PPHB
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

Confusion Over Alternative Fuel Vehicle Market Outlook

These forecasts and articles suggest dire outlooks for the oil industry

Almost every day we find a new forecast for electric vehicle sales or an article claiming to demonstrate how changing social attitudes toward car ownership and their use will hurt the oil industry. Most of these forecasts and articles suggest dire outlooks for the oil industry, their only disagreements being how quickly the damage will happen. Yet, oil company economists continue to present long-term energy outlooks that suggest only a modest impact on future oil consumption from these supposedly draconian shifts underway in the transportation sector. How can this be? Or maybe the better question is: Are any of these forecasts right?

The problem is that all three trends are relatively immature so it may be several years before forecasters have a better handle on the timing of the outcome

There are three primary long-term trends playing out in the global light duty vehicle market. How each trend develops may alter business-as-usual oil demand forecasts with the results ranging widely from possibly adding significantly to transportation fuel demand to cutting it materially. As a result, the interaction of the trends makes forecasting future fuel consumption challenging, and largely problematic. The problem is that all three trends are relatively immature so it may be several years before forecasters have a better handle on the timing of the outcome. Most forecasters employ linear trending tools in assembling their forecasts, which may not be realistic given the state of automobile technology. Technology, economic and social trends seldom move in a linear trend, often due to unforeseen events or because forecasters fail to grasp unintended outcomes. In the meantime, oil forecasters need to develop scenarios that encompass reasonable expectations for these trends in order to better assess the magnitude of change that could be heading their way. In that regard, we were intrigued to read a report recently prepared for the Energy Information Administration (EIA) to help it improve its transportation fuel forecasts.

It is important to understand both the broad trends as well as the various options within each trend

The report focused on the three broad trends reshaping the transportation sector. Those trends are: 1) vehicle ownership versus sharing; 2) human driving versus fully-autonomous; and 3) social costs, which is an attempt to capture the pace at which technology will be embraced by consumers. To those three trends, we would suggest a fourth: the issue of how future vehicles are powered. Will they have internal combustion engines (ICE) or drive trains powered by alternative energy sources, most likely electricity. Within each of the broad trends are a range of options and considerations, some of which may become more important than others as a force impacting fuel consumption. Thus, when preparing a future fuel consumption forecast, it is important to understand both the broad trends as well as the various options within each trend to adequately assess the impact on future transportation fuel needs.

One study shows that partial-ownership of one urban vehicle could replace nine to 13 urban vehicles

The issue of car ownership versus car/ride sharing is a key one as it impacts how much a vehicle will be driven in the future as well as how many vehicles may be needed. To appreciate the significance of this issue, one study shows that partial-ownership of one urban vehicle could replace nine to 13 urban vehicles. That has significant implications for new car sales as well as for total fuel consumption. The concept surrounding car ownership is sometimes referred to as mobility, but we consider that a much broader category, which to us would also include how vehicles are driven.

A 2015 *Forbes* article discussed six transportation trends the authors, all investors in the Green Growth Fund at Kleiner Perkins Caufield & Bryers, one of the oldest technology-oriented venture capital firms in this country, thought was important in shaping the sector in the future. We considered several of their trends as merely sub-trends within our broader categories.

Leading-edge investors are attempting to capitalize on the emerging vehicle-sharing trend

The authors pointed out that in 2014, the venture capital industry had invested $5.7 billion in transportation businesses, more than twice the level of investment in the previous two years. Over half of the 2014 funding went to Uber, which is now the leading ride-sharing company globally. The Uber investment was followed by GrabTaxi, a taxi booking app, Lyft, another ride-sharing company, BlaBlaCar, a long-distance ride-sharing app, and INRIX, a navigation and parking app developer. While these investments were all made in 2014, for technology start-up companies, three years in business can be an eternity and sufficient time to demonstrate the success of their vision. The range of transportation services leveraging technology and the explosive growth of smart phones being invested in shows how leading-edge investors are attempting to capitalize on the emerging vehicle-sharing trend.

The growth of ride-sharing services reflects to some degree the maturing of Millennials who are much more comfortable with leading-edge, social technology, and who are swarming to urban areas to begin their careers. Millennials are discovering that living in

Ride sharing has become a way to access personal transportation at a reduced cost

Cities is stimulating but also challenging due to smaller apartments and fewer spaces for parking vehicles, all of which they are finding come at inflated prices. As a result, ride sharing has become a way to access personal transportation at a reduced cost – less than the prices charged by regulated taxis or limo services – while gaining increased flexibility compared to the cheaper transportation alternatives of subways or busses.

Car sharing is another aspect of this trend, although it started ahead of ride sharing. The idea of car renting by the hour on college campuses and in urban areas was envisioned by the founders of Zipcar, which now has over 730,000 members who reserve and use 11,000 cars by the hour. The success of Zipcar convinced traditional rental car companies such as Hertz Global Holdings (HTZ-NYSE) and Enterprise Rent A Car, as well as auto maker Daimler (DDAIY-OTC), to start competitive car-sharing services.

Navigant Research projects that global car sharing services revenue will grow from $1.1 billion in 2015 to $6.5 billion in 2024

Professor Susan Shaheen of UC Berkeley, has written a paper about shared mobility. For her, the subcategories of car sharing include roundtrip, one-way and personal vehicle sharing, including fractional ownership models. All of these trends are enabling explosive growth for the business. Navigant Research projects that global car sharing services revenue will grow from $1.1 billion in 2015 to $6.5 billion in 2024. The service allows households to own only one car, instead of two or three, or for some families to forgo car ownership entirely. That flexibility is important in expensive and congested urban areas. As the trend grows, as suggested by Navigant Research, it will negatively impact both vehicle sales and vehicle miles traveled, meaning less fuel consumption.

Car sharing services are also being touted as a low-cost way for people to try out different vehicle models that they might be considering buying with a more flexible test-driving experience than your traditional dealer test-drive with the salesman along. Car sharing services, because of their locations in urban areas, where drivers travel limited distances, are becoming a test market for electric vehicles (EVs).

The move toward fully-autonomous driving vehicles is pushing more technology into cars

The issue of how cars will be driven in the future has significant implications for energy markets. Whether they will largely be driven by humans or by machines has yet to be determined. However, safety considerations are pushing car manufacturers and vehicle regulators to place greater machine-controlled technology into vehicles. At one time, cruise control, anti-lock brakes and even air bags and seatbelts were considered leading edge technology in cars. Today, the move toward fully-autonomous driving vehicles is pushing more technology into cars. Key technologies such as lane-keeping assistance, adaptive cruise control, collision avoidance systems, electronic stability control, parking assistance, blind spot warning systems, drowsiness alerts, as well as 360° cameras are making driving much safer. The ultimate goal of safety experts is

Fully-autonomous driving with absolutely minimal involvement by a human. This goal is driven by government statistics that show 97% or greater of all accidents in this country are caused by driver error. While attempting to eliminate the prime cause of accidents is a laudatory goal, the pace at which the necessary technology can be introduced into the vehicle fleet is a significant impediment. The best example of this transition hurdle comes from the experience with Electric Stability Control (ESC), which was introduced in 1995. ESC is computerized technology that improves a vehicle's stability by sensing and reducing loss of traction that helps control a vehicle during skids. ESC was mandated on all new light duty vehicles beginning in 2011, 16 years after its commercial introduction. Estimates are that ESC will not be installed on 95% of registered vehicles until 2032, which is 37 years after its introduction and 21 years after it was mandated. As other crash avoidance systems have exhibited similar adoption timeframes, one must question the assumption of fully-automated systems following a different trajectory.

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As automobiles transition from being completely under the control of a human driver to being totally controlled by machines and computers, several things can happen. If cars can operate without having accidents, highway speeds can be increased, which could reduce vehicle fuel-efficiency, boosting fuel consumption. Fully-autonomous driving will also enable classes of the population currently unable to utilize vehicles, adding more vehicle miles traveled to the nation's transportation system and increasing fuel consumption. Those classes of people include non-drivers, along with the elderly, disabled and young people. A study by Carnegie Mellon University estimates that this expansion of the driving population could increase vehicle miles traveled by 14%, or adding 295 billion miles of driving annually. That will mean more fuel consumed, regardless of how fuel-efficient the vehicles are that these classes of people utilize. A rough calculation based on vehicles with 30 miles per gallon ratings, means about 675,000 barrels a day of additional gasoline, or approximately a 7% increase on today's gasoline consumption. Fully-autonomous driving suggests more vehicle use, more miles driven and more fuel consumed. The offset is if fully-autonomous vehicles dominate the growing car/ride-sharing segment of the transportation sector, which could act to reduce fuel consumption.

This expansion of the driving population could increase vehicle miles traveled by 14%, or adding 295 billion miles of driving annually

Whether the vehicles of the future are ICE-powered or derive their power from some other fuel source will be influenced by the outcomes of the other two broad trends. For example, if we become a nation of car-sharers, there will be fewer vehicles needed, vehicle miles traveled might decline, although they just as easily could increase. A fully-autonomous vehicle provides the possibility of having a greater impact on fuel consumption than human-driven vehicles. First, cars that don't have accidents can be made from lighter materials that facilitates more EVs since greater battery

If we become a nation of car-sharers, there will be fewer vehicles needed, vehicle miles traveled might decline, although they just as easily could increase

With fully-autonomous vehicles offering the potential for increased vehicle use, fuel consumption is likely to increase

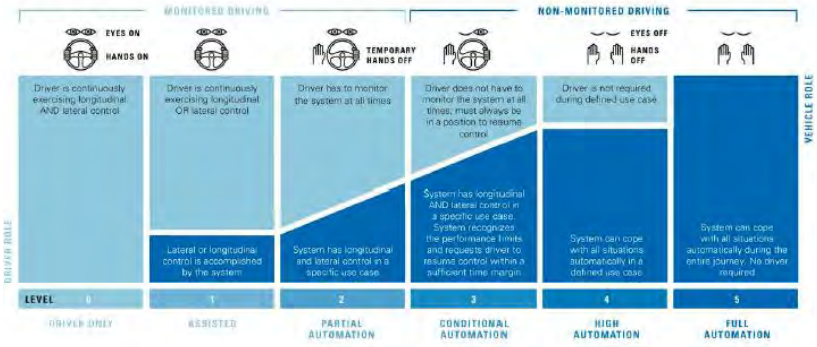
Weight will be offset by lighter vehicle bodies and frames. That could help EVs overcome some of the range-anxiety challenges for many potential buyers. It could help accelerate the electrification of the automobile fleet, which would have a significant negative impact on vehicle fuel consumption. On the other hand, if ICE powered vehicles remain the popular option, fuel consumption might not be as impacted as in an EV-favored scenario. With fully-autonomous vehicles offering the potential for increased vehicle use, fuel consumption is likely to increase.

As mentioned earlier, the EIA commissioned a "Study of the Potential Energy Impacts of Connected and Automated Vehicles." The study involved a literature search of the issues involved in shaping energy consumption if, and when, connected and automated vehicles (CAV) gain a greater share of the American vehicle fleet. The study also involved forecasting the potential impact on future fuel consumption given certain assumptions about the pace of and impact from various technologies and social factors discussed previously.

They go from zero, total human control, to five, with the vehicle completely under the control of a computer utilizing vehicle sensors and artificial intelligence

One of the first issues in preparing the forecast was to identify the various stages of automated vehicles, which was accomplished by using the categories set forth by the Society of Automotive Engineers International (SAE). Those categories are shown in Exhibit 1, and go from zero, total human control, to five, with the vehicle completely under the control of a computer utilizing vehicle sensors and artificial intelligence.

Exhibit 1. Sizing Up The Range Of Autonomous Vehicles



Source: EIA

Before translating the impact of CAVs to fuel consumption, the study examined other issues impacted by the technology such as state and federal regulation, as well as the impact on the insurance industry due to changes in liabilities and elimination of vehicle accident claims. The latter consideration could be significant due to the impact on the revenues of the insurance industry and the number of jobs the industry supports – employees, claims adjusters and body repair workers, for example.

Mainstream adoption of autonomous driving technology is more than 10 years away, or after 2025

One of the key determinants in forecasting the potential impact on fuel consumption from CAVs is understanding the possible pace of acceptance of the technology. The report examined information from the Gartner Group, a leading technology consulting and forecasting firm. It produced a chart showing the time of acceptance of a number of relatively new and important technologies, including autonomous vehicles. Based on their Hype Cycle for Emerging Technologies curve (Exhibit 2), mainstream adoption of autonomous driving technology is more than 10 years away, or after 2025.

Exhibit 2. Autonomous Vehicle Technology Still A Ways Away

Source: EIA

While Gartner has had a number of high profile and precise technology acceptance forecasts, it also has had some key misses. The study listed a number of other forecasts for autonomous vehicle technology acceptance including:

ABI Research targets automated vehicle commercialization by 2012, with Level 2 and Level 3 systems accounting for 86% of global automated vehicle sales through 2026, and the higher levels of automation approaching one-third of total automated vehicle sales by 2030.

Deloitte believes CAVs will account for 80% of total U.S. vehicle sales by 2040.

Goldman Sachs predicts 100% market penetration by 2025, with Level 1 and Level 2 automation on 85% of total new sales and Level 3 and Level 4 on the remaining 15%. The higher automation level will reach 100% of vehicle sales by 2045.

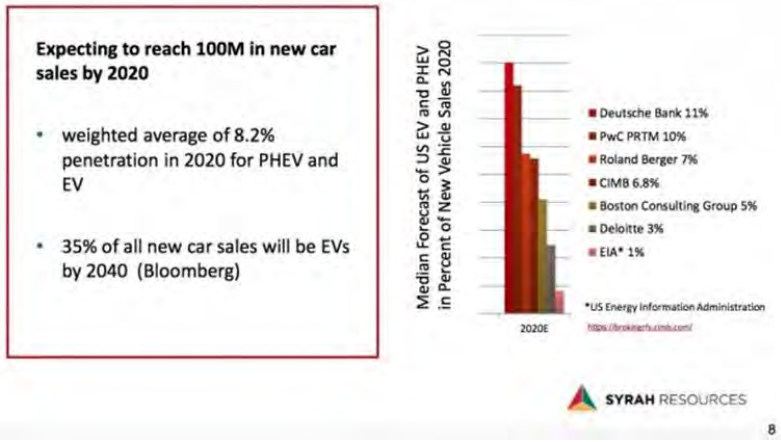
IHS Automotive forecasts U.S. sales of several thousand Level 4 and Level 5 automated vehicles in 2020, growing to nearly 3.5 million vehicles sold in 2035.

Juniper Research predicts widespread driverless vehicles in the 2020-2025 time frame (global production of 14.5 million vehicles with an installed capacity of over 22 million), but these vehicles will be limited to certain urban city centers or other specific operational domains because of a need for vehicle-to-vehicle communication infrastructure.

McKinsey & Company expects 15% of total new car sales by 2030 to be fully automated.

Here is another set of forecasts comparing a wide range of estimates for EVs in the U.S. auto fleet in 2020.

Exhibit 3. Can We Go From 1% to 8% Share In Four Years?



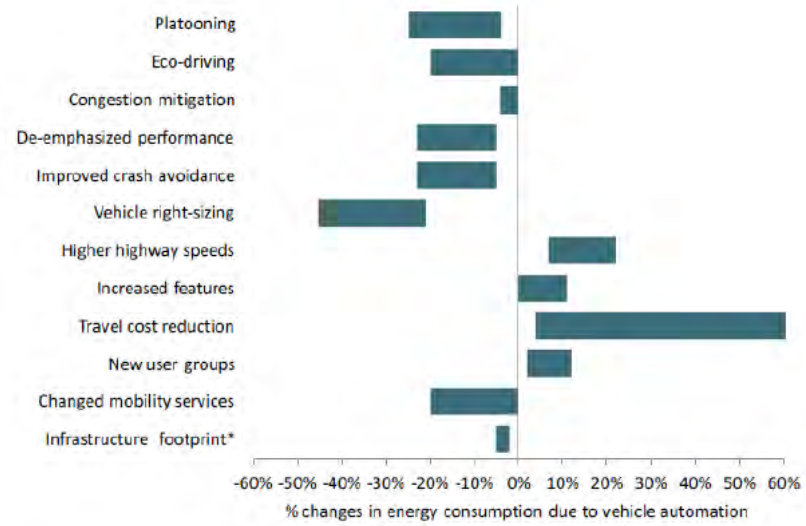
Source: Syrah Resources

If every technology were adopted, it looks like the net result would be a reduction in fuel consumption

The question quickly becomes how all the variables discussed may impact future fuel consumption. One 2014 study in Road Vehicle Automation showed the chart in Exhibit 4 (next page) that enumerates the potential positive and negative impacts on fuel consumption from the adoption of vehicle automation technology and changes in vehicle use. If every technology were adopted, it looks like the net result would be a reduction in fuel consumption. Obviously, not all will be adopted at the same time and to their maximum impact.

As part of the study, a model to predict fuel consumption (including both light duty vehicles, buses and trucks) was developed to measure increases and decreases from the 2017 EIA Reference Case. The critical ingredients in the forecasts required estimating vehicle miles traveled, vehicle fuel efficiency and travel cost, which the study's authors use as a measure of consumer adoption of CAV

Exhibit 4. Fuel Demand Impacted By Automated Vehicles

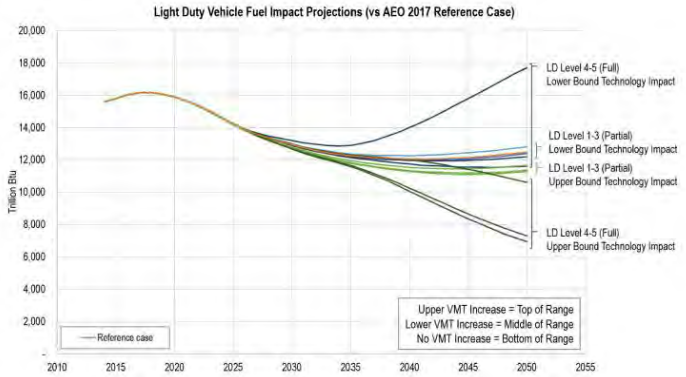


Source: Road Vehicle Automation

Using today's roughly nine million barrels a day of gasoline consumption, the 2050 spread would mean we could be consuming anywhere from five million and 13 million barrels a day of gasoline

Technology. The chart in Exhibit 5 shows the results of the various models. The range of impact on light duty vehicle fuel consumption is estimated to be between -2% to +2% by 2030 from the Reference Case volume, and from -16.6% to +16.1% by 2040. The range of potential fuel impacts in 2050 is much greater at between -44.4% to +42.0%. To put this range in perspective, using today's roughly nine million barrels a day of gasoline consumption, the 2050 spread would mean we could be consuming anywhere from five million and 13 million barrels a day of gasoline. Should oil companies be planning to build new refineries or not?

Exhibit 5. Who Can Be Wrong With This Forecast Range?



Source: EIA

The conclusion one draws from the study for the EIA, and all the other studies we have examined, is that forecasts of EV penetration into auto fleets should be viewed skeptically. Seldom do the studies reveal all the assumptions, and ranges of assumptions, underlying

We have yet to see a forecast that integrates, and prices out, the charging infrastructure needed for a 100% EV fleet, nor whether the existing power infrastructure can handle the electricity loads

The forecasts, making it easy for an anti-fossil fuel supporter to show how much fuel consumption can be reduced if only certain technologies or social changes are adopted. On the other hand, many of the forecasts overlook factors that could counter fuel reduction forces, or that might even add to the nation's future transportation fuel use. As pointed out earlier, the wide range of adoption times of many of the technologies that are projected to significantly impact automated driving, makes forecasts that blindly assume the impact to be significant in the near term have significantly less credibility than ones assuming a more conservative adoption pace. We have yet to see a forecast that integrates, and prices out, the charging infrastructure needed for a 100% EV fleet, nor whether the existing power infrastructure can handle the electricity loads. Nor have any forecasts measured the impact of battery performance due to cold and extremely hot temperatures. Of course, if everyone has solar panels and charges their EVs at home, we will resemble the Wild West ranchers whose horse corrals contained the totality of their horsepower, along with their wind turbine to lift water from their wells. What happens to all the apartment dwellers?

For energy company executives, there isn't a need to be constantly reforecasting oil use, but instead they should be closely watching how rapidly the various technologies needed to facilitate the EV revolution are being adopted. While the conclusion is not known, the pace of technology adoption and regulatory embrace will help determine at which end of the range the demand impact will fall, and possibly how quickly it will develop.

Rumble In The Desert, Or The 2010s Version Of Bonanza?

These actions potentially may force the government to concede that its economic and social reorientation strategy for Saudi Arabia will need to be adjusted – either scaled back or operated on a longer timetable, or both

On April 22nd, Saudi Arabia King Salman bin Abdulaziz Al Saud made significant personnel shifts within his government and announced a reversal of a previous policy action. While the actions will help insure the kingdom's stability, they also reflect the pressure the leadership feels about its potential vulnerability to social upheaval. These actions potentially may force the government to concede that its economic and social reorientation strategy for Saudi Arabia will need to be adjusted – either scaled back or operated on a longer timetable, or both. The most immediate impact may be on Saudi Arabia's leadership in renewing the OPEC production cut agreement, and pushing for a higher global oil price sooner than had appeared to be the government's plan.

The Saudi Arabian drama is much like the long-running (1959-1973) television western Bonanza, in which the patriarch, Ben Cartwright played by Lorne Greene, bands with his three sons – Adam played by Pernell Roberts, Eric "Hoss" played by Dan Blocker, and Joseph "Little Joe" played by Michael Landon - to deal with moral dilemmas in defending their Ponderosa Ranch near Virginia City, Nevada,

Exhibit 6. Cartwright Clan Ponders Challenges To Their Morals

Source: NBC

Now we have King Salman along with three of his sons directing much of what is and will go on within Saudi Arabia, the global energy market and the geopolitical struggles of the Middle East

Against evil doers. Now we have King Salman along with three of his sons directing much of what is and will go on within Saudi Arabia, the global energy market and the geopolitical struggles of the Middle East. That metaphor may be better, although similar, than comparing Saudi Arabia to Joe Foreman, the undefeated world heavy weight champion, who was knocked out by former heavyweight champion, Muhammed Ali, aka the U.S. shale, in the famous Rumble in the Jungle in the Congo in 1974. Maybe some reruns will help us understand the present.

Exhibit 7. Ali Over Foreman; Shale Over Saudi Arabia?

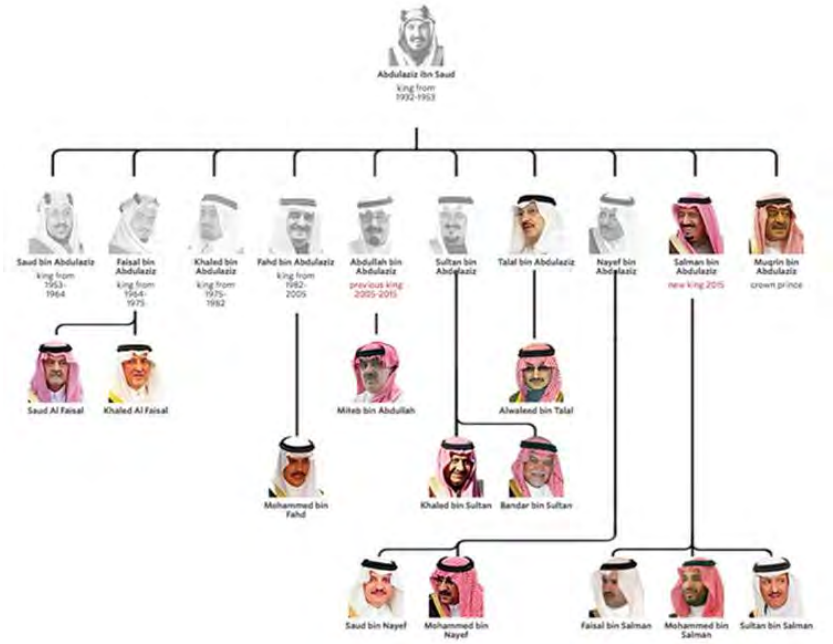
Source: You Tube

On the personnel shifts, King Salman elevated his son, Prince Abdulaziz bin Salman to Minister of State for Energy. He previously held senior management positions within the ministry during his 20

Prince Abdulaziz bin Salman was opposed to the "market share" strategy behind the November 2014 decision to allow oil prices to seek their own level

Year career, but most notably he was opposed to the "market share" strategy behind the November 2014 decision to allow oil prices to seek their own level. His argument was that the strategy would eventually lead to a "super spike" in oil prices due to a lack of adequate investment in finding and developing new crude supplies. The Prince's half-brother and full brother of Deputy Crown Prince Mohammed bin Salman (MBS), Prince Khaled bin Salman, a former F-15 fighter pilot in the nation's air force, has been appointed Saudi Ambassador to the United States. This move is seen as an attempt to forge closer relations with the Trump administration. These moves further concentrate the political power within the Salman line of the Royal Family.

Exhibit 8. The Current Royal Family Power Line-up



Source: ***WSJ***

The army leader's removal reflects the problems Saudi Arabia has had in leading the Gulf States military coalition to oust the Iranian-backed rebels currently controlling neighbor Yemen

As these personnel moves were being announced, King Salman relieved civil service minister Khled al-Araz, who is now under investigation for hiring irregularities in the ministry, information minister Adel al-Toraifi, technology minister Mohammed al-Survaiyel, and army head Lieutenant General Eid al-Shalawi from their positions. The army leader's removal reflects the problems Saudi Arabia has had in leading the Gulf States military coalition to oust the Iranian-backed rebels currently controlling neighbor Yemen.

King Salman reversed the civil service and benefits cuts instituted last September

On the economic front, King Salman reversed the civil service and benefits cuts instituted last September as the kingdom's finances were strained due to low oil prices (which didn't show signs of recovering) and continued high spending. The move last fall involved reducing minister salaries by 20%, along with instituting

Sharp reductions in civil service benefits. These moves followed steps taken earlier to cut government spending by reducing subsidies for fuel costs and utilities for residents in the kingdom.

The king also decreed that two months extra salary would be paid to members of the armed forces taking part in the war in Yemen

The reversals have been helped by rising government revenues in 2016, as a result of higher oil prices during the second half of the year and better spending control. The revenue boost helped reduce the budget deficit from $98 billion in 2015 to $79 billion last year. According to a press release from the Saudi Press Agency, the government was able to cut its projected budget deficit in half during 2017's first quarter. The king also decreed that two months extra salary would be paid to members of the armed forces taking part in the war in Yemen. Earlier in April, King Salman boosted by up to 60% the salaries of pilots flying bombing attacks against the rebels in Yemen.

The citizens eschew political activism in return for the government providing for most of their everyday needs

The challenge for Saudi Arabia is balancing economic and oil policies in order to maintain the social contract at the core of the country. The citizens eschew political activism in return for the government providing for most of their everyday needs. Oil revenues have been the source of the government's largesse, and with the 2014 decision, the country has been faced with a deteriorating financial condition. Besides last year's social benefits cuts, and energy and utility subsidy reductions, the government started looking at all other spending plans. The Bureau of Capital and Operational Spending Rationalization, an agency established last year, has been looking into shelving billions of dollars-worth of social reform and development projects.

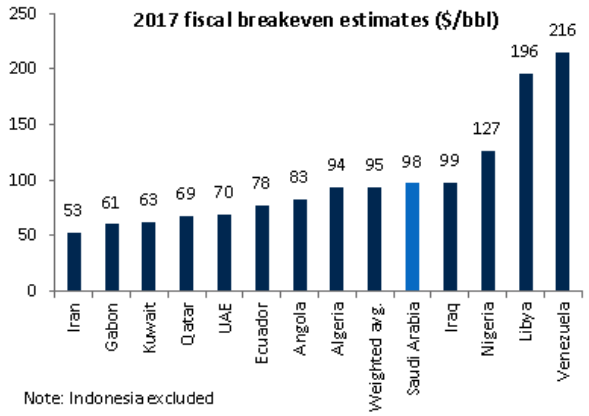
It was always perceived that the income and benefit cuts would be temporary, and when the government's revenues increased, restoring those benefits became important.

The compensation actions last year was also part of the Vision 2030 plan conceived under MSB to modernize the country's economy, wean it from its dependency on crude oil exports and create a 21st Century economy based on technology and finance. Critical in that plan was devising a way to not destroy the social contract that has and continues to provide stability for the country in a region where government stability is highly tenuous. Therefore, it was always perceived that the income and benefit cuts would be temporary, and when the government's revenues increased, restoring those benefits became important. The salary boosts for the military is also important as a way to prevent social unrest there to foment a coup.

Last year saw significant improvement in the government's overspending – falling from an average of 25% a year during the prior decade to only 10.7%

For the rest of the world, recognizing that a stable Saudi Arabia in the Middle East region is critically important, the question becomes what do these actions mean for oil prices? After having cut its deficit meaningfully last year, the spending actions probably eliminate any chance of the government hitting its 2017 target of only a $53 billion deficit. Last year saw significant improvement in the government's overspending – falling from an average of 25% a year during the prior decade to only 10.7%. The 2017 deficit target suggests the kingdom believed it could further control spending going forward and that oil prices would be higher.

Exhibit 9. Saudi Arabia Needs Higher Price To Break Even



Source: RBC

With oil prices hovering around $50 a barrel, Royal Bank of Canada (RY-NYSE) estimates Saudi Arabia's fiscal breakeven price is nearly twice that price. While we don't have any breakeven estimate from prior years from RBC, others have projected a price well above $100 a barrel.

The IMF is projecting the country's economic growth this year will only be 0.4%, down from 1.4% last year

The huge budget deficits since the drop in oil prices have sharply cut into the country's international currency reserves. Within the past two weeks, Saudi Arabia went to the debt market to borrow $9 billion, the second such offering in the past six months. With the International Monetary Fund (IMF) projecting the country's economic growth this year will only be 0.4%, down from 1.4% last year, the government is presenting the salary and benefit cut restorations as a

Exhibit 10. Saudi Currency Reserves Slipping Away

Source: *Bloomberg*

Reports from within Saudi Aramco, the state oil company, indicate analysts cannot reach an implied stock market value of $2 trillion for the company as originally touted by MBS

Way to stimulate economic growth. At the same time, reports from within Saudi Aramco, the state oil company, indicate analysts cannot reach an implied stock market value of $2 trillion for the company as originally touted by MBS when he unveiled the plan to float the company on world stock markets. If true, this means the offering, targeted for early 2018, would raise less money for the government putting further pressure on controlling spending or getting higher oil prices, or both.

All of these pressures point to Saudi Arabia becoming more anxious about seeing the global oil price stay in the $50s a barrel range or even go higher

All of these pressures point to Saudi Arabia becoming more anxious about seeing the global oil price stay in the $50s a barrel range or even go higher. That also suggests Saudi Arabia, after providing tacit support for extending the production cut agreement, may become a more active cheerleader for this to happen. The government's prior "less enthusiastic" support for a six-month extension may become much warmer in the coming weeks as the May 25th OPEC meeting, at which the extension is to be considered, draws near. Russia, who also needs a higher oil price to keep its economy functioning, has indicated coolness to the extension, probably because it likes to be the pursued damsel. Will Saudi Arabia be leading that pursuit, and if so how hard?

Will the need to preserve its social contract force Saudi Arabia to delay its economic redevelopment plans?

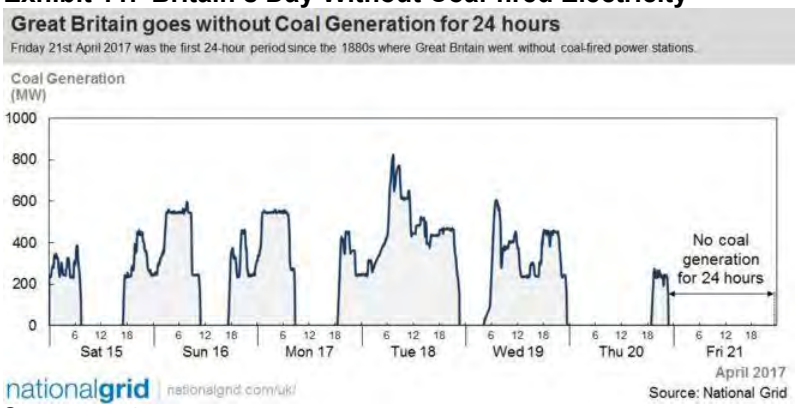
We are sure Saudi Arabia would like a stronger oil price to support a potentially higher valuation for the Saudi Aramco offering, but it also continues to cast a warry eye on the shale basins in the United States where the rig count has surged and production is accelerating. Will the need to preserve its social contract force Saudi Arabia to delay its economic redevelopment plans? More importantly, will Saudi Arabia find itself, along with the rest of the world's oil industry, trapped in an extended "do loop" of higher oil prices, higher oil output, lower oil prices, reduced capital investment, falling activity, and lower production, until the foundation of the world's oil supply is destroyed? How long might that purgatory last?

A Day In The Life Of A Country Powered Without Using Coal

For a 24-hour period on Friday, April 21, 2017, Great Britain went without any electricity being generated by coal-fired power plants

The BBC reported that for a 24-hour period on Friday, April 21, 2017, Great Britain went without any electricity being generated by coal-fired power plants, the first time this has happened in the country in 135 years. The news came via a Tweet from the control room of National Grid plc (NGG-NYSE), the UK energy provider. The previous longest continuous periods without coal-generated electricity were the prior day, Thursday, and again during May 2016, when the nation went for 18 hours. Instead, Britain got its electricity natural gas (50.3%), nuclear (21.2%), wind (12.2%), imports from other countries (8.3%), biomass (6.7%), and solar (3.6%). The total doesn't add to 100% due to power exports and hydropower. At the same time, lower demand due to being in the shoulder-months of energy demand also made this event possible.

Exhibit 11. Britain's Day Without Coal-fired Electricity



Source: ***BBC***

Coal-generated electricity was only 9% of the nation's total in 2016, down from 23% the prior year

This news is being hailed as a harbinger of the future for Britain's power system as coal generated electricity was only 9% of the nation's total in 2016, down from 23% the prior year. Coal for the power market accounted for 40% of output as recently as 2012, showing just how rapidly renewables and natural gas, coupled with reduced power needs, have changed the British electricity market. The last deep coal mining operation in England, Kellingley Colliery in North Yorkshire, closed in December 2015, although open cast mining is still conducted. Coal remains an important fuel for heavy industrial users such as steel mills and cement plants. The nation's last coal-fired power plant is scheduled to close in 2025, and the country currently operates nine coal-fired electricity generating plants.

Great Britain was the home of the world's first public coal-fired generating plant, opened by Thomas Edison at Holborn Viaduct in London in 1882. At the time the plant opened, it was reported in the *Observer* that "a hundred weight of coal properly used will yield 50 horse power for an hour." It further reported that each horse power "will supply at least a light equivalent to 150 candles". We have certainly progressed from candle power.

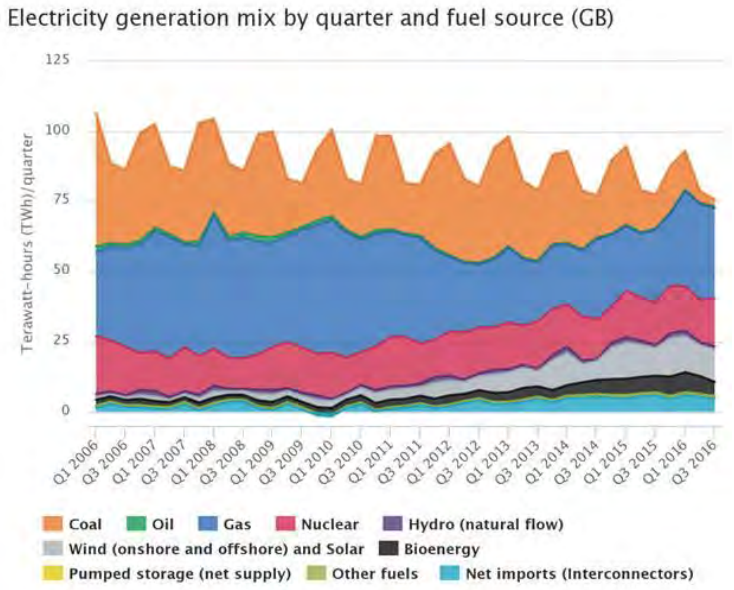
In 1956, the UK enacted the Clean Air Act in an effort to reduce air pollution in response to the famous "pea soup" fogs known to envelop England, especially in the southern portion of the country. One action from this law was the effort to move coal-burning power plants outside of cities to help improve urban air pollution.

During the 1970s, the growth of North Sea natural gas enabled the country to displace coal used for heating homes, a positive for air pollution

During the 1970s, the growth of North Sea natural gas enabled the country to displace coal used for heating homes, a positive for air pollution. In the 1980s, nuclear power emerged as a potent electricity generation source, reaching a consistent 25% of total power supply in England. Once again, natural gas received considerable attention – the "Dash for Gas" effort pushed its share of total UK power to 30%, largely at the expense of coal-fired power

During the 1980s and 1990s. Since the turn of the century, Great Britain has pushed to develop a renewables-based electricity generation business focused on wind, and in particular, offshore wind. By 2015, renewables – wind, solar and biomass – had reached 25% of the nation's power supply.

Exhibit 12. How Britain Is Fueling Its Electric Generation



Source: Ofgem

Wood is not carbon neutral and emissions from burning wood pellets are higher than coal, making pellet use a flawed emissions' reduction policy

Two issues with the renewables push have emerged. First, a report from the prestigious Chatham House in February said wood is not carbon neutral and emissions from burning wood pellets are higher than coal, making pellet use a flawed emissions' reduction policy. As expected, the utility industry rejected the report's conclusions, saying that wood energy cuts carbon emissions significantly compared with fossil fuels.

To avoid possible power blackouts when the wind didn't blow, National Grid contracted for 10 coal and gas-fired power plants to remain on standby at a cost of £122 million ($157 million)

The second issue has to deal with the intermittency of renewables, especially wind, which is the fastest growing source of new electricity generation. Wind now accounts for 53% of total renewable power, which is 24% of total UK electricity generation, or about 13% of total electricity. Wind's share has grown significantly since 2011 when it accounted for a very low single digit share of electricity output. But due to the growing share of electricity being generated by renewables, last winter, to avoid possible power blackouts when the wind didn't blow, National Grid contracted for 10 coal and gas-fired power plants to remain on standby at a cost of £122 million ($157 million). We don't know whether that step will need to be taken during the upcoming winter, but we would not be surprised.

Exhibit 13. The Source Of England's Electricity Supply

Source: ***Good Energy News***

60% of the fuel to power Great Britain is imported

The other most surprising fact about Britain's electricity is where its fuel supplies come from. According to *Good Energy News*, 60% of the fuel to power the country is imported. Of the 40% of fuel supplies that come from local sources, almost half of it comes from renewables. We are not sure whether that fuel supply mix puts England at a risk of fuel supply disruptions or not, but it certainly is a geopolitical risk. What role might this play in the upcoming Brexit negotiations?

China EV Market Size Heats Up Debate About Its Attraction

The Chinese government's answer to the bad air is to restrict the use of coal for generating electric power and to push Chinese auto buyers to purchase EVs

The recent Shanghai auto show highlighted a large number of new and conceptual electric vehicle (EV) offerings from the world's leading auto manufacturers. China has struggled with very poor air quality in many of its major cities. The pollution has been so bad at times that city governments have been forced to shut down industrial plants as well as relocate power plants outside the city limits. Weather patterns have also contributed to inferior air quality conditions in certain locales. The Chinese government's answer to the bad air is to restrict the use of coal for generating electric power and to push Chinese auto buyers to purchase EVs. The government proposed last September that EVs or gasoline-electric hybrids make up 8% of every auto brand's production as early as next year, with that figure to rise to 10% in 2019 and 12% in 2020. The auto manufacturers have warned the Chinese government that these targets are too aggressive, and reports are that the regulators may have eased off on the target, but nothing has been released officially.

While the government wants EVs, the buyers want SUVs

The push for EVs has created a headache for auto manufacturers, who see sales volumes in the country slowing and are concerned about their ability to retain whatever proprietary EV technology they profess as they are forced to operate in joint ventures with local companies, given China's history in failing to protect intellectual capital. These problems are compounded by the fact that while the government wants EVs, the buyers want SUVs. First quarter sales of SUVs reached 2.4 million units, up 21% over the same period in 2016, while EVs fell 4.4% to only 55,929, or a little over a quarter of the government's proposed sales target.

Numerous electrified SUV and crossover models were either shown or talked about at the Shanghai show, but the overall slowing of auto sales in China was a point of much discussion. March auto sales increased only 1.7% over last year, when the rate of increase then was 15%. SUVs accounted for 40% of March sales.

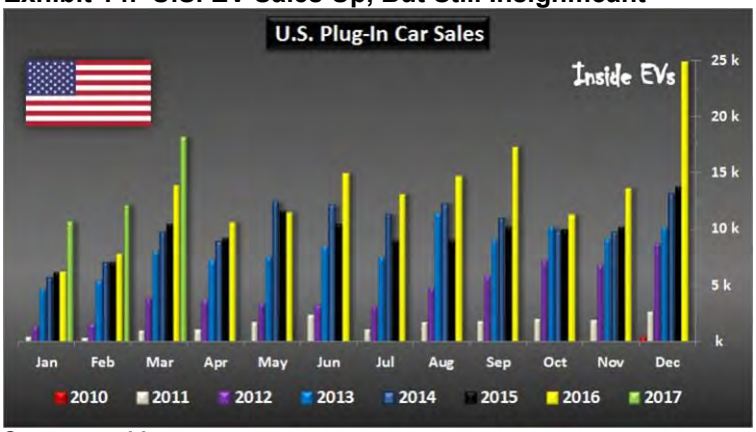
While the 2016 sales were up 50% over 2015, the results fell short of the CAAM prediction that 700,000 plug-in vehicles would have been sold

With auto sales running at 28 million units versus the U.S.'s 17.5 million annual rate last year, China is clearly the world's leading auto market. This market is critically important to certain global car companies such as VW, who recorded 40% of its sales in China. What has some auto forecasters concerned is that the tax cut on larger engines instituted in 2016 pulled forward sales from 2017. The full effect of the sales tax cut will be gone by 2018, when some forecasters are predicting a fall in Chinese auto sales. It is unclear what this may mean for EV sales. The China Association of Automobile Manufacturers is predicting 800,000 plug-in vehicles will be sold in 2017, up from the 507,000 battery EVs and plug-in EVs sold in 2016. While the 2016 sales were up 50% over 2015, the results fell short of the CAAM prediction that 700,000 plug-in vehicles would have been sold. The health of the automobile market plus the uncertainty about the imposition of the 8% sales requirement has resulted in one auto research firm suggesting that 2018 EVs sales could range anywhere between 650,000 and 2.6 million units.

"If people are saying they are interested in electric vehicles and intend to make their next purchase one, then that interest is not translating into sales"

Similar consternation is evident in the U.S. and Germany. A recent survey by AAA found that more than 30 million Americans are likely to buy an EV as their next car. Unfortunately, they didn't give a time frame, and with vehicles lasting now beyond 11 years, that number may be more impressive in aggregate than providing any accurate measure of true demand. An article on *CNBC.com* about the survey quoted Michelle Krebs, senior analyst for Autotrader, saying, "The AAA survey does not correlate at all with what Cox Automotive's Kelly Blue Book or Autotrader see in surveys or in shopping and sales data. If people are saying they are interested in electric vehicles and intend to make their next purchase one, then that interest is not translating into sales." For the first quarter of 2017, about 1% of new car sales were EVs.

Exhibit 14. U.S. EV Sales Up, But Still Insignificant



Source: ***Inside EVs***

The problem according to the study is RIP – range, infrastructure and price

In Germany, a new report by WWF Germany and renewable power provider LichtBlick notes that the country is trailing China and the U.S. when it comes to electric transportation. The problem according to the study is RIP – range, infrastructure and price. "Germans are used to jumping in their cars and driving 600 or 700, or even 1,000 kilometers without the need to fill up the tank, and there's always a gas station nearby. Realistically, the range for electro cars is about 150, max 200 kilometers, and the worry about being stranded and not being able to go any further is very big for consumers," stated Gregor Kolbe, a transport and consumer politics expert at the Federation of German Consumer Organizations.

Specific models can range from 25% or 100% more for the EV version

The cost of EVs compared to similar gasoline or diesel versions in Germany is significant. Specific models can range from 25% or 100% more for the EV version. In a country focused on reducing carbon emissions and becoming powered exclusively by renewables, one wonders how long its auto manufacturing sector can hold off EVs. Maybe the answer will come when the German car makers target the Chinese auto market and are forced to develop competitive EVs. That might be the tipping point for Europe, and possibly the U.S.

Issues Affecting Germany's Electricity Market

This is a reflection of Dong's belief that the cost of offshore wind is now competitive without government subsidies

In the first of two German auctions, the Bundesnetzagentur, Germany's Federal Network Agency, on April 13th awarded DONG Energy (DENERG-Nasdaq), the Danish power company, the right to build three offshore wind projects in the German North Sea. Importantly, two of these projects were won with a zero subsidy bid. This is a reflection of Dong's belief that the cost of offshore wind is now competitive without government subsidies. This announcement is being heralded as a significant breakthrough in the economics of offshore wind and renewables in general in Europe. However, even some proponents of wind power question whether the economics

Have improved sufficiently to enable offshore wind to compete with onshore power without a subsidy.

The company will sell its power directly to customers at whatever price it can negotiate from these two projects

In the auction, DONG Energy submitted six project proposals and won three of them. The projects were OWP West with 240 megawatts (MW), Borkum Riffgrund West 2 with 240MW, and Gode Wind 3 with 110MW. Collectively, these three projects will have 590 MW of wind power capacity. Dong Energy won two of the projects at a zero euro per megawatt-hour (MWh) price and no subsidy on top of the wholesale power price. In other words, the company will sell its power directly to customers at whatever price it can negotiate from these two projects. The third project was won under the more traditional pricing structure of a guaranteed electricity price of 60 euros ($64) per MWh, which is a measure of wholesale power prices.

Importantly, the three projects are planned to be commissioned in 2024, subject to a final investment decision by DONG Energy in 2021

Importantly, the three projects are planned to be commissioned in 2024, subject to a final investment decision by DONG Energy in 2021. That is a critical point, along with certain technical assumptions made by DONG Energy when it submitted its offers. Samuel Leupold, Executive Vice President and CEO of Wind Power at DONG Energy, stated, "It's important to note that the zero bid is enabled by a number of circumstances in this auction. Most notably, the realization window is extended to 2024. This allows developers to apply the next generation turbine technology, which will support a major step down in costs. Also, the bid reflects the fact that grid connection is not included."

In the press release announcing the award of the three projects, DONG Energy offered the following observation about cost-drivers that enabled it to bid at a zero subsidy price:

"Platform change: Significantly bigger turbines – probably 13-15MW – will be on the market by 2024. With bigger turbines, the developer can increase electricity production while at the same time reduce the number of turbine positions. This contributes significantly to cost reductions during construction (fewer towers and array cables, and lower costs for installation vessels and manpower) as well as during a lifetime of operations and maintenance.

"**Scale**: OWP West and Borkum Riffgrund West 2 will be combined into one large-scale project with the option of adding additional volume in next year's auction to further increase the total size of the project.

"Location: The projects benefit from average wind speeds of more than 10 m/s, which is among the highest wind speeds measured across DONG Energy's portfolio of wind farms. Also, the projects are located next to DONG Energy's Borkum Riffgrund 1&2 which means that operations and maintenance can be done from DONG Energy's existing O&M hub in Norddeich.

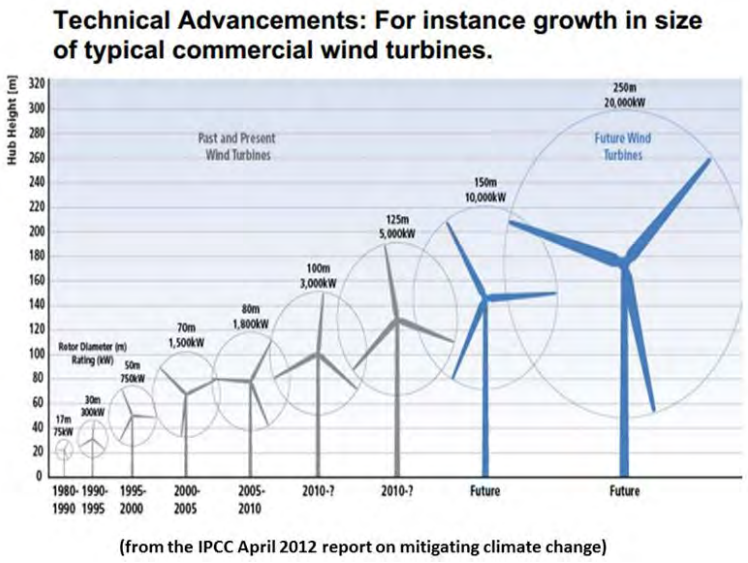
"**Extended lifetime**: The German authorities have approved the possibility to extend the operational lifetime of the asset from 25 to 30 years.

"**Not full scope**: Developers were not bidding for the grid connection in the German auction, which means that grid connection is not included in the bid price."

The taller wind turbines can carry a larger set of blades and produce greater energy, enabling the company to install fewer facilities, which reduces the installation and maintenance costs

Of the five cost-saving considerations, the "platform change" and "not full scope" may be the more important ones. DONG Energy is counting on further improvement in wind turbine capacity, something that has been happening. Exhibit 15 shows the history of the size of wind turbines along with a view of their future size. The 13-15 MW turbines discussed by Dong Energy would seem to fall somewhere between the two suggested future designs – 10 MW and 20MW. We have read that the ones being considered may be closer in size to the 20MW turbine, which is essentially 300 meters (1,000 feet) tall. The taller wind turbines can carry a larger set of blades and produce greater energy, enabling the company to install fewer facilities, which reduces the installation and maintenance costs.

Exhibit 15. Offshore Wind Turbines Growing In Size



Source: IPCC

Power customers will be responsible for the cost of the subsea power cables, which traditionally have cost 7%-10% of the total cost of an offshore wind farm development

The "not full scope" issue is also important, and a point DONG Energy management pointed out when discussing the no-subsidy bid. This means that the power customers will be responsible for the cost of the subsea power cables, which traditionally have cost 7%-10% of the total cost of an offshore wind farm development. That cost is a function of both the amount of power that is being moved at peak times, the distance the power must be transmitted and the number of wind turbines connected. Each wind turbine needs its own connection to a master cable system to allow the operator to control

The turbine. The greater the number of turbines, the greater the cable and installation cost.

While DONG Energy focused on the cost-driving savings the project offers, it is important to remember that it is four years away from having to make a FID, so if technology does not improve as assumed and the cost of the project escalates beyond the current target, it is possible that this project will not be done. Another consideration is what happens to electricity costs, as that goes to the revenues that can be earned. Wind power analysts, including the head of Germany's wind power association, are questioning the technological risk involved in the project along with how high future electricity prices need to be for DONG Energy to earn a satisfactory return on these projects. As one critic put it, the winner of the bid is a very large European utility with significant state ownership, which possibly helps the management in making such a risky proposal, something smaller, non-state owned utilities cannot do.

If technology does not improve as assumed and the cost of the project escalates beyond the current target, it is possible that this project will not be done

Power costs in Germany have been a significant issue due to the country's rapid move toward a carbon-free economy, which also involves the accelerated shutdown of the nation's nuclear power plants. The structure of utility regulation under the clean-energy program has shifted much of the burden away from the industrial sector and onto households, creating a significant "energy poverty" problem. As of the end of 2016, Germany's household power costs per kilowatt-hour (kWh) were second to Denmark and ahead of Belgium and Ireland, the next two most expensive countries in Europe. But Germany has experienced the fastest rising power cost of all. Between the first half of 2008 and the second half of 2016, Germany's power cost increased by 8.3 cents/kWh compared to Denmark's that increased by 4.5 cents/kWh. Belgium saw its price rise by 7.5 cents/kWh, while Ireland's rose by 5.7 cents/kWh.

As of the end of 2016, Germany's household power costs per kilowatt-hour (kWh) were second to Denmark and ahead of Belgium and Ireland, the next two most expensive countries in Europe

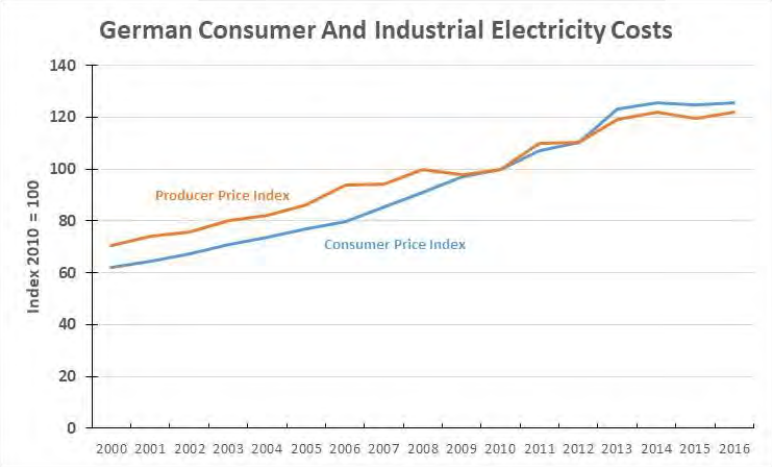
The chart in Exhibit 16 (next page) shows how the consumer price index for residential power has increased faster in recent years than the producer price index for industrial electricity customers. This is a function of the structure of the country's feed-in tariff for renewable power that has favored industry over households. Where will power prices be in the future? Most likely that depends on how many coal-fired power plants are shut down.

The consumer price index for residential power has increased faster in recent years than the producer price index for industrial electricity customers

To forestall expected criticism, DONG Energy, in its press release announcing the winning bids, included the following two paragraphs about its economic/electricity price assumptions along with a list of risk factors that the company will monitor before making its FID.

"The above drivers deliver a cost-of-electricity below our forecasted wholesale power price and will allow us to create value and meet our return requirements at the expected market prices without subsidies. Compared to German power price forecasts available from leading research firms, we consider our price forecast to be relatively

Exhibit 16. Households Bear The Brunt Of Power Cost Inflation



Source: German Federal Statistical Office, PPHB

Conservative. We have applied a higher cost-of-capital than in previous projects to reflect the potential increase in market price exposure.

"The cost reductions required for a German project without subsidies are fully feasible, both technically and commercially. Towards a final investment decision in 2021, DONG Energy will monitor the key factors which will determine long-term power prices in Germany. These factors include the impact of EU actions to reinvigorate the European carbon trading scheme; the phase-out of conventional and nuclear capacity; the future role of coal in Europe; and the build-out of onshore transmission grids."

Proclaiming the competitiveness of wind power without subsidies may be overstating the case after closer examination

While it is notable to highlight the significance of the no-subsidy wind power proposal, there are more than sufficient risk elements that could allow DONG Energy to reject building the wind farms under the terms of its winning bids. Would that merely send management to negotiate a different pricing structure in 2021, or would this project die, potentially leaving Germany with less renewable, and total power in the mid-2020s than planned? Proclaiming the competitiveness of wind power without subsidies may be overstating the case after closer examination.

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