice the amount of total offshore wind power installed across Europe today, over an area about eight times the size of New York City. Target start-up is 2027.

This project typifies the challenge facing the offshore wind industry, which was aptly summed up by Rob van der Hage, TenneT's program manager. "The big challenge we are facing towards 2030 and 2050 is onshore wind is hampered by local opposition and nearshore is nearly full. It's logical we are looking at areas further offshore," said Mr. van der Hage.

Are Autonomous Cars Ready For Prime Time In The Snow?

The media hyped the storm by calling it "Bombogenesis," which is an obscure meteorological term

Late last week, the Eastern Seaboard, and especially the Northeast, was blasted by a blizzard. The media hyped the storm by calling it "Bombogenesis," which is an obscure meteorological term. The term originated in a 1980 paper published by two MIT meteorologists, which states that a "bomb cyclone" is a "predominantly maritime, cold-season event...usually found ~400 n mi [nautical miles] downstream from a mobile 500 mb [millibar] trough, within or poleward of the maximum westerlies, and within or ahead of the planetary-scale troughs." (Is this obscure enough?)

Contrary to the media hype, this is not a rare occurrence, as data shows that we experience about 45 “bomb cyclone” events every year

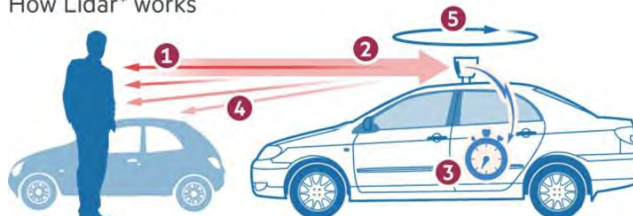
That the cars often become confused seems to be the answer

What the term means in actuality is that there is a rapid drop in pressure and intensification of the storm. It doesn't refer to actual effects of the storm on people, structures and wildlife. Also, contrary to the media hype, this is not a rare occurrence, as data shows that we experience about 45 “bomb cyclone” events every year.

What we had was a good old New England blizzard. Having grown up in New England, we lived through (shoveling) numerous ones. What is new is that we have autonomous vehicles in development that are designed to revolutionize our lives. The big problem is that they are being developed primarily in temperate climates – warm and sunny, with only occasional rainstorms. Unfortunately, that is not the year-around climate for a large portion of this country. As people with electric vehicles (EV) are finding, the battery life of their cars is reduced during periods of extreme heat and cold, along with the use of interior creature comforts such as heaters and air conditioners. Now that EVs are being outfitted with autonomous driving capability (conventional cars, too), the question becomes how will they work in snow storms when the roads are covered and near-by hazards are obscured? That the cars often become confused seems to be the answer.

Exhibit 14. Driverless Technology Needs Help In Winter

How Lidar* works



- 1 The scanner on the car emits a pulse of laser light, similar to the way bats emit sound waves for echolocation
- 2 An object reflects the pulse back to the scanner's receiver
- 3 Measuring the time taken for the pulse to return enables distance to be calculated
- 4 By emitting pulses at a very high rate, thousands of times per second, a very accurate picture of the surrounding environment can be modelled
- 5 Rotating scanners can yield a 360-degree model, while 'solid state' lidars that do not rotate can scan up to 120 degrees

* Light detection and ranging

Source: FT research
Graphic: Ian Bott © FT

Source: **FT.com**

The cars, however, have a problem distinguishing road features needed to guide the vehicle during heavy snow and with snowbanks around

Several of the leading autonomous vehicle companies are testing their cars in cities like Detroit, Pittsburgh and Boston this winter. And engineers are rewriting their algorithms to help the radar-guidance systems distinguish between snowflakes and solid objects – supposedly with some success. The cars, however, have a problem distinguishing road features needed to guide the vehicle during heavy snow and with snowbanks around.

Exhibit 15. Snow Creates Problems For Driverless Cars

However, when it snows ...



- 6 Snowflakes can confuse the scanner
- 7 In addition snow banks and drifts can alter the appearance of objects, causing further issues with the car's system

Source: FT research
Graphic: Ian Bott © FT

Source: **FT.com**

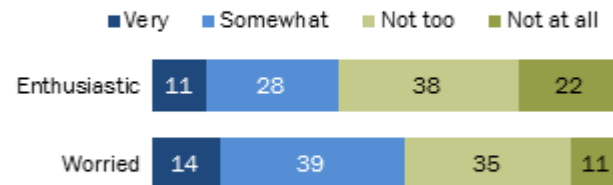
If roads are mapped, a driverless vehicle may have an advantage over a human driver new to the area

What the developers are focusing on is making sure that EVs are equipped with radar that helps the vehicle see through precipitation and can utilize the internal memory of the road and surrounding hazards. That is much like a human's familiarity with local roads, but lack of local knowledge hurts anyone traveling elsewhere. If roads are mapped, a driverless vehicle may have an advantage over a human driver new to the area. In our view, this technology still has a long way to go in development for the typical American driver to feel comfortable. As it works now, autonomous driving technology is great on the open highway with limited traffic, and may work, albeit haltingly, in urban areas. According to a Pew Research Center survey last May, Americans are more worried about driverless vehicles than they are enthusiastic about them.

Exhibit 16. Americans Still Fear Driverless Cars

Public somewhat more worried than enthusiastic about driverless vehicles

% of U.S. adults who say the development of driverless vehicles makes them feel...



Note: Respondents who did not give an answer are not shown.
Source: Survey conducted May 1-15, 2017.
"Automation in Everyday Life"

PEW RESEARCH CENTER

Source: Pew Research

It found that three-quarters of American drivers report being “afraid” to ride in a self-driving car

This view was supported in a survey by AAA. It found that three-quarters of American drivers report being “afraid” to ride in a self-driving car, and only 10% report that they actually “feel safer” sharing the road with driverless vehicles. Interestingly, the survey showed that a majority of U.S. drivers are seeking various forms of autonomous driving technology in their next car purchase, which holds out hope for driverless vehicles in the future. The most telling statistic supporting that view is the AAA survey result showing “Baby Boomer (60%) are more likely to *feel less safe* than Generation X (56%) or Millennials (41%).” The youth of America will ultimately decide the pace of this technology’s acceptance.

Could A Boom Develop In 2018 For The Oil & Gas Industry?

Will the word “boom” be uttered by anyone in the industry this year, or will it be verboten

Those involved in the oil and gas industry are well acquainted with what a “boom” means, even if it isn’t the number one definition in the dictionary. If you search for the definition of boom as a noun, you are presented with information about the long spar used to extend the foot of sail, or a chain of connected floating timbers extended across a river, lake or harbor to obstruct movement, or a long more or less horizontal supporting arm or brace as for holding a microphone. But, it is also the term for a rapid expansion or increase, which is how the oil business thinks of booms.

So, if there is any reason to keep one’s fingers crossed and not speak of booms, it is the possibility that conditions that have aided the recent oil price surge disappear as we move further into 2018

Over 2017, the West Texas Intermediate crude oil futures price rose 12.5%, closing at \$60.42 a barrel on December 29th. However, the price increased 40.5% from the June 23rd low of \$43.01 a barrel. While either improvement was satisfying, it was the remarkable run during the second half of 2017 that has oil industry executives starting to dream about what could happen for their businesses in 2018. Will the word “boom” be uttered by anyone in the industry this year, or will it be verboten; fearing that merely speaking the word might jinx the recovery underway?

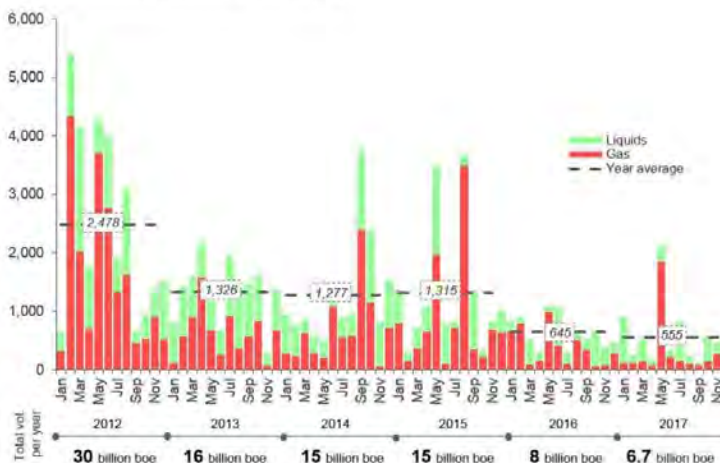
Although industry executives are enjoying higher oil prices, they worry that some of the recent strength has been driven by geopolitical events. So, if there is any reason to keep one’s fingers crossed and not speak of booms, it is the possibility that conditions that have aided the recent oil price surge disappear as we move further into 2018. Could a miracle turn around the Venezuelan political landscape, and improve the economic lot of its people, but more importantly its national oil company? Will Iran tamp down the current civil unrest and avoid possibly new economic sanctions? Will Saudi Arabia and Russia decide that oil prices are rising too high, too fast, and thus imperiling their market shares?

Any of these scenarios could happen, but none of them are likely. Although Iran might avoid new economic sanctions, its precarious political condition will probably keep many oil companies from stepping up investment there. While geopolitics may shape the long-term future for oil, it is the economic changes the industry has

undergone over the past 12-36 months that will drive the oil price trajectory. The two most important changes are: 1) the impact of sharply reduced capital spending that has resulted in new oil discoveries falling to the lowest level in recent history; and 2) the flood of investment money coming into the industry that is now demanding stricter performance metrics.

Exhibit 17. Low Prices Hurt E&P Discovery Success

Global conventional discoveries** [Million boe]



Source: Rystad Energy UCube and Rystad Energy research and analysis

Source: Rystad Energy

2017 saw the oil companies discover only seven billion barrels of oil equivalent reserves, the lowest year since the 1940s

According to industry consulting firm Rystad Energy, 2017 saw the oil companies discover only seven billion barrels of oil equivalent reserves, the lowest year since the 1940s. Based on incomplete data for 2017, Rystad has estimated that the oil industry only found 6.7 billion barrels, down from the already low eight billion barrels found in 2016, which was about half of what was found in each of the years during 2013-2015, and well below the 30 billion barrels found in 2012. Those earlier year successes were a function of \$100 a barrel oil prices, which generated healthy cash flows for the industry and stimulated the desire to plow most of this money, and then some, into new wells seeking additional reserves and output.

The last time the industry replaced 100% of consumption was in 2006

Sonia Mladč Passos, a senior analyst at Rystad, was quoted saying, "We have to face the fact that the low discovered volumes on a global level represent a serious threat to the supply levels of some 10 years down the road." This is a growing risk being contemplated by industry executives. What they know is that based on the 2017 discoveries, they only replaced about 11% of the world's oil production. Significantly, the last time the industry replaced 100% of consumption was in 2006. The devastating financial impact the industry experienced during the 2008-2009 financial crisis and recession and the slow recovery in the following years meant that by 2012, only 50% of our oil consumption was replaced with newly discovered reserves.

Therefore, the industry must make three discoveries at this average size to match two average offshore discoveries in 2012

So far, oil company managers have opted to wait for a signal from sustained higher oil prices before stepping up spending and drilling for reserves that offer large volumes and greater production, such as conventional and offshore prospects

This thinking rewarded significant capital spending, regardless of the impact on balance sheets from the borrowing necessary to fund the spending

A reason for the lower reserve replacement ratio was the reduction in industry capital spending over the past three years. Between 2014 and 2017, capital spending dropped nearly in half, forcing sharp adjustments in spending priorities and corporate structures. The focus of E&P company spending shifted to exploitation of shale formations with rapid paybacks, further altering normal oilfield industry activity. Additionally, the industry is finding smaller pools of hydrocarbons, meaning it takes more actual discoveries in order to achieve the same level of reserve replacement seen in prior years. For example, according to Rystad's data, an average offshore discovery held 150 million barrels of oil equivalent in 2012 compared to only 100 million barrels in 2017. Therefore, the industry must make three discoveries at the current average size to match two average offshore discoveries in 2012. Even with lower oilfield service costs, the additional effort to find new discoveries means reduced profits. Given smaller discoveries, Rystad estimates that potentially one billion barrels of oil equivalent reserves discovered this year won't be developed because they will prove too costly.

The oil industry recognizes the need to find and develop more reserves in order to meet future demand, but exactly how much more needs to be found and when it needs to be onstream remain unanswered questions. The impact of maturing demographics and economies in the western world, coupled with the growth of renewable energy everywhere, is making forecasting future oil needs more difficult. So far, oil company managers have opted to wait for a signal from sustained higher oil prices before stepping up spending and drilling for reserves that offer larger volumes and greater production, such as conventional and offshore prospects.

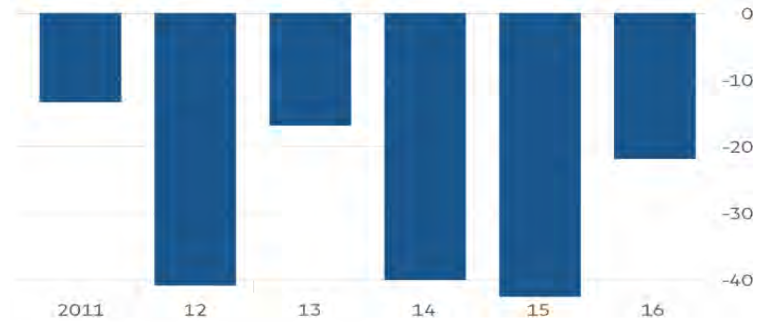
While industry spending trends, driven by demand forecasts, oil price levels and oilfield inflation, are increasing slowly, energy company shareholders have changed, which will further influence the anticipated pace of the industry's recovery. After years of high octane growth, E&P companies exploiting the shale formations in North America are no longer in a race to build acreage positions at astronomical prices. Those expenditures were acceptable to growth inventors who bought into the explanation that the shale revolution required heavy upfront investment in acreage, along with spending on geological and geophysical research to determine the optimal locations for drilling. Shale wells also proved more expensive because they needed to be drilled down, turned and then drilled laterally long distances in order to expose the maximum amount of reservoir rock. Oil companies then needed to employ massive hydraulic horsepower to crack the rock and open up fissures that would allow the trapped hydrocarbons to migrate to the wellbore to be produced. In other words, substantial upfront investment was needed before one could reap the rewards of the investment. This thinking rewarded significant capital spending, regardless of the impact on balance sheets from the borrowing necessary to fund the spending. The future was always greener than the present!

The industry overspending was clear, but the financial damage was explained away by high share prices during the years of \$80-\$100 a barrel oil prices.

Exhibit 18. E&P Are Serial Overspenders

US exploration and production companies have been outspending their cash flows

Cash from operations minus capital spending* (\$bn)



Source: Bloomberg
 * For a sample of 48 leading listed US E&P companies

© FT
 Source: FT.com

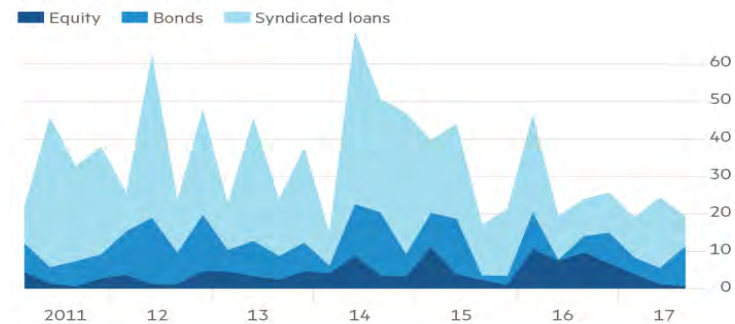
The price paid by the industry for the huge borrowings when oil prices collapsed at the end of 2014 was enormous

The industry's need for capital at times appeared insatiable. While equity played a role, debt and syndicated loans seemed to be a preferred alternative, largely because of the near zero interest rate policy of the Federal Reserve. The magnitude of debt raised annually in the shale revolution era, as shown in Exhibit 20, (next page) increased dramatically compared to the past. Not surprisingly, as shown in Exhibit 19, the trend in capital raised by E&P's trended lower in 2016 and 2017 as the industry recession and low oil prices made energy loans and equity raises challenging. But, the price paid by the industry for the huge borrowings when oil prices collapsed at the end of 2014 was enormous.

Exhibit 19. High Prices Opened Capital Market For E&P

Capital raising by US E&P companies

Amount raised (\$bn)

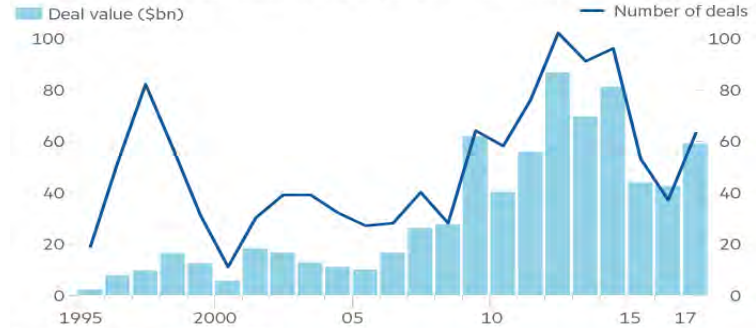


Source: Dealogic
 © FT
 Source: FT.com

Exhibit 20. E&P Companies Lived Off Debt In Shale Boom

Exploration and production bond sales highest since 2014

US marketed bond sales from oil and gas E&P companies



Source: Dealogic; Graphic: Eric Platt/FT © FT

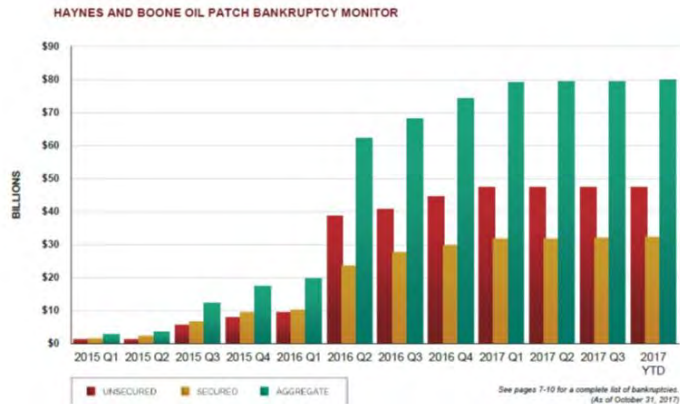
Source: FT.com

Collectively, the two and three-quarters years of history witnessed 134 exploration companies with \$79.8 billion of debt having to resort to bankruptcy in order to deal with their overly leveraged balance sheets

According to the “Oil Patch Bankruptcy Report” from law firm Haynes and Boone LLP, in 2015, 44 E&P firms filed for bankruptcy protection owing \$17.4 billion of secured and unsecured debt. The following year, 70 E&P companies went under, taking down \$56.8 billion of debt. That was the watershed year, as through October 31st, the last data available, only 20 E&P companies with \$5.6 billion of debt entered bankruptcy. Collectively, the two and three-quarters years of history witnessed 134 exploration companies with \$79.8 billion of debt having to resort to bankruptcy in order to deal with their overly leveraged balance sheets. In many cases, the debt holders wound up owning the companies after having their secured debt converted into equity. The assets of many of the companies were sold and the companies liquidated. For others, balance sheets were restructured and the new owners either installed different management teams and sold some of the properties, or merged the companies with stronger players.

Exhibit 21. The Financial Cost Of E&P Bankruptcies

2015-2017 CUMULATIVE E&P UNSECURED DEBT, SECURED DEBT AND AGGREGATE DEBT



Source: Haynes and Boone LLP

The investors certainly believe so, and are betting on that success with their pocketbooks!

In recent months, E&P company stocks have actually fared much better given the lift in crude oil prices

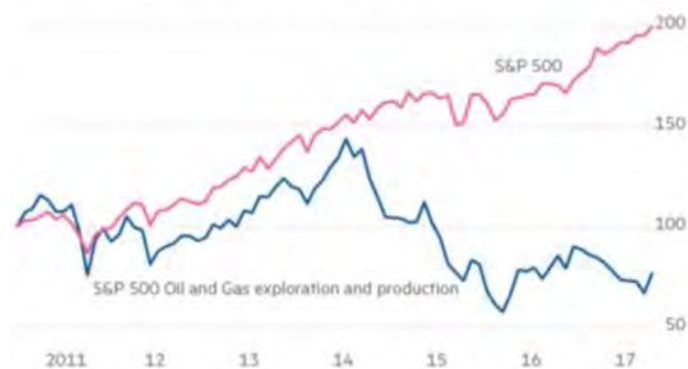
While the devastation has been wide and severe, one offsetting consideration is that assets have often moved into the hands of stronger industry players, or new companies founded by private equity funds or through new public companies in the form of blind pools of capital (blank check companies) headed by recently retired senior E&P company executives with outstanding records of creating value for their shareholders. Can they do it again? The investors certainly believe so, and are betting on that success with their pocketbooks!

Given the debt loads of producers, it is not surprising that when oil prices began their slide in mid-2014, the shares of those E&P companies comprising the Standard & Poor's 500 Oil and Gas segment fell. The underperformance relative to the broad stock market widened throughout all of 2015 and in early 2016. Since then, the share price underperformance has not been that large, and in recent months, E&P company stocks have actually fared much better given the lift in crude oil prices. However, the financial performance of E&P companies has led a number of large institutional investors to muster an effort to force greater capital discipline on the managements. This had led to some producers reducing their capital spending plans, while also announcing large share repurchase programs and/or dividend increases. This means that company cash flows will see a larger portion redirected toward returns to shareholders and less to aggressively trying to grow reserves and production. As part of the response of these producers to the demands of their large shareholders, management compensation metrics have been reworked to shift the emphasis from "growth at any cost" to "profitable growth with increased stakeholder returns." The imponderable now is whether this shift will be sustained, and if so, for just how long?

Exhibit 22. How E&P Has Underperformed The Market

US exploration and production companies have underperformed relative to the market

Share price indices, rebased at 2011 = 100



Source: Thomson Reuters Datastream
© FT

Source: *FT.com*

Restrained E&P spending and a less robust growth in domestic production in 2018 could lift oil prices to where they begin with the number seven

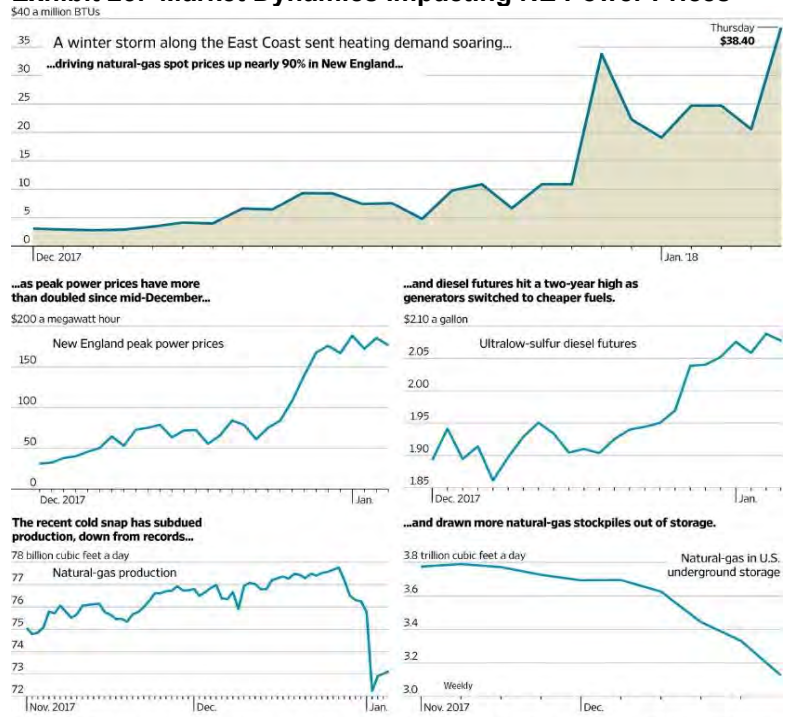
A boom is likely not in the cards for 2018, although we could be surprised. It is more likely to develop in 2019, but possibly not until 2020, depending on how industry trends progress this year, and especially the psychology of executives and investors. Restrained E&P spending and a less robust growth in domestic production in 2018 could lift oil prices to where they begin with the number seven. That might be enough to spark an industry boom. If that happens, we will not be surprised if the oilman's lament – Lord, give me one more boom and I promise not to screw it up – is quickly ignored.

Mystery Of The Natural Gas Market

The price for natural gas purchased on the spot market in New England soared into the high \$20s - \$30s per thousand cubic feet

The New England blizzard of late last week, coupled with a few days of bitter cold prior, and likely more cold weather after the storm, drove demand for natural gas in the Northeast to record high levels and sent spot gas prices soaring. An article in Friday's *Wall Street Journal* contained a series of charts showing what has happened to spot natural gas prices in the Northeast, as well as heating oil (diesel) and electricity prices. While the price for natural gas purchased on the spot market (what utilities typically need to purchase because of restrictions on long-term contracts) in New England soared into the high \$20s - \$30s per thousand cubic feet (Mcf), Henry Hub futures prices were falling to \$2.80/Mcf as forecasts calling for a warm-up dominate traders' thinking.

Exhibit 23. Market Dynamics Impacting NE Power Prices



November witnessed a 37% jump in the average wholesale price for power compared to the same month last year

Electricity bills in New England will be higher this winter because November witnessed a 37% jump in the average wholesale price for power compared to the same month last year. December's price was 48% higher than 2016. National Grid (NGG-NYSE), the primary electricity provider in Rhode Island had raised its winter fuel component price for power by 50% to reflect higher anticipated fuel bills this winter. Depending on the balance of the winter, if this rate hike was not sufficient, summer power prices will be raised to help make-up any fuel cost shortfall from the winter.

Electricity providers last week were burning oil to generate over a third of the power needed, while natural gas's share had fallen to only 25%

According to Independent System Operator New England, the non-profit organization that manages the region's power grid, electricity providers last week were burning oil to generate over a third of the power needed, while natural gas's share had fallen to only 25%. The last time oil accounted for over 30% of New England power generation was during the polar vortex experienced in 2014-2015. This cold snap has lasted for at least two weeks, and is likely to last a few more days. The reliance on cheaper oil and coal power for generating electricity is due to the lack of natural gas pipeline capacity. Efforts by the major natural gas pipeline owners to expand their capacity into the region has been met with significant environmental protests. We hope those protesters are enjoying their higher electricity bills, and the increased state and local expenditures needed to help low-income residents meet their bills.

Exhibit 24. New England Gas Demand Soars In Cold Weather

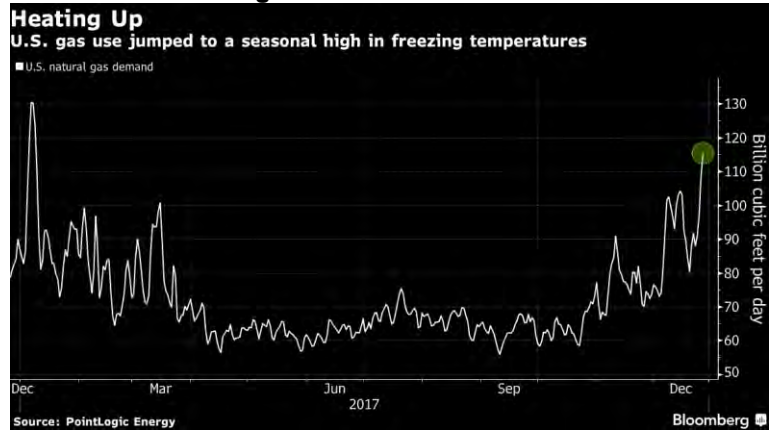
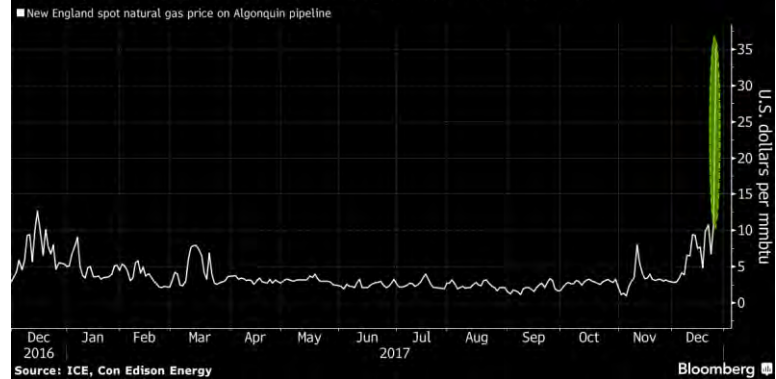


Exhibit 25. Pipeline Capacity Shortage Drives Up Prices**Surge Pricing****New England becomes world's premium gas market in arctic chill****Source: Bloomberg****A disconnect exists between the Henry Hub futures price and local spot gas prices**

We've offer several additional charts from a late December *Bloomberg* article on natural gas consumption and prices in New England during the initial cold snap. Given the disconnect between the Henry Hub futures price and local spot gas prices, we will be exploring the mysteries of the natural gas market in upcoming *Musings* issues.

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