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ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

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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

Will Faltering Oil Prices Alter The New Industry Cycle?

We often find ourselves focusing every hour, sometimes every minute of our day, on the significance of the latest gyration in oil and gas prices

Crude oil prices continue to waffle - now slightly above $50 a barrel – as traders and executives struggle to decipher how quickly the high compliance of OPEC and non-OPEC countries with the production cut agreement of last November will shrink global oil inventories sufficiently to restore balance to the world's oil market that can be sustained. For those of us actively involved in the energy business, we often find ourselves focusing every hour, sometimes every minute of our day, on the significance of the latest gyration in oil and gas prices, or the most recent assessment by leaders of OPEC, or even trying to understand whether oil company executives are making investment decisions based on long-term objectives or short-term needs.

After being one of the hottest investment sectors in 2016, will energy stocks still lead the market this year?

Are dividends now more important than investments to deliver new oil supplies in the next decade? Was BP's Lord Brown's "beyond petroleum" a more correct corporate strategy than Lee Raymond's "we are an oil company" view of ExxonMobil's modus operandi? After being one of the hottest investment sectors in 2016, will energy stocks still lead the market this year? These, and similar questions, dominate our daily thoughts and conversations. However, we always wonder whether this myopic focus on energy industry minutia risks our failure to grasp broader and more far-reaching trends that will re-shape the long-term future of this business?

Where we were going to find the oil resources our growing economy needed?

Merely a decade ago, the issues confronting the U.S. oil and gas industry included wondering where we were going to find the oil resources our growing economy needed given the relentless decline in domestic output. On the natural gas side, we were well along in a race to build regasification terminals to handle the anticipated competition for liquefied natural gas (LNG) cargoes destined to arrive on America's shores to satisfy our thirst for energy.

As a nation, we faced a world of increased energy costs

With U.S. oil and gas production in terminal decline, OPEC was not only a viable cartel, but its power was growing. Future oil prices would be dictated by this group, and for them, the ceiling price was the cost to find and deliver more oil sands, deepwater and harsh environment oil and gas. None of these sources would produce cheap oil and natural gas, and that meant, as a nation, we faced a world of increased energy costs and higher input prices for all our manufactured goods and services. Crude oil prices were climbing toward $100 a barrel, while natural gas sported double-digit dollars per Mcf (thousand cubic feet) price tags.

If the computer climate models were right, the steps necessary to repair the planet would force serious life-style changes on the developed world's populations

At that time, the nation was also reeling from one of the most active and costly tropical storm years (2005), as the debate over global warming, its impact on our future climate and what role mankind played was exploding. If the computer climate models were right, the steps necessary to repair the planet would force serious life-style changes on the developed world's populations. Moreover, this outcome meant that developing economies – especially those lacking adequate access to power – would not reap the social and economic gains of all previous populations. Malthusian-like outlooks became the norm, and billions of people were being condemned to live their shortened lives in perpetual poverty and hunger.

The landscape for energy has changed dramatically

Fast forward a decade, while ignoring the travails of the past couple of years. The landscape for energy has changed dramatically. We are no longer an energy wasteland. We discovered shales and figured out how to tap them (thank you, George Mitchell, and your team at Mitchell Oil & Gas). Instead of further declines in U.S. oil production, it expanded by over four million barrels a day during the decade, with shale/tight oil contributing five million barrels a day of new supply. With the aid of massive hydraulic fracturing technology, and improved horizontal drilling capability, we have gone from Peak Oil to Saudi America!

Forecasts that domestic oil output might double from here, if true, will help prevent oil prices back from revisiting the $100-a-barrel level again

Energy abundance, coupled with the prospect of further oil supply growth, has helped crash oil prices. Forecasts that domestic oil output might double from here, if true, will help prevent oil prices back from revisiting the $100-a-barrel level again. That doesn't mean prices won't go up. Rather, it means that they are likely to only rise marginally. More importantly, oil prices are likely to remain stable in the range they have traded in so far in 2017. This suggests the possibility that future oil price behavior may be more consistent with how oil prices traded during the late 1980s and 1990s after the oil price spikes of the late 1970s and the resulting market bust of the early and middle1980s, than the early-2010s.

Natural gas is experiencing a similar revolution. From a gas short and large import template, we now are producing a surplus of gas and have become an exporter. This dramatic supply turnaround, along with an outlook that points to substantial untapped resources available for development, has pushed natural gas prices down.

Major chemical and oil companies are actively engaged in plant expansions

They are now at levels that have significantly altered the investment thrust of the global petrochemical industry. Major chemical and oil companies are actively engaged in plant expansions and new greenfield projects to capitalize on this changed supply outlook. Billions of dollars in new plants are being planned that will return the industry to a commercial environment similar to what it experienced in the latter part of the 1970s.

These changes have forced companies to re-examine and adjust their corporate strategies

The fundamental changes that have happened to the oil and gas industry over the past decade have radically altered what was a mature, well-understood investment sector. These changes have forced companies to re-examine and adjust their corporate strategies in many cases, which will have long-term ramifications for how the industry invests its cash flows. That investment flow reallocation process will be important for pointing to where new profit-making opportunities will emerge. For example, if the long-term industry outlook a decade-ago projected future oil supplies would have to come from oil sands, deepwater and harsh environment projects, what happens to the companies that built their businesses on the foundations of developing technologies and services to help oil companies meet those specific challenges. Think of the offshore drilling industry, which was a significant driver for industry activity as well as capital spending and investment for more than a decade. What is its future now?

Players in shale now have visibility about their future

The successful exploitation of shale resources has changed the oil and gas game. Shale is a quick-adjusting, low incremental cost, manufacturing-style process that has demonstrated an ability to migrate down the cost curve to profitability as oil prices have fallen. Players in shale now have visibility about their future, maybe for as much as five years, something they never had before. A decade ago, their futures were captive to their next wildcat discovery. With a discovery, you were liquidating.

Projects took decades from start to production because they required significant planning and regulatory approvals

Shale presents a low-cost, highly-reactive opportunity for companies that can work within an environment of high oil price volatility. That was (is) not the case for the offshore, harsh environment and oil sands project-oriented world of yesterday's oil industry. Projects took decades from start to production because they required significant planning and regulatory approvals. They had huge costs attached, often due to the remote location of the hydrocarbons and the necessity for significant infrastructure investment before any revenues could be generated. Oftentimes, new technologies were required to facilitate a project's success. These trends drove industry thinking and spending for years. These projects were largely the preserve of large oil companies since they were the only ones with sufficient resources capable of managing them. As a result, these projects dictated the capital investment allocations of the companies, and in turn, the industry. That is changing.

Shale and scale have become the watch-phrase for the industry

If we look at what has happened over the past six months, which essentially has marked the bottom of the recent industry downturn, which we acknowledge rests on the collective actions of a handful of players, there are significant industry changes underway. Shale and scale have become the watch-phrase for the industry. For the major oil companies who lacked meaningful exposure to American shale – they have stepped up with acquisitions of companies and acreage, wagering billions on the new strategies. These companies are retooling their organizations to try to mimic the operational flexibility of independent oil and gas operators.

You don't want to be drilling and fracturing on your neighbor's lease

The ability to reduce finding and developing costs has come from the embrace of the manufacturing process, which necessitates operational scale. At the same time, as companies have been able to extend the lengths of horizontal wells from a few thousand feet to two miles, or more, companies have needed to consolidate the areal extent of their acreage holdings. You don't want to be drilling and fracturing on your neighbor's lease.

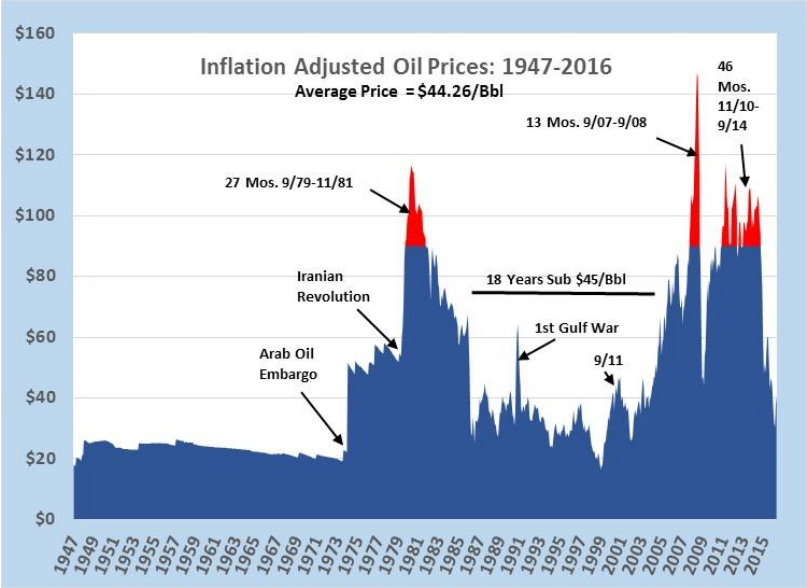
They now need to have a blend of long-term and short-term projects

The characteristics of successful shale endeavors have resonated with oil company executives. It is showing up in how they assemble their investment portfolios of new projects. No company can only have a portfolio of long-term, expensive, high breakeven-cost projects. They now need to have a blend of long-term and short-term projects. This mix has significant implications, not only on allocation of capital decisions and balance sheet structures, but also on how companies are structured and staffed – an important change following the recent oil price decline and the painful and costly organizational dislocations necessitated by the reduction in business activity. This change should help companies better manage future staffing needs in the era of the "Great Crew Change." Periods of mass hirings and firings do little for the success of organizations. The most progress is made when organizations are stable and people can focus on the tasks at hand.

What broke the back of that price explosion was new, large sources of oil – offshore basins in the North Sea and West Africa, in particular, along with Alaska

As we contemplate the next cycle, we cast our view back on the industry's history. The last great cycle came out of the explosion in oil prices in the latter half of the 1970s due to geopolitical events, but realistically it resulted from the peaking of U.S. oil output and the transferring of pricing power to the OPEC cartel. What broke the back of that price explosion was new, large sources of oil – offshore basins in the North Sea and West Africa, in particular, along with Alaska. Those were the resources that drove the industry over the subsequent 30 years. Shale is what is driving the industry now, and likely will drive it for the foreseeable future. What could that mean for oil prices? Look at Exhibit 1 where we show the inflation-adjusted oil prices from the late 1960s to 2016. After the bust of the early 1980s, the oil price traded for 18 years without ever going above $45 a barrel in current dollar prices except in response to one-off geopolitical events.

Exhibit 1. High Oil Price Booms Create Structural Issues



Source: EIA, BEA, PPHB

The oil industry is fighting maturing economies around the world, meaning slower demand growth

The recent oil price bust followed a much longer period of super-high oil prices than in the 1970s. To our way of thinking, we are likely to experience another extended period of lower, but stable, oil prices. Will it be 18 years? We don't know. Will oil prices stabilize around $45 a barrel? We don't know. Might the price range be $55-$60 a barrel? It could be. Will it be $70 a barrel or more? We doubt it, except for brief periods. This isn't because we think history always repeats itself, but rather because the oil industry is fighting maturing economies around the world, meaning slower demand growth. Developing economies are where oil demand is growing the fastest, but those countries have the benefit of employing the most recent equipment designs and technologies, suggesting their economies will be much more energy-efficient than earlier developing economies at the same point in time. Think about how no country now would consider string telephone wires to allow communication – cell towers are the answer. The oil industry is also fighting a global push to de-carbonize economies in order to fight the damage of climate change, which has the potential to significantly lower global oil consumption growth.

This cycle is characterized by the rise of shale and the decline of oil sands, offshore and harsh environment focus

The next industry cycle, however long it lasts, will also have its mini-cycles and periods of volatility, which, for those in the business, will attract significant attention. This cycle is characterized by the rise of shale and the decline of oil sands, offshore and harsh environment focus. Adjustments to the re-ordering of capital spending priorities within exploration and production (E&P) companies must still work their way through the system. That means those sectors dependent on those long-term, expensive projects still need to recapitalize and resize their businesses, much like the E&P sector has done in recent

years. So while the industry is in recovery mode, not everyone will experience the improvements at the same time. That unevenness may cause heartburn among industry participants, but over the next 12-18 months, industry conditions will improve and survivors will gain a greater appreciation for how the fundamentals of the industry going forward will be different from the past.

They need to always consider the What if? scenarios

As they manage their company transitions, executives must think, if they haven't already, about how these fundamental shifts in the oil business cycle will impact them. More importantly, they need to always consider the What if? scenarios. What if shale can't deliver on this miracle? What if electric vehicles do come to rule the transportation sector? What if there are battery technology breakthroughs? What if global growth never improves? The only thing we are confident about is that whatever scenario we lay out, the reality will be different. History doesn't repeat, but it does give us hints.

The Troubled Natural Gas Market Maybe Finding Some Help

The winter of 2016-2017 started off strongly

After what was hoped would be a good winter for natural gas demand, which would lift prices into a sustained $3.50-$4.00 range, instead, disappointment became the watchword. The winter of 2016-2017 started off strongly with heating degree days for the 4th quarter of 2016 some 11.6% greater (colder temperatures) than experienced during the comparable period in 2015. That pattern changed, however, in the final three months of the winter.

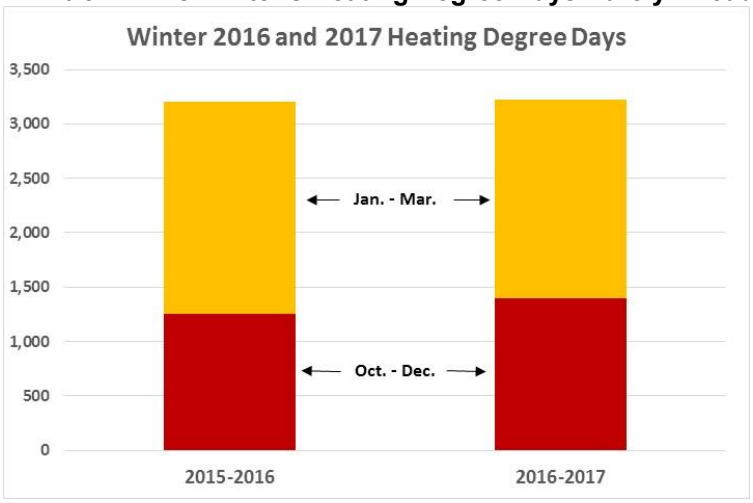
This winter's heating degree day count was barely ahead of last winter

The Energy Information Administration (EIA) uses climate projections from the National Oceanic and Atmospheric Administration (NOAA) to estimate heating degree days. What their latest (March) estimates suggest is that the extended periods of very warm temperatures experienced across the nation during January and February, along with projections for March's weather, offset the short bouts of extremely cold temperatures that impacted regions of the U.S. during the first quarter of the year. Comparing the actual heating degree days experienced during the 1st quarter of 2016 with the estimate for the same quarter in 2017, finds 6.2% fewer this winter. Overall for the entire six-month winter period, this winter's heating degree day count was barely ahead of last winter, which was one of the warmest recorded.

The early cold winter this season propelled natural gas prices to around $3.75/Mcf

The impact of this winter weather pattern can be seen in the trend for natural gas prices during the months of October through March (still incomplete for 2017) for the two respective winter seasons. The early cold winter this season propelled natural gas prices to around $3.75 per thousand cubic feet (Mcf), as traders and the industry expected additional cold weather as the winter progressed. Colder temperatures would have meaningfully reduced the nation's bloated natural gas storage inventory that had swelled during the

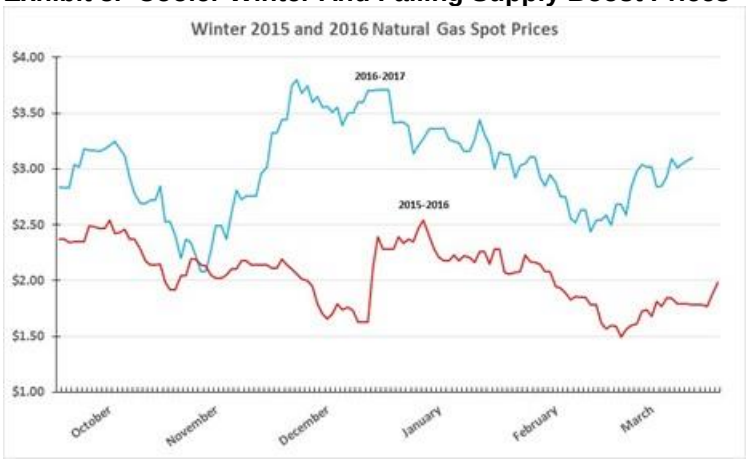
Exhibit 2. This Winter's Heating Degree Days Barely Ahead



Source: EIA, PPHB

winter of 2015-2016, as the U.S. experienced one of its warmest winters in history.

Exhibit 3. Cooler Winter And Falling Supply Boost Prices



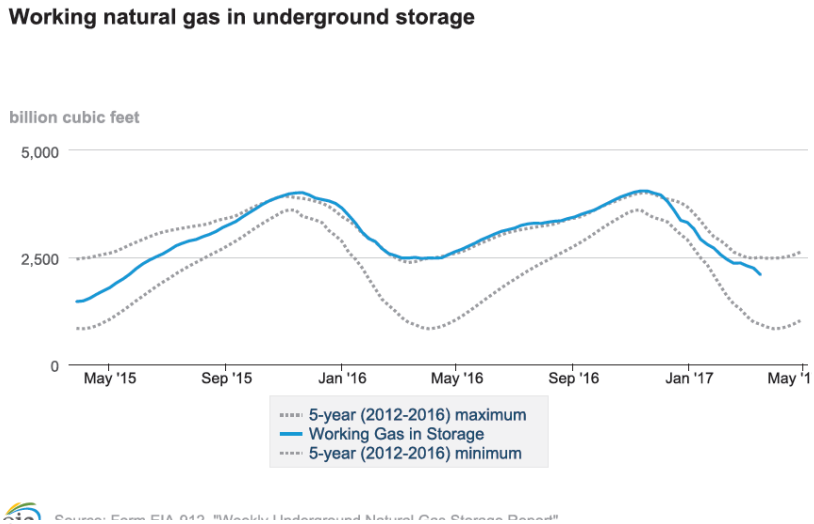
Source: EIA, PPHB

For almost all of 2016, gas storage volumes were even with, or slightly ahead of, the 5-year maximum storage levels

The EIA reports weekly changes in the volume of natural gas in storage. In its report, the agency publishes a chart of weekly storage volumes compared to the maximum and minimum volumes for the respective weeks over the past five years. As Exhibit 4 (next page) shows, for almost all of 2016, gas storage volumes were even with, or slightly ahead of, the 5-year maximum storage levels. That situation existed up until December 2016, at which point, gas storage injections began to trail prior peak weekly injections resulting in total volumes in storage falling sharply below the 5-year maximum. This drop helped revive natural gas prices, which had peaked early in the second half of November, but had subsequently dropped below $3.00/Mcf. As the gas inventory situation improved,

natural gas prices jumped back up. Since that good news was delivered, despite further improvement in the natural gas storage situation, gas prices continued sliding until late February when they bounced higher in response to a blast of arctic weather that swept across the Midwest and Northeast parts of the country, also sending chilly temperatures as far south as the Gulf Coast.

Exhibit 4. Gas Storage Finally Responded To Falling Supply



Source: EIA

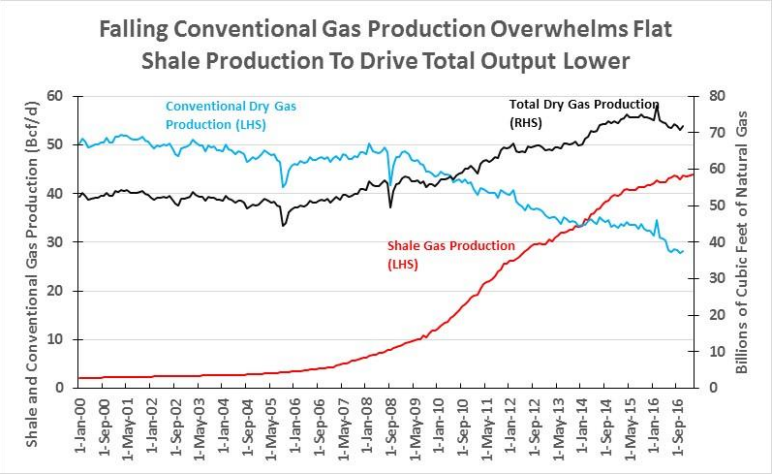
Gas production has declined by 3.2 Bcf/d

With uncooperative winter temperatures, the principal driver behind the decline in gas storage has been falling production. The shale revolution had contributed to a surge in natural gas output, initially from gas wells but later as significant volumes were added from oil well drilling. With the collapse in oil prices in late 2014 and the associated fall in drilling for both oil and gas, production growth began to slow. Gas production eventually peaked in April 2015 (ignore the spike in February 2017, which we believe is a data reporting error). From that point through the latest data (November, due to lagging government reporting), gas production has declined by 3.2 billion cubic feet per day (Bcf/d). The reported November total gas production figure of 71.83 Bcf/d reflects an increase of 1.15 Bcf/d over October's production estimate, signaling something we must watch to see if gas output will start growing again.

EIA projections call for shale gas output to have increased in January and February

Based on another EIA database for shale gas production, which obviously includes estimates, the government sees shale gas output rising in the future. Production was higher in November, but then was estimated to have fallen in December, probably due to winter storm issues such as those experienced in the Bakken formation in North Dakota. EIA projections call for shale gas output to have increased in January and February. The November production increase was about 0.7 Bcf/d, but from November 2016 to February 2017, shale gas production is estimated to have only increased by

Exhibit 5. Falling Supply Has Supported Natural Gas Prices



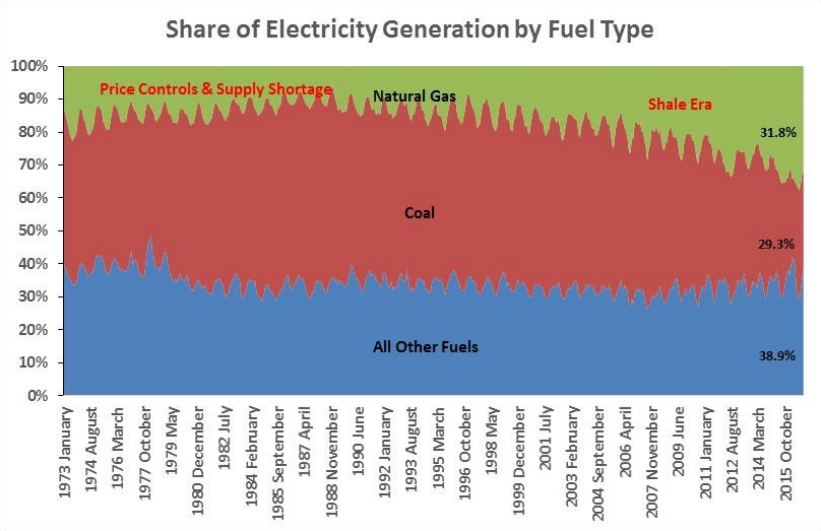
Source: EIA, PPHB

0.3 Bcf/d. Given the fact that it appears all natural gas drilling in this country is shale-oriented, it is likely that conventional natural gas output has continued to decline. An offset could come from additional wells being brought on production from conventional fields in the Gulf of Mexico.

Until rising summer temperatures boost air conditioning loads, natural gas will not get too much of a lift from the electric generation sector

If we are re-entering a period of natural gas production growth, we need to turn our attention to gas demand. Until rising summer temperatures boost air conditioning loads, natural gas will not get too much of a lift from the electric generation sector. It was this sector that actually hurt gas demand growth during the winter, as rising natural gas prices pushed electric utilities to switch back to cheaper coal to generate power.

Exhibit 6. Coal's Share Of Power Market Squeezed By Gas



Source: EIA, PPHB

Coal's share of the power market has also been squeezed by the growth of other fuels, primarily renewables

A long-term chart of the percentage of total electricity generated from coal, natural gas and all other fuels shows how the natural gas share has increased since the early 2000s at the expense of coal. Coal's share of the power market has also been squeezed by the growth of other fuels, primarily renewables. At the end of last year, natural gas accounted for nearly 32% of total electricity generation. As the chart shows, not only has natural gas' share increased significantly since the shale revolution and climate change moved front and center for the utility business in the mid-2000s, but its share is now roughly 50% greater than it was in the early 1970s when intrastate natural gas supplies were being snapped up by utility companies as federally-controlled gas output was being throttled by unrealistically low price controls.

At one point in the late 1970s, 41% of all natural gas produced in this country was controlled by the intrastate gas markets in three states – Texas, Oklahoma and Louisiana

That price control era commenced with the 1954 Phillips Petroleum Supreme Court case that established Federal Power Commission (FPC) control over wellhead gas prices for all natural gas sold into the interstate market. Developing a mechanism for determining wellhead prices became a quagmire as all other economic regulation conducted under the FPC was based on cost-of-service, which was nearly difficult to determine for natural gas wells and an impossible administrative task for determining the cost for every single producing gas well. This task confounded the commission, which then attempted to develop broader price-setting mechanisms for groups of wells in an area, rather than attempting to decide prices for every single well. The challenge faced by the FPC staff and the pace at which they moved insured that regulated natural gas prices remained well below market prices causing producers to refocus their drilling efforts to those states with active intrastate (decontrolled prices) gas markets. At one point in the late 1970s, 41% of all natural gas produced in this country was controlled by the intrastate gas markets in three states – Texas, Oklahoma and Louisiana - and that share was growing rapidly. These price control issues existed from 1954 until the Natural Gas Wellhead Decontrol Act of 1989 was enacted that ensured that all wellhead gas prices would be decontrolled by 1993. This act followed various attempts to create regulatory pricing schemes, each of which created other dislocations within the natural gas market.

During this period of regulatory purgatory, natural gas initially continued gaining market share as both the interstate pipeline network expanded and cheap, clean natural gas displaced heating oil in many localities. However, by the late 1970s, and thereafter, the gas industry's growth was limited by supply shortages created by the regulatory chaos surrounding gas pricing for the interstate pipeline industry.

The gas shale revolution that took hold by 2005, ultimately boosted domestic gas supplies and, in less than a decade, created a glut of natural gas. One result of the shale revolution was the knocking down of double-digit natural gas prices, interestingly, the original

stimulus behind shale drilling. Another result of the shale revolution was the creation of a huge supply of cheap gas that began undercutting coal prices and coal volumes being consumed by utilities, helping the U.S. address its carbon emissions challenges.

The battle between coal and natural gas continues to play out in the electric power sector

The battle between coal and natural gas continues to play out in the electric power sector. Exhibit 7 shows the year-over-year change in total natural gas use in this country compared to the year-over-year change in the amount consumed by the electric power generation sector. As the red line shows changes in total gas use, the spikes up and down coincide with the two coldest and two warmest winters in modern times. The final spike in the chart reflects the impact of the early cold weather during this past winter.

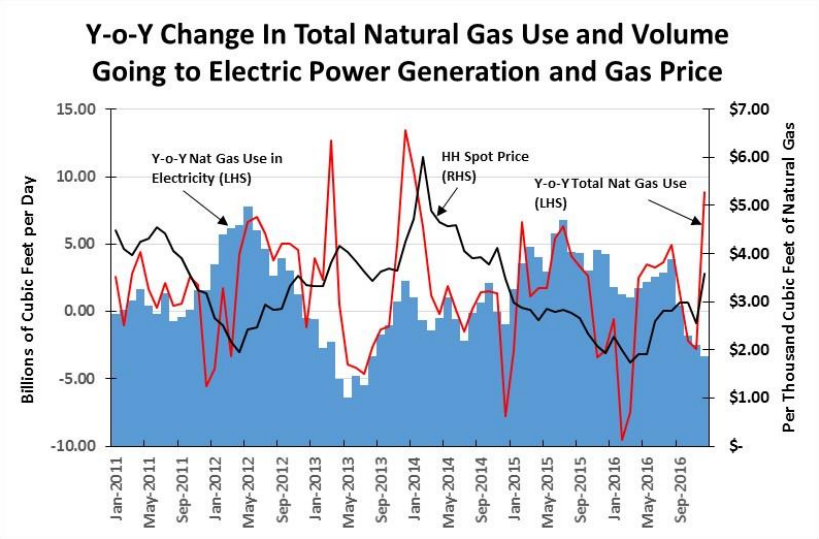
During the warm winter of 2011-2012, total gas use declined while power consumption rose, largely reflecting falling gas prices

In contrast, the blue bars in the chart show the change in gas use by the power sector and reflect factors such as seasonal demand and competitive fuel prices. During the warm winter of 2011-2012, total gas use declined while power consumption rose, largely reflecting falling gas prices. However, during the cold winter of 2012-2013, power generation's consumption of natural gas declined in response to rapidly rising gas prices driven by weather-related gas demand.

Falling gas prices during 2015 and early 2016 contributed to rising gas use by electricity generation until gas prices began climbing

High natural gas prices during 2013 and 2014 curtailed natural gas use by power generators, but when gas prices fell below $3.00/Mcf during the warm winter of 2014-2015, power generation's consumption of gas increased. Falling gas prices during 2015 and early 2016 contributed to rising gas use by electricity generation until gas prices began climbing. As gas use by electric generators fell, the real pressure point for gas prices seemed to come around $3.00/Mcf, at which point coal became more competitive. That seems to have been the same relationship we saw in late 2016.

Exhibit 7. Power Demand For Gas Has Reacted To Gas Prices

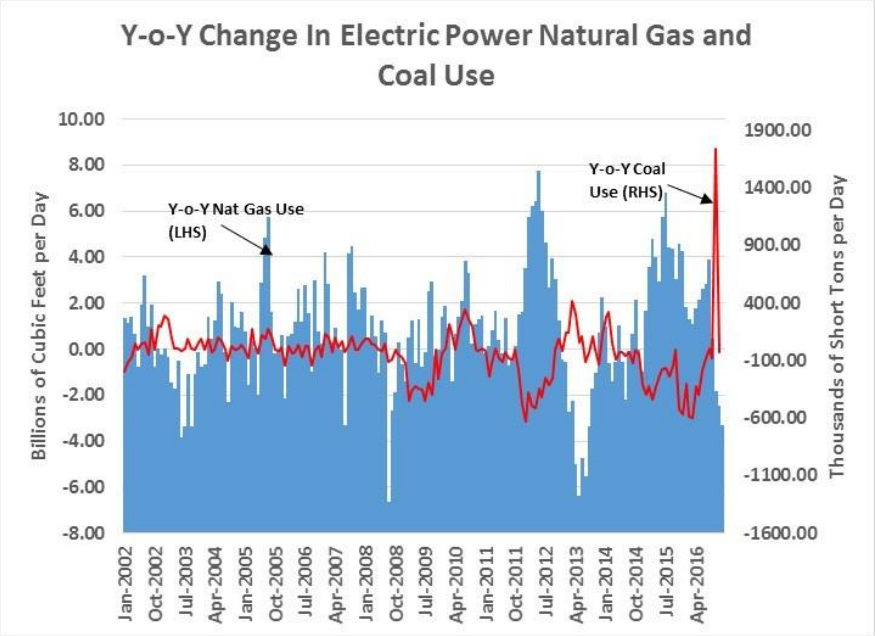


Source: EIA, PPHB

From 2002 through the financial crisis of 2008, coal consumption for generating electricity was essentially flat

The impact of natural gas prices on coal's use in the power sector is shown in Exhibit 8. From 2002 through the financial crisis of 2008, coal consumption for generating electricity was essentially flat. As the gas use spikes demonstrate, natural gas became the swing supply for the power sector. Beginning in 2010, following the 2009 recession, coal consumption began a slow decline, only interrupted by the winter of 2011-2012, until this past fall when coal use spiked as natural gas consumption by the power sector fell sharply.

Exhibit 8. Higher Gas Prices Drove Utility Switch To Coal



Source: EIA, PPHB

Natural gas will gain increased market share in the electricity generation market due to its lower carbon emissions as well as being aided by the states pushing for cleaner fuel mixes for their utilities

In our view, the struggle over market dominance between coal and natural gas will continue for the foreseeable future. While the battle will be fought in the price arena, eventually the environmental issues and state mandates for increased use of renewables by the utility sector will dictate the timing and the eventual outcome. While West Virginia has moved to eliminate its renewables portfolio mandate, Maryland has recently increased its percentage from 20% to 25% by 2020. It appears all the other states have stayed with their renewables portfolio standards. The potential loosening of environmental rules by the Trump administration may give coal a slight reprieve but ultimately, natural gas will gain increased market share in the electricity generation market due to its lower carbon emissions as well as being aided by the states pushing for cleaner fuel mixes for their utilities. Natural gas producers will need to see the power market grow if they truly want gas prices to return to healthy levels or they will need to shift their focus to the export market, which has been growing and is projected to grow further in the future. For the time being, though, falling gas supply is what is

supporting gas prices, but that is likely to change given the recent pickup in domestic drilling activity.

Oil Prices Heading Up, But Is It All Based On Sentiment?

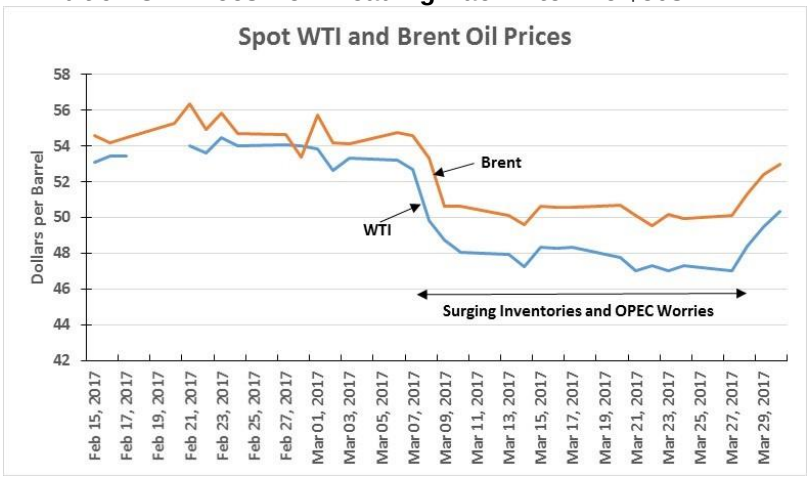
Oil prices crossed that magic threshold Thursday morning.

Following the latest Energy Information Administration's (EIA) report on weekly crude oil storage inventory changes, along with other petroleum industry production and demand data, oil prices rallied back above $50 a barrel. Oil prices crossed that magic threshold Thursday morning. The momentum from the rally that started on Tuesday, as oil traders became optimistic about a more favorable weekly inventory report than analysts were anticipating, continued and carried oil prices higher.

The worries were driven by a sharply higher-than-expected weekly inventory report in early March

Last week's oil price rally marked the end of a three-week span when market worries over the potential that oil prices might crash, just as they had a year ago, reached their apex. The worries were driven by a sharply higher-than-expected weekly inventory report in early March, which also happened to coincide with expressions of doubt about the veracity of the OPEC/non-OPEC production cut agreement from speakers at the high profile CERAWeek energy industry conference.

Exhibit 9. Oil Prices Now Heading Back Into The $50s



Source: EIA, PPHB

Its conclusion that compliance with the target cuts was high (94% for OPEC members)

Concerns over the health of the production-cut agreement and whether it might be extended in June when its six-month term ends were also put to rest early last week. The prior weekend, OPEC's technical group, which was charged with assessing the agreement, examined member country output data as well as export information from the non-OPEC countries who are supporting OPEC and offered its conclusion that compliance with the target cuts was high (94% for OPEC members). While non-OPEC production cut compliance lagged OPEC's performance, it was improving. As a result, OPEC

member energy officials cautiously expressed the opinion that there was every reason to believe that the production cut agreement would be extended for the balance of 2017.

OPEC officials said that these temporary factors were working their way through the system

The observed lack of a reduction in global oil inventories was chalked up to temporary factors such as the late 2016 surge in production/exports immediately prior to the start of the agreement and weaker demand growth. OPEC officials said that these temporary factors were working their way through the system and global oil inventories would soon begin to shrink. The official view was that the production cut agreement is working; it just needs more time.

The boost in refinery oil input suggests that the industry is determined to build gasoline stocks in anticipation of a robust summer driving season

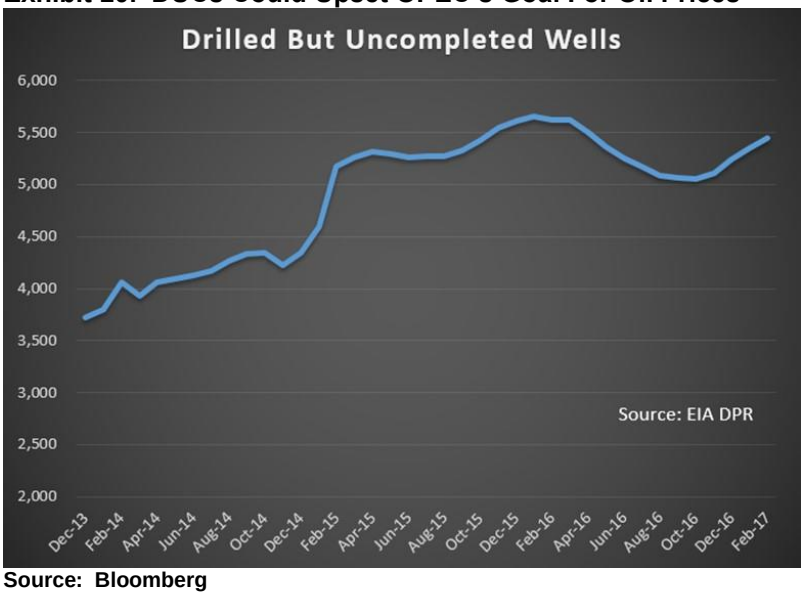
In last week's EIA Petroleum Balance Sheet report, the good news for the industry was not only that the increase in crude oil inventories was only 900,000 barrels, well below analysts' estimates, but also that gasoline inventories fell by 3.7 million barrels, substantially greater than the analysts had predicted. Domestic crude oil production, as well as oil imports, were essentially flat with the prior week's reported figures. Importantly, crude oil input to refineries increased by 425,000 barrels a day, a healthy development following the ending of the refinery maintenance cycle. The boost in refinery oil input suggests that the industry is determined to build gasoline stocks in anticipation of a robust summer driving season. The logic of that move was supported by the Conference Board's recent report that American consumer sentiment had surged in March to the highest level since December 2000, just when the great dot-com stock market bubble was imploding, which would eventually lead to a recession starting in March 2001 and lasting to November 2001, shortly after the terrorist attacks of 9/11.

Manpower availability in the oilfield service sector is an obvious issue for the recovery as it will impact how much drilling and completion work can be accomplished

It was clear last week that optimism for a sustained oil patch recovery had returned to the oil trading pits. At the same time, however, there remain conflicting industry data points that may determine the pace of the recovery. Manpower availability in the oilfield service sector is an obvious issue for the recovery as it will impact how much drilling and completion work can be accomplished. For the first two months of 2017, Texas has added 54,500 new jobs, or an annualized rate of 2.7%, a full one percentage point greater than the rate the state achieved in 2016. Both manufacturing and mining (oil and gas extraction) experienced upticks in employment said a Dallas Federal Reserve economist who commented, "There's a lot more optimism in the oil-and-gas sector." Bringing back more oilfield labor may require higher wages that will impact service costs and well breakeven points, which could limit the speed and magnitude of the recovery, at least marginally.

Another measure of activity that bears watching is the growth in the number of drilled-but-uncompleted wells (DUCs) in this country. During the oil price downturn, the number of DUCs grew as wells were drilled prior to rigs being able to be shut down. Wells were not

Exhibit 10. DUCs Could Upset OPEC's Goal For Oil Prices



Source: Bloomberg

completed because it made no sense to produce additional oil and gas into already glutted markets and at low prices. Now it appears that DUCs may be growing because completion service capacity has not grown as rapidly as drilling activity, and that wells are being drilled on leases in order to hold the lease and/or to ensure the availability of future productive capacity once gathering pipelines are constructed to haul the hydrocarbons away.

Fundamental factors appear to be supportive of higher oil prices, but those factors could quickly evolve into negatives

As we have pointed out previously, there are many other considerations that interact in setting oil prices, especially in the short term. Factors such as the strength or weakness of the value of the U.S. dollar, oil price volatility, and geopolitical developments such as civil wars in Libya and Nigeria, and the ongoing economic destruction of the Venezuelan oil business are just a few examples. The important consideration from our viewpoint is that the return to an oil price that starts with the number five has largely been driven by a positive shift in industry sentiment regarding future developments that are assumed will lead oil prices higher. Fundamental factors appear to be supportive of higher oil prices, but those factors could quickly evolve into negatives. For the time being, we are happy with the positive sentiment shift.

Climate Change, Green Energy And Fossil Fuels' Future

President Donald Trump has signed an executive order that nullifies most of President Barack Obama's climate change agenda and provides for a more favorable regulatory environment for fossil fuels. The order, long promised during his election campaign and coupled with his appointment of Scott Pruett, an avowed climate skeptic to

head the Environmental Protection Administration (EPA), has heated up the debate over climate change, green energy, America's leadership role in fighting global warming, and the future of environmentally-friendly vehicles. This latter consideration is receiving extensive discussion and attention because it plays into the narrative about the future need for additional crude oil production and whether oil company executives are ignoring an impending cliff in their companies' journeys to growth.

It plays into the narrative about the future need for additional crude oil production

While the Trump rollback of the Obama-era climate change agenda is the focal point of debate, from a broader perspective, the clean energy movement is well underway and will not be derailed, although it might be slowed. The future of fossil fuels is tied to global economic growth, which in turn is a function of population growth. More people wanting better lifestyles requires more energy. To restrict energy consumption growth is to condemn those living in poverty to shorter and less comfortable lives. Providing more energy to improve the living standards for this segment of the global population requires decisions about how much more energy is needed and how it will be generated. These are legitimate topics and worthy of serious and rational debate.

The future of fossil fuels is tied to global economic growth, which in turn is a function of population growth

Fossil fuels have been the catalyst for global growth for centuries. People seem to forget that wood and charcoal predated oil and gas, and certainly nuclear power. Renewables – wind, water and solar - have always been available, but their output has never satisfied the increasingly demanding energy needs of growing economies. What we have witnessed throughout mankind's history have been long transitions in our primary energy sources – moving from those with less energy and needing more area per unit to those with reduced area requirements and much greater energy output per unit. With this transition has come more carbon emissions. However, a wide array of highly productive energy resources exists, also with a wide range of carbon emissions. Through the use of technology, many of these carbon emissions can be captured or mitigated, further improving the "green" nature of the fuels.

What we have witnessed throughout mankind's history have been long transitions in our primary energy sources

One of the hottest topics in the green energy versus fossil fuels debate involves the transportation sector and just how "green" electric vehicles (EV) truly are. EVs are by the nature of their power train more efficient in transferring the power into energy to move the vehicle. This increased energy efficiency, coupled with no tailpipe emissions from burning fossil fuels, are what drives the argument for EVs over internal combustion engine (ICE) vehicles. These characteristics are important for the petroleum industry as the success of EVs in carving out a significant market share of the global automobile fleet will determine how much oil will need to be produced in the future.

This increased energy efficiency, coupled with no tailpipe emissions from burning fossil fuels, are what drives the argument for EVs over internal combustion engine vehicles

Although we have covered the debate between researchers convinced that EVs will become so popular so quickly that a

"Together with other oil-saving approaches, such as more efficient vehicles and advanced biofuels, EVs can help cut projected U.S. oil use in half over the next 20 years"

significant share of global oil output will be eliminated versus major oil company economists who see slower green-vehicle growth and thus significantly less threatening to their corporate futures. A 2015 report by the Union of Concerned Scientists (UCS) opens with the following statement: "Together with other oil-saving approaches, such as more efficient vehicles and advanced biofuels, EVs can help cut projected U.S. oil use in half over the next 20 years." In 2015, the United States used an average of 9.2 million barrels per day (mmb/d) of gasoline out of an average of 16.7 mmb/d of refined petroleum products produced. While some of the output was shipped abroad, the figures provide a rough measure as to the magnitude of the UCS claim for future oil consumption savings.

The possibility of the industry losing potentially 4.6 mmb/d of demand over the next two decades should have oil company executives concerned

If the UCS claim is for half of the gasoline output, the 4.6 mmb/d in savings was almost equal to the growth in tight oil output in this country between 2005 and 2015. With some government forecasts projecting continued gains in tight oil output for the foreseeable future, the possibility of the industry losing potentially 4.6 mmb/d of demand over the next two decades should have oil company executives concerned. Maybe they are, but just aren't showing it. On the other hand, given the magnitude of investments they are directing towards acreage purchases and drilling activity in just the Permian Basin, the latest hot spot for tight oil development activity, one imagines that these executives are not paring back their efforts.

The UCS report, "Cleaner Cars from Cradle to Grave: How Electric Cars Beat Gasoline Cars on Lifetime Global Warming Emissions," is a detailed examination of the global warming emissions over the "life cycles" of battery-electric vehicles (BEVs) and similar sized gasoline powered vehicles. The report highlighted three conclusions: 1) "from cradle to grave, BEVs are cleaner"; 2) "EVs are now driving cleaner than ever before;" and 3) "EVs will become even cleaner as more electricity is generated by renewable sources of energy."

There are more carbon emissions generated from the production of the raw materials for, and the manufacture of, a BEV

The key point the report brought out was that "even when the higher emissions associated with BEV manufacturing are taken into consideration," the modeling of the two most popular BEVs available and the regions where they are currently being sold, "excess manufacturing emissions are offset within 6 to 16 months of average driving." In effect, although there are more carbon emissions generated from the production of the raw materials for, and the manufacture of, a BEV, the better emissions performance when the BEV is driven quickly offsets the vehicle's emissions' deficit.

According to the authors of the UCS report, they found that driving an average EV results in lower emissions than driving an ICE vehicle that gets 50 miles per gallon (mpg). Moreover, they found that where EVs are being sold and driven now, given the fuel mix for the production of the electricity in these regions to charge them, these EVs are equivalent to the emissions of an ICE vehicle achieving 68 mpg. This is significant as the current automobile fuel-

efficiency standard calls for the U.S. car fleet to average 54.5 mpg by 2025.

The comparative analysis of the report was focused exclusively on the greenhouse gas emissions from the production of the raw materials that go into producing the modeled BEVs

One thing we found fascinating about the UCS report was that in its 44 pages, there was not a single mention of cost, i.e., the economics of BEVs. The comparative analysis of the report was focused exclusively on the greenhouse gas emissions from the production of the raw materials that go into producing the modeled BEVs (Nissan Leaf and Tesla Model S) - both the chassis and body of these vehicles as well as their battery packs compared to selected comparable ICE vehicles. We decided to examine two aspects of these vehicle comparisons – the vehicle's cost and its range on a full tank of gasoline or battery charge.

The explanation was that the Leaf drivers drove less because of the time and frequency for charging the car

For the Leaf, the study selected five ICE models – one comparable model from each of Mazda, Ford, Mitsubishi, Volkswagen and Kia. The five models had an average vehicle curb weight of 3,000 pounds, some 10% less than the Leaf with its battery pack that weighs 650 pounds. The ICE vehicles achieved an average 29/mpg, or based on the average size gasoline tank in the models, an average range of 435 miles on a fill-up. That compares to the 84-mile range of the Leaf. An interesting point in the report was that recent data collected on Leaf vehicles shows that they are only driven 9,000 miles a year on average, less than the 12,000-mile average for the ICE models. The explanation was that the Leaf drivers drove less because of the time and frequency for charging the car.

The five ICE cars averaged a retail sales price of $18,205 compared to the Leaf's $30,680

Using the web site autotrader.com, we priced out the ICE models and the Leaf, finding the five ICE cars averaged a retail sales price of $18,205 compared to the Leaf's $30,680. Now, we believe the Leaf's price is before the $7,500 federal tax credit for EVs, or any state of local credits. Still, the 68% to 27% higher vehicle cost for the Leaf has to be offset by the savings from the cost of electricity versus gasoline. Given the range issue, which was highlighted in the reduced mileage of Leaf drivers, we have to assume that there are other issues beyond emissions savings influencing the buyers.

In the analysis of the Tesla Model S, it suffers from a 400-pound curb weight disadvantage (4,700 versus 4,300 pounds). Again, the UCS report compared the Tesla Model S against an average of five ICE models from Hyundai, Chrysler, Mercedes, Porsche and Audi. Examining the models selected, we questioned the comparability of the Hyundai and Chrysler. However, averaging all five models, they had an average cost of $71,588 compared to the estimated $68,000 price tag for the Tesla. Given that it is described as a generic Model S, and the suggested price range for all the versions of this vehicle is $68,000 to $134,000, we are not sure how to compare the vehicle costs.

The travel range for the ICE models ranged between 357 to 523 miles

What we do know is that the Tesla Model S selected was one with a 265-mile range on a single battery charge. Based on the gasoline tank sizes, the travel range for the ICE models ranged between 357 to 523 miles.

They estimate a BEV lifetime of 135,000 miles compared to an ICE vehicle's 179,000 mile lifetime

Another consideration in the analysis was the vehicle lifetimes. Since BEVs haven't been around very long, the UCS researchers estimated the lives based on extrapolating early data. They estimate a BEV lifetime of 135,000 miles compared to an ICE vehicle's 179,000 mile lifetime. The BEV lifetime is defined as the life of one battery pack, which raises other questions for individual buyers. Based on the estimated 12,000 miles per year driving average, the difference in estimated lifetimes is equal to 3.7 years in favor of the ICE models. We couldn't see any obvious economic analysis of this difference, but a vehicle that lasts nearly four years longer and likely costs less than the BEV to purchase initially, may prove cheaper in the long-run to own and operate than an EV. The BEV's cost advantage would shrink if you factored in the additional cost of a new battery pack so the two cars could last for the same length of time. But if one is only concerned about greenhouse gas emissions between the two vehicle types, then the BEV has an advantage.

They can be used as electricity storage capacity for renewable storage, such as GM is doing to power its Enterprise Data Center

One consideration about BEVs that we have been trying to assess is the impact of the battery life and its disposal. There were some studies conducted a few years ago showing that EV batteries are prime candidates for re-purposing, although they can be recycled. BEV batteries still have about 70%-80% of their original capacity left when they no longer can function for the EV. Therefore, they can be used as electricity storage capacity for renewable storage, such as GM is doing to power its Enterprise Data Center. Tesla is working on battery storage units for buildings, and used BEV batteries can be a component. We are not sure how easy it is, or how costly, to establish an EV-battery backup system for a homeowner's solar panels.

Their longevity will be compromised if ambient temperatures are outside of the range of 14o – 122o F

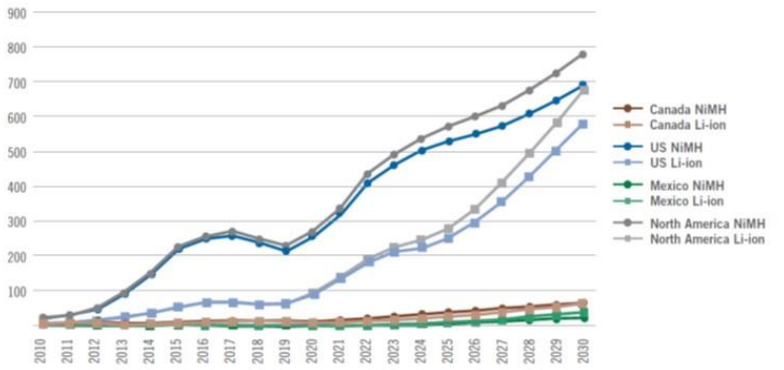
BEV batteries can be recycled for their materials – nickel and cobalt – that do have commercial value. Early hybrid and BEV batteries were made mostly of nickel metal hydride, but these vehicles are now switching over to lithium-ion batteries because of their better performance. These lithium-ion batteries do suffer from issues such as temperature extremes, meaning their longevity will be compromised if ambient temperatures are outside of the range of 14^{o} – 122^{o} F. Our understanding is that the damage to the standard EV lithium-ion battery when it experiences extreme temperatures is almost immediate. The temperature range would suggest that these vehicles need to be garaged in temperature-controlled environments, raising questions about parking them overnight in northern regions during winter months and outside during the day in desert conditions.

A big issue going forward is the switch to new battery designs that employ cheaper raw materials, meaning that they will have less recycled value

A big issue going forward is the switch to new battery designs that employ cheaper raw materials, meaning that they will have less recycled value. This reduction in value will limit the development of a battery-recycling industry. The lack of such an industry now has forced auto manufacturers to develop reverse supply chains for recovering and recycling EV batteries, as they can be dangerous and toxic if placed in landfills.

Exhibit 11. EV Battery Disposal Could Be An Issue In 15 Years

Figure 10. Estimated Number of Nickel Metal Hydride (NiMH) and Lithium-ion (Li-ion) Batteries from Electric-drive Vehicles (EDVs) at End of First Life, in Original Vehicle, in Canada, Mexico, and the United States, 2010–2030 (in thousands of units)



Source: CEC

If BEVs become very popular, we could have a problem with dealing with a growing battery disposal issue in the next 10-15 years

A report by the Commission for Environmental Cooperation (CEC) that focused on the North American battery recycling market, points out that while it estimates 276,000 electric drive batteries (NiMH and Li-ion) reached their end of life in 2015, it sees that number growing to almost 1.5 million batteries by 2030. The CEC forecast for BEVs does not seem to be aggressive, which may mean that if BEVs become very popular, we could have a problem with dealing with a growing battery disposal issue in the next 10-15 years.

Executives in the oil industry need to watch the EV evolution since the pace of acceptance will dictate how soon its disruptive impact will be felt

There is little doubt that the EV industry is becoming a disruption agent for the fossil fuel industry. The best summary of how its disruptive power may evolve was highlighted in an article “Is an all-electric car a bad investment?” The article’s author, Akweli Parker, wrote, “If you want a really good picture of how BEVs might play out in the marketplace, look no further than the Toyota Prius. The first generation Prius was by most accounts underpowered and awkward to behold. When it came to the United States in 2000, sales were sluggish. As Toyota revamped, refined and repositioned the Prius, it began to carve out its own category and dominate it. Critics of hybrid gasoline-electric technology went from outright dismissal to opposition, to finally a grudging respect. I think going completely electric is the next logical step from hybrids like the Prius.” Executives in the oil industry need to watch the EV evolution since the pace of acceptance will dictate how soon its disruptive impact will be felt. In our judgment, EVs will impact the oil business faster

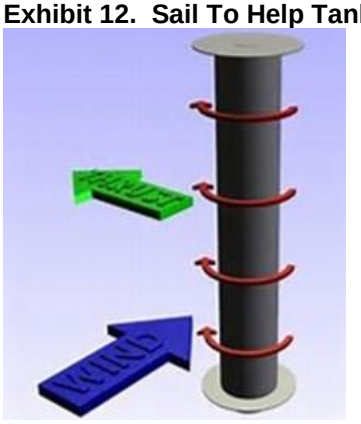
than managements expect, but slower than the environmentalists want it to happen.

Marine Sail Experiment Reminds Us Of Offshore History

Expectations are these sails will reduce average fuel consumption on typical global shipping routes by 7%-10%

We were pleasantly surprised last week to read a brief article in a shipping publication about the first planned installation of wind-powered energy technology on a product tanker. Maersk Tankers is partnering with Norsepower Oy Ltd., the Energy Technologies Institute and Shell Shipping & Maritime to install and test Flettner rotor sails on board a Maersk product tanker. The plan calls for two 30 meter (100 feet) tall by 5 meter (16 feet) wide Norsepower Rotor Sails to be installed on a 109,647-deadweight ton Long Range 2 product tanker during the first half of 2018. The ship and sail units will be tested and data will be collected about performance through the end of 2019. Expectations are these sails will reduce average fuel consumption on typical global shipping routes by 7%-10%.

Exhibit 12. Sail To Help Tanker



Source: Norsepower

Norsepower Rotor Sail Solution is a modernized version of the Flettner rotor – a spinning cylinder that harnesses wind power to propel a ship. When wind conditions are favorable, the ship's main engines can be throttled back, providing fuel savings while not impacting scheduling.

It showed that the rig's towing speed could be increased by 0.5 - 1.0 knots, saving an estimated $6,000-$9,500 in daily travel costs

This article reminded us of the 1980 experiment Robert "Bob" Palmer, CEO of Rowan Companies Inc. (RDC-NYSE) did by stringing sails between the elevated legs of one of the company's jackup drilling rigs to aid in propelling the rig. Tests were conducted in the Gulf of Mexico, demonstrating that the sails could be rigged up properly. The major test was done on a 2,400-mile tow of the Rowan Juneau rig. It showed that the rig's towing speed could be increased by 0.5 -1.0 knots, saving an estimated $6,000-$9,500 in daily travel costs. However, the sails required 4-5 days to install and remove, limiting their economic use to only very long tows. (The details were obtained from an Oil & Gas Journal article.)

While a noble experiment, the economics and logistics of the effort proved disappointing as a sustainable cost-reduction step

This experiment was conducted before heavy-lift ships for carrying rigs on major moves existed, which also helped rig owners save both on costs and on insurance for rig moves. While a noble experiment, the economics and logistics of the effort proved disappointing as a sustainable cost-reduction step. We remember following the experiment and discussing it with Mr. Palmer at the time. The Maersk news story brought back those memories. So who says history doesn't repeat?

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