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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

Summary:

Spring Has Sprung: What Does It Mean For Commodities?

As the last snows of winter blast parts of the U.S., the focus of energy markets are now paying more attention to geopolitical and supply/demand fundamentals. The crude oil market is mirroring the 2014-2015 price recovery, but our natural gas industry remains one of the more boring markets.
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Pressure To Revamp Subsidies Questions EV Market Health

A debate is underway on how, or if, to revamp the tax credit scheme for electric vehicle purchases. The debate is being flamed by the poor sales of Tesla, the dominant EV manufacturer in the U.S., and as the Trump administration weighs freezing fuel-efficiency standards that push EVs forward.
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Saudi Aramco And The Wild West, Emerald City and Oz

Saudi Aramco successfully raised $12 billion in a bond sale. To execute that sale, the company issued a prospectus that revealed information and data about the workings of Saudi Arabia's oil and gas industry. We now know more about Aramco, which may help to understand its future actions.
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It's Hurricane Forecasting Season, But Should We Worry?

As spring arrives nationwide, those whose careers involving worrying about the upcoming hurricane season are revealing their forecasts. The forecasts are calling for a below-normal storm season, which is welcome news for people living on our coasts. What does it mean for the energy business?
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Spring Has Sprung: What Does It Mean For Commodities?

People in the Midwest and Plains states may be wondering about Punxsutawney Phil, the meteorological groundhog, who predicted an early spring after being dragged from his lair in the early morning hours of February 2nd. Last week, those residents grappled with yet another blast of wintery snow and cold, which came on top of record flooding as earlier snows had melted with spring-like temperatures.

Global crude oil prices continue marching higher in response to geopolitical events and the OPEC+ group's discipline in implementing its production cuts

As American's grapple with the shift from winter to spring temperatures, reducing fuel consumption, global crude oil prices continue marching higher in response to geopolitical events and the OPEC+ group's discipline in implementing its production cuts. Global supply has also been restricted by mandated production cuts in Canada designed to boost wellhead prices. The deteriorating Venezuelan production situation was highlighted by the International Energy Agency's (IEA) report that output had fallen by 289,000 barrels per day (b/d) to roughly 732,000 b/d in March. The IEA numbers were in stark contrast to those reported by OPEC, of which Venezuela is a member, showing that in March, the country's production was 960,000 b/d, down from 1.432 million a day in February. Potentially more significant was data showing that due to U.S. financial sanctions on PDVSA, the Venezuelan national oil company, the country's exports to the U.S. fell from 500,000 b/d in late January to zero in March. Venezuelan imports to the U.S. rebounded to 139,000 b/d in early April, as PDVSA has until April 28th to complete sales of oil to the U.S. and in U.S. dollars before the financial sanctions become 100% effective.

Other oil price support came from fears about the supply impacts due to the political problems in Libya and tightening sanctions on Iran. Restricted oil supplies are coming just as the global refining industry is exiting its seasonal turnaround phase and restarting crude oil purchases. In other words, the Oil Gods are smiling on crude oil prices.

We should not be surprised if current oil prices hold, or even move higher

We can see that favoritism in Exhibit 1 (next page), where we have been tracking oil price movements since the beginning of October 2018 against the oil price track of late 2014 and early 2015. The patterns of the two periods have been remarkably similar, suggesting that we should not be surprised if current oil prices hold, or even move higher. What the 2014-2016 price history shows is that the second half of 2019 might be challenged if it follows history.

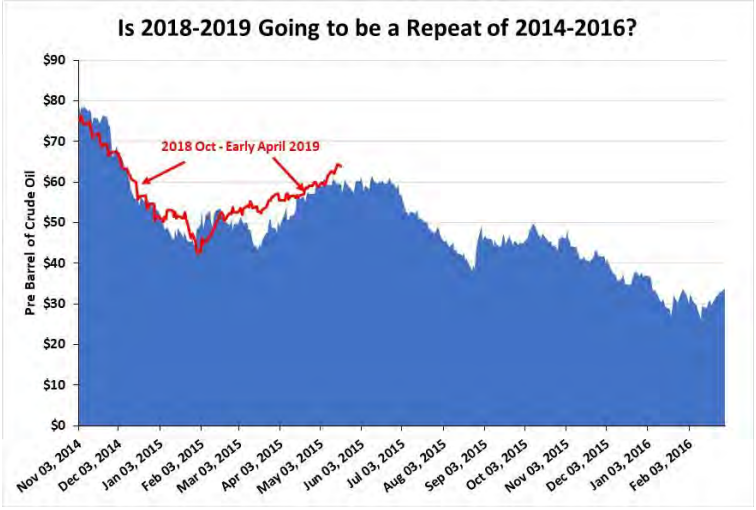
Why might the pattern repeat? There are two possible reasons. First is that global oil demand forecasts are being trimmed in response to concerns over global trade due to the tariff wars and slowing economic growth. The International Monetary Fund recently cut its economic growth forecast for 2019 to 3.3% from its prior 3.5% projection, and the 3.6% growth recorded in 2018. The IMF expects

a rebound in growth to 3.6% for 2020 based on a pickup beginning in 2019's second half, supported by a "more accommodative stance" by major economies.

The unanswered question is whether their cut will be extended for the balance of 2019

Secondly, balancing global oil markets so far this year has been due to the production cuts by OPEC and Russia. The OPEC+ group pledged to cut 1.4 million b/d from the global supply through the first six months of 2019. The unanswered question is whether their cut will be extended for the balance of 2019. Russia has been slow to implement its share of the production cut, blaming the cold weather for preventing companies from being able to shut in some production. Lately, Russia has sounded warnings it might not want to extend the output cut. In addition to the OPEC+ group, Canada's mandatory output cap for 2019, coupled with the Venezuelan and

Exhibit 1. How Oil Prices Are Tracking 2014-2016 Era Prices



Source: EIA, PPHB

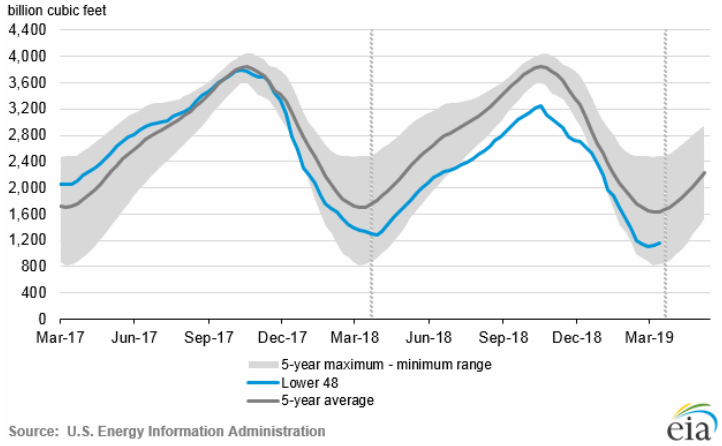
Libyan production challenges, is helping balance global supply and demand. Without the OPEC+ support in the second half of 2019, it is possible inventories could begin to build, putting pressure on oil prices. We are not forecasting that happening, only pointing out how precariously balanced the global oil market remains.

Although gas inventories were drawn down to near record lows this past winter, gas prices have not rebounded

In contrast to strengthening oil prices, U.S. natural gas prices remain in their long-term funk. Last Friday, the near-month natural gas futures price sat at $2.66 per thousand cubic feet (Mcf). Although gas inventories were drawn down to near record lows this past winter, gas prices have not rebounded, which suggests that gas buyers lack fear that the market will be able to satisfy current consumption and export needs while still injecting sufficient volumes into storage this spring and summer to meet next winter's needs. So far this year, we have had two weekly storage injections, lifting inventories off the bottom of the 5-year range.

Exhibit 2. Natural Gas Storage Is Starting To Grow

Working gas in underground storage compared with the 5-year maximum and minimum



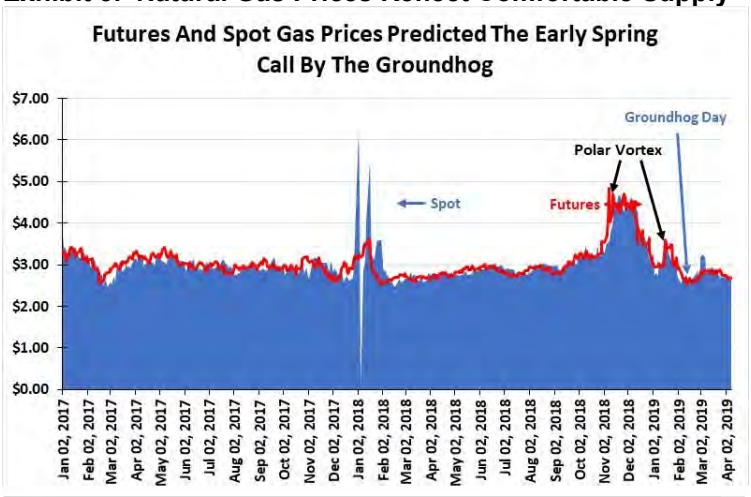
Source: EIA

Recently, the Asian benchmark gas price has fallen below the estimated cost of buying, liquefying and shipping U.S. gas to Asian markets

Liquefied natural gas (LNG) prices in Asia have collapsed due to a milder winter and more coal and nuclear usage for generating power. Recently, the Asian benchmark gas price has fallen below the estimated cost of buying, liquefying and shipping U.S. gas to Asian markets. While this will not limit contractual gas volumes from being shipped, it will put downward pressure on spot gas volumes moving to the Pacific market, which could limit some LNG exports.

U.S. natural gas production continues to grow, limited only by available pipeline capacity to get it to market. The net effect of gas production growth, and the Energy Information Administration's (EIA) Short-Term Energy Outlook projection of continued production growth through the end of 2020, is that gas prices are locked into a

Exhibit 3. Natural Gas Prices Reflect Comfortable Supply



Source: EIA, PPHB

Only in the depths of next winter (December, January and February) are current gas futures prices above $3/Mcf

flattish price scenario for almost as far as the eye can see. Only in the depths of next winter (December, January and February) are current gas futures prices above $3/Mcf. After those months, one needs to go out to January 2024 to find a futures price quote above $3/Mcf. There are numerous winter months in the interim where the futures price is in the high $2.90s/Mcf, but the $3 threshold appears to be a real resistance level.

The surging associated gas output from oil shale plays has largely eliminated drilling for natural gas

As Exhibit 3 (prior page) demonstrates that after upside help from polar vortex events this winter, natural gas prices have fallen below the level that existed for the past two years. The market believes the U.S. has more than enough natural gas supply now and for the foreseeable future. The surging associated gas output from oil shale plays has largely eliminated drilling for natural gas. Last week, the Baker Hughes rig count reported 194 drilling rigs targeting natural gas, or only 19% of all rig activity. Unfortunately, watching the natural gas market is much like "watching grass grow." Maybe that will change, but it is hard to determine what set of events might bring the gas market to life like its fellow crude oil market is experiencing.

Pressure To Revamp Subsidies Questions EV Market Health

The average of the first two months of 2019's sales were only 26.7% of the average of November and December 2018 sales

In our last *Musings*, we raised the question of whether Tesla, Inc.'s (TSLA-Nasdaq) dismal car sales for the first two months of 2019 signaled the need for greater subsidies for electric vehicle sales (EV)? At that time, we only had estimates of sales by model for January and February. The problem was that Tesla's total sales for these two months – 8,000 and 7,275 for January and February, respectively – were substantially below the final months of 2018. In fact, the average of the first two months of 2019's sales were only 26.7% of the average of November and December 2018 sales.

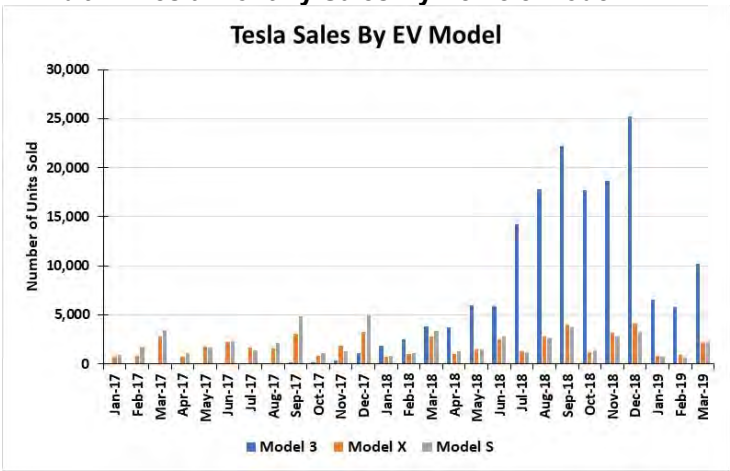
If we focus only on the quarterly averages, 1Q 2019 sales were 38.6% of those for 4Q 2018

We now have Tesla's first quarter production and sales data, which enabled *InsideEVs.com* to confirm that its January and February sales estimates for specific Tesla models were correct. The March sales data reflects a healthy rebound for Tesla sales. While the March figures showed Tesla sold almost as many vehicles in that month as it did in the prior two months (96%) combined, sales still trailed the second half of 2018 by a significant margin. Average monthly sales during the second half of 2018 were 24,575. As a result, the first quarter of 2019's average monthly sales of 9,967 were less than 41% of the earlier period's average. If we focus only on the quarterly averages, 1Q 2019 sales were 38.6% of those for 4Q 2018.

To put the sales record of Tesla into perspective, we have prepared a series of graphs showing Tesla's production relative to various EV markets, as well as a chart of the overall health of the EV market. The first chart shows monthly sales for each Tesla model – 3, X, and S - from 2017 through March 2019. The chart (Exhibit 4, next page) highlights how Tesla has focused on building its brand name with

hopes of eventually producing the mass-market EV the world has supposedly been clamoring for. While the mass-market EV is targeting a price in the $35,000 range, there is little evidence such an EV can be built profitably today.

Exhibit 4. Tesla Monthly Sales By Vehicle Model

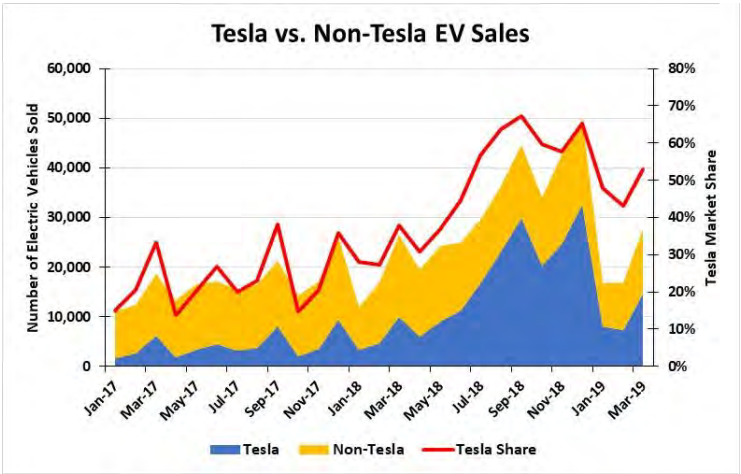


Source: ***InsideEVs.com*, PPHB**

Tesla represents 7% of the model choices available to American buyers of plug-in EVs

Most people understand that Tesla has been the dominant EV company in the United States, helping to drive the popularity of these vehicles. That U.S. market dominance is demonstrated in Exhibit 4 showing Tesla monthly sales in comparison to all other EV models sold here. According to *InsideEVs.com*, there are currently 42 EV models sold in the United States, with three being Tesla models. That means Tesla represents 7% of the model choices available to American buyers of plug-in EVs, including both battery-powered (BEV) and plug-in hybrid EVs (PHEV).

Exhibit 5. Tesla Dominates U.S. EV Market



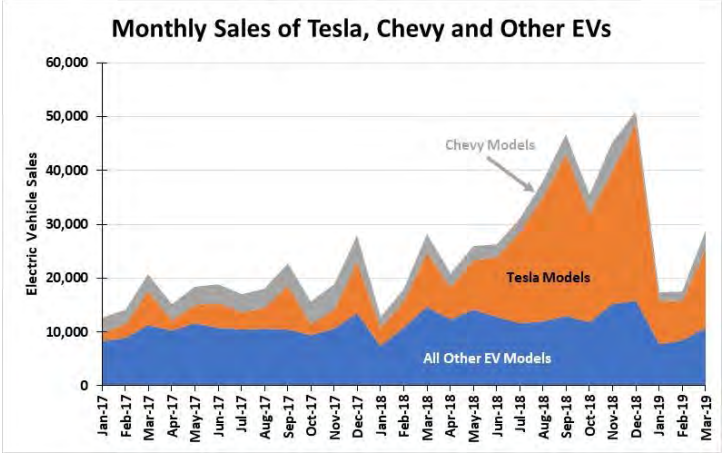
Source: ***InsideEVs.com*, PPHB**

As the realization grew that the credit would be cut in half at year-end 2018, the final months of the year showed Tesla with a market share averaging in the 60%+ range

Exhibit 5 (prior page) shows that since mid-2018 Tesla commanded the lion's share of the U.S. EV market. A dominance helped by the impending elimination of the EV tax credit. As the realization grew that the credit would be cut in half at year-end 2018, the final months of the year showed Tesla with a market share averaging in the 60%+ range. While market dominance remains high, Tesla's overall 2019 market share has averaged only in the high 40% range.

A similar phenomenon exists for General Motors, Inc. (GM-NYSE), whose Chevy Bolt, a BEV has emerged as the company's prime EV market bet. GM has produced EVs before, but they could never establish a market or gain customer support. Prior to the introduction of the Bolt, GM centered its strategy around the Volt, a PHEV. That model has ceased production with the company betting on the Bolt until its next Chevy entrant arrives, as well as GM's

Exhibit 6. U.S. EV Market Broken Down By Company



Source: ***InsideEVs.com*****, PPHB**

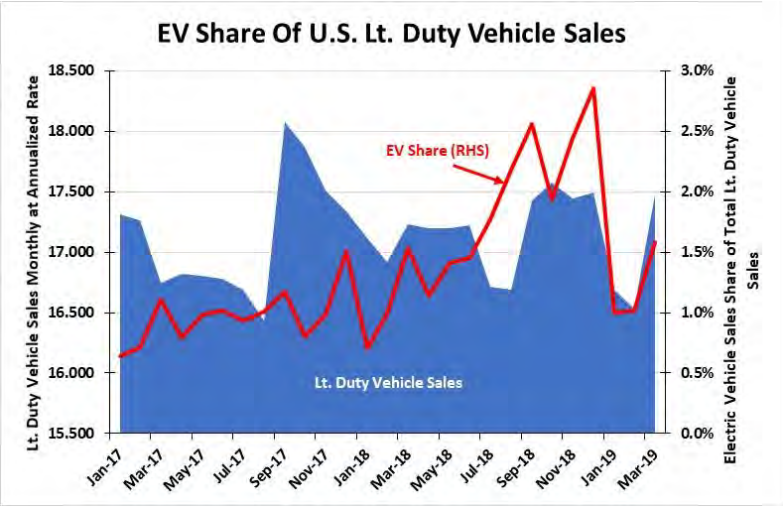
entrees into the luxury vehicle market, where it will be challenging Tesla. As Exhibit 6 shows, GM has yet to gain meaningful market share. The Chevy volumes depicted represent the combined Bolt and Volt sales, which will soon become only Bolt sales. Again, the importance of the impending end of the tax credit is shown by the late 2018 surge in Tesla sales.

While there has been a steady increase in EV market share since January 2017 through March 2019, the surge in market share in the second half of 2018 is clear

Although EV sales have grown, helped by the $7,500 per vehicle tax credit, along with various state credits, EVs have yet to establish a significant automobile market share. Exhibit 7 (next page) shows the monthly U.S. light duty vehicle sales with the EV share superimposed. While there has been a steady increase in EV market share since January 2017 through March 2019, the surge in market share in the second half of 2018 is clear. The fact that the market share has fallen back in line with the historical rate, it seems clear that the impending end to the tax credit impacted Tesla's monthly sales. During those final 2018 months, Tesla's market shares averaged closer to 2.5% than its prior average of 1.5%. This

performance raises the question of the importance of subsidies for growing EV sales, and whether this tax policy is working properly and should be extended or eliminated.

Exhibit 7. EV Market Share Still Small In U.S.

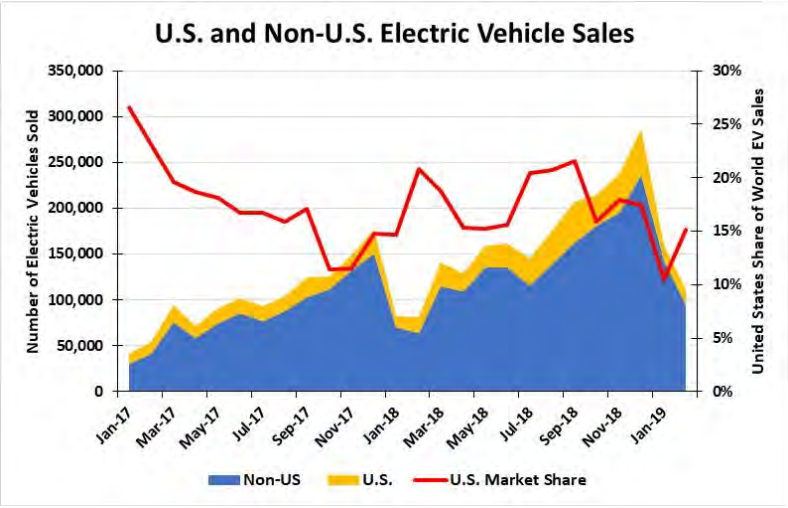


Source: ***InsideEVs.com*****, PPHB**

When we examine how U.S. EV sales are performing compared to those in the rest of the world, we find that our market gains are at a slower pace than experienced throughout the rest of the world

When we examine how U.S. EV sales are performing compared to those in the rest of the world, we find that our market gains are at a slower pace than experienced throughout the rest of the world. By focusing on the U.S. market share, which was above 25% in January 2017, it stabilized in the 15%-20% range until the fourth quarter of 2018. At that time, even with the EV sales surge of Tesla, helped by the tax credit upcoming demise, the U.S. EV market share began falling. That non-U.S. EV sales surge was helped by various

Exhibit 8. U.S. Does Not Dominate Global EV Market



Source: ***InsideEVs.com*****, PPHB**

While European subsidies largely remain in place, China has announced a planned cutback in its EV subsidies that may slow the worldwide growth of EVs

European countries – in particular Italy and Germany – instituting subsidies at the same time they were banning diesel vehicles. The significant push by China to lift its EV sales via aggressive incentives for EV buyers, as well as putting in place disincentives for owners of internal combustion engine cars, further lifted the non-U.S. EV market share. While European subsidies largely remain in place, China has announced a planned cutback in its EV subsidies that may slow the worldwide growth of EVs.

The Driving America Forward Act would boost all EV manufacturers' available tax credits from 200,000 to 600,000 units, but reduce the subsidy amount on the last 400,000 units to $7,000 from $7,500

A bipartisan group of U.S. legislators representing districts where manufacturing facilities are located that are either suppliers to or assemblers of EVs have recently introduced legislation in Congress to extend EV subsidies. The Driving America Forward Act would boost all EV manufacturers' available tax credits from 200,000 to 600,000 units, but reduce the subsidy amount on the last 400,000 units to $7,000 from $7,500. The bill would also shorten the wind down period once the cap on units eligible for the full credit is reached to nine months from the current 15-month schedule. The bill would provide the full tax credit to new startup EV manufacturers or even new Chinese EV suppliers entering the U.S. market. In contrast, a bill proposed by California Democrat Ro Khanna, whose district is home to Tesla's Fremont factory, wants to limit the tax credits to "American" EV manufacturers, without defining what makes a manufacturer "American."

The broader proposal would also extend the current $7,500 tax credit on fuel-cell vehicles through 2028. It is estimated that the legislation, which does not put a cap on the potential cost of the tax credits, will cost U.S. taxpayers $11.4 billion over 10 years, with all but $91 million going to the EV tax credit. This bill stands in contrast to the Trump budget proposal calling for ending the EV tax credit and saving taxpayers an estimated $2.5 billion over ten years.

What should be the role of government in promoting a currently uneconomic business?

The battle over ending subsidies highlights the fundamental challenge EVs face: What should be the role of government in promoting a currently uneconomic business? Those promoting the revision of the tax credits for EVs, to help avoid drastic sales declines for models/brands that have reached their sales cap, argue that the current subsidy structure penalizes the most successful American EV manufacturers, Tesla and GM, while rewarding foreign suppliers who import EVs into the U.S.

An opinion article in *Green Car Reports* about the need to reform EV tax credits ends with the following statement: "…it's time to reform the federal Plug-In Vehicle tax credit with an eye toward making it more equitable and convenient, and setting realistic limits—before electric car opponents use runaway costs to justify eliminating it before it has accomplished its original mission of getting more Americans into electric cars."

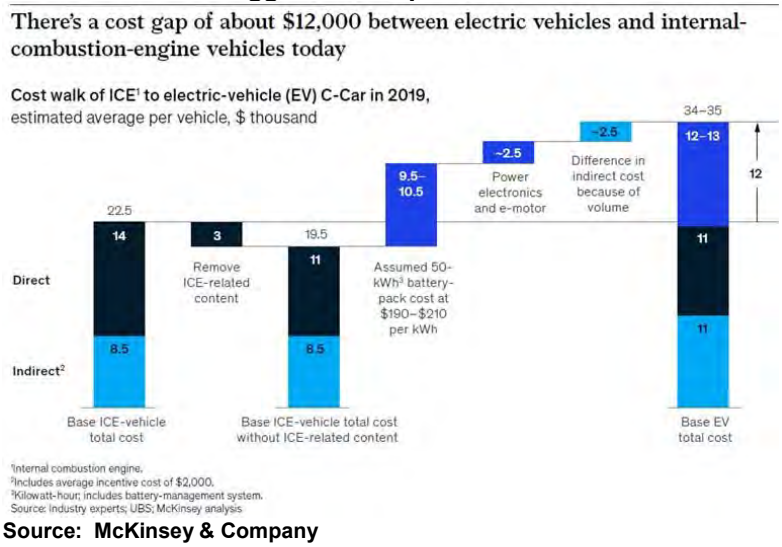
"So would efforts to turn the annual tax credits into point-of-sale rebates to lower EV buyers' car payments"

According to the author, the problem is that our successful auto companies are now at risk of being outmaneuvered by start-up Chinese and Indian automakers looking to enter the "lucrative U.S. market." By eliminating internal combustion engines with their emission certification requirements, and replacing them with commodity batteries and motors, EVs have lowered the cost of entry to build cars. Under our subsidy scheme, these new EV market entrants would get their own 200,000-unit tax credits with virtually no limit on the cost to U.S. taxpayers. The changes to the subsidy program the author would like to see "…include those that set an end date on the program, reward rather than penalize early adopters, or possibly set a price limit on how much eligible electric cars can cost. So would efforts to turn the annual tax credits into point-of-sale rebates to lower EV buyers' car payments." The latter change would actually turn the subsidy into a corporate grant rather than a tax credit for the buyer. That might expand the EV market, given auto manufacturers inability to build profitable low-cost EVs.

It was because of the cost of parts and labor compared to the sales price

In 2017, insiders at GM told reporters that the company expected to lose $9,000 per car on its new EV, the Chevy Bolt. As they explained, the problem was not the cost of development. It was because of the cost of parts and labor compared to the sales price. This disclosure had us wondering at the opinion writer's characterization of the "lucrative" U.S. car market. Yes, Tesla has generated some profits, but its average selling price has been $70,000 per car, not exactly a mass-market vehicle. The U.S. car market may be "lucrative" because of the profits made from sport utility vehicles, which actually are not classified as cars.

Exhibit 9. EVs Struggle To Compete On Car Cost



Source: McKinsey & Company

The cost differential to be overcome can be as much as $12,000 per vehicle

A recent study by McKinsey & Company titled "Making electric vehicles profitable," stated that the cost differential to be overcome can be as much as $12,000 per vehicle. They created a chart to show that the primary problem is with the cost of the battery. In McKinsey's view, battery prices may decline sufficiently in 5-7 years to enable EVs to become profitable, but that is a long time to wait.

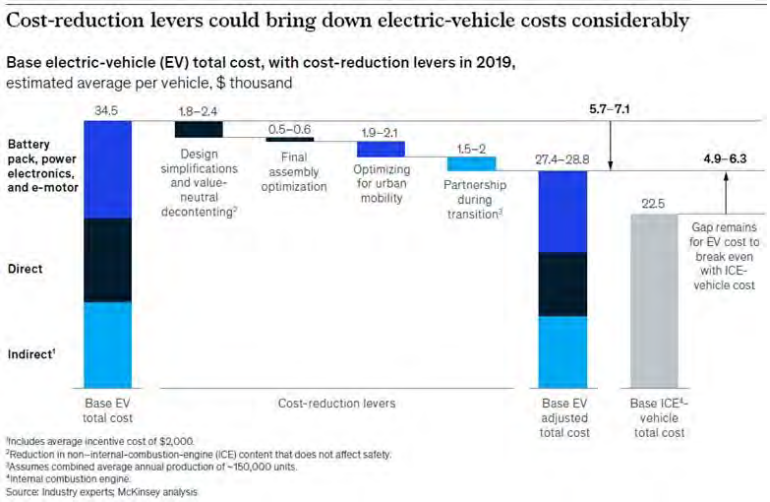
They framed the problem for EVs as the "payback" period of EV buyers. As McKinsey put it:

> "Today, a typical BEV in the United States, priced around $30,000, does not provide a reasonable payback period for many buyers, given the size and cost of a battery pack; to recoup the price premium for an EV versus an ICE vehicle through savings on fuel and maintenance, the payback period is five to six years for an average US buyer driving 13,000 miles a year. For high-mileage drivers exceeding 30,000 miles per year—such as full-time cab, Uber, and Lyft drivers—EVs are already "in the money" during a typical two- to three-year ownership or lease period. Looking ahead, each 20 to 25 percent improvement in battery cost reduces payback by one year, but OEMs will need to take other actions to accelerate profitability."

EV manufacturers need to take other actions to reduce costs and open new markets

On this basis, the easiest market for EV manufacturers to penetrate would be fleet sales. But it will not be enough for them to achieve sufficient profitability. Therefore, EV manufacturers need to take other actions to reduce costs and open new markets. The range of options McKinsey suggests includes: "decontenting," optimizing range for urban mobility, partnering with other EV manufacturers to reduce R&D and capital expenditures, targeting specific customer segments, and exploring battery leasing.

Exhibit 10. EV Companies Must Innovate Costs

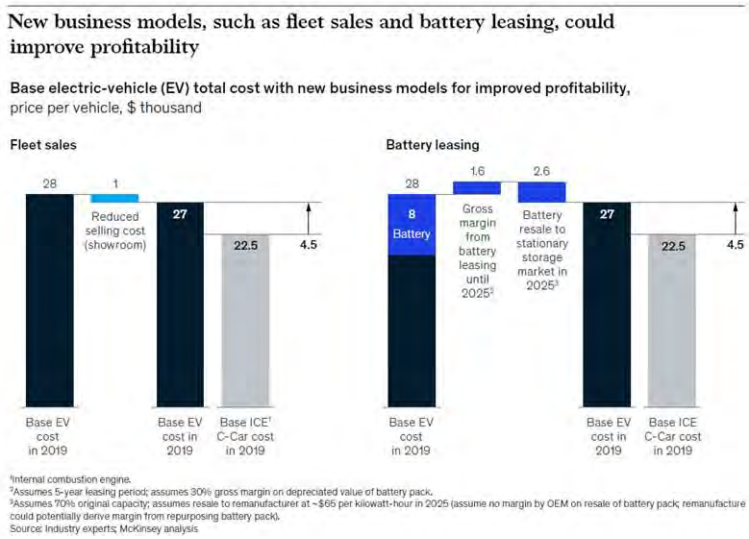


Source: McKinsey & Company

We can only imagine that a decontented EV, as suggested by McKinsey, would resemble the stripped-down, small cars sold in the U.S. in the 1970s and 1980s when imported cars and Detroit attempted to deal with the first energy crisis

Decontenting essentially involves changing the cockpit design, removing electronics and simplifying body design to reduce costs. McKinsey engages in a proprietary teardown study of EVs, which allows them to assess how costs can be lowered and manufacturing processes improved. We can only imagine that a decontented EV, as suggested by McKinsey, would resemble the stripped-down, small cars sold in the U.S. in the 1970s and 1980s when imported cars and Detroit attempted to deal with the first energy crisis. We are not sure today's EV buyers will accept barebones EVs when they can have more luxurious gasoline-powered cars for the same or less money. Of course, government mandates may eliminate customer choice.

Exhibit 11. Possible Business Models For EVs



Source: McKinsey & Company

The total cost of operating a fleet of vehicles is the focus of fleet operators, and on that basis EVs can be effective competitors to gasoline-powered cars

Creating new business models may offer another way for EV manufacturers to achieve profitability sooner than by continuing to follow the track they are on and waiting for battery costs to fall further. Focusing on fleet sales makes incredible sense because these vehicles are driven much more than the typical vehicle. As a result, the total cost of operating a fleet of vehicles is the focus of fleet operators, and on that basis EVs can be effective competitors to gasoline-powered cars. Battery leasing may also be a way of addressing EV buyer concerns about cost since they will only be paying a small portion of the power they use, helping to reduce the EV price premium and making them more competitive with gasoline-powered cars. These are intriguing business opportunities, but ones that don't seem to be on EV manufacturer agendas.

As the debate over revamping the EV tax credit scheme progresses, we will not only follow the various proposals, but will continue to dig deeper into the economics of EVs. We are very interested in understanding the actual progress in cost reductions EV

manufacturers are able to achieve, and not the aspirational targets for when EV costs will achieve parity with gasoline-powered cars. This issue reflects two additional battles underway that will impact the success of EVs. First is the implementation of road taxes on EVs, which traditionally have not had to pay taxes, especially the tax buried in gasoline pump prices. At the present time, close to 20 states, including Oregon, Oklahoma and West Virginia, have imposed road taxes on EVs.

First is the implementation of road taxes on EVs, which traditionally have not had to pay taxes, especially the tax buried in gasoline pump prices

The second issue is the impact of the proposed Trump administration's freeze on fuel-efficiency targets for automobiles. If they are frozen at their current level, it will reduce the pressure on auto manufacturers to add EVs to their fleets in order to meet a rising fuel-efficiency standard. Much of the near-term fuel efficiency mandate can be attained by improvements in existing internal combustion engines, negating the need for significant investment and financial losses to increase EV sales.

In 2011, the Obama administration cut a deal with automakers that would boost the fuel-efficiency rating requirement for domestic car and light-duty truck fleets to an average of 54.5 miles per gallon (mpg) in 2025, up from about 43 mpg this year. To achieve the target, automakers need to increase the share of EVs in their new vehicle sales. EVs are accorded whopping mpg ratings, helping boost overall fleet ratings. For example, the Environmental Protection Agency rates the Chevy Bolt at 119 mpg, while the Tesla Model X sports a 103-mpg rating. For GM, adding even a small number of Chevy Bolts to its new car sales total can help the company meet the fuel-efficiency mandate and avoid huge fines for non-compliance. An easing of the fuel-efficiency standard will reduce the pressure for more EVs.

EVs are accorded whopping mpg ratings, helping boost overall fleet ratings

There is little doubt that 2019 will become a battleground over how much the auto industry will need to change its vehicle line-ups in coming years to meet environmental regulations. With California leading the fight, the vehicle greenhouse gas emissions war is likely headed to court, where the battle will be protracted. Car manufacturers are caught in the crossfire. Failing to meet California's EV car rules could restrict their ability to do business there, which would be a costly business move given that the state represents about 2 million vehicles out of national sales of roughly 17 million, or about a 12% market share. Importantly, one in ten cars sold in California are electric, translating into the state accounting for nearly 60% of all EV sales nationwide.

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While the EV tax credit and auto emissions battle rages on, it is important to keep in mind that the United States is not the driving force behind the global EV market. According to a study last year by Bloomberg New Energy Finance, the global EV market will reach 11 million vehicle sales in 2025, up from 1.1 million sold in 2017. China and Europe combined will account for 60% of this global sales total.

Environmentalists and politicians backing the Democratic Green New Deal plan envision a similar gasoline-free future for the U.S. auto industry

Both of those markets are planning to eventually ban internal combustion engine cars, meaning only EVs will be sold. Environmentalists and politicians backing the Democratic Green New Deal plan envision a similar gasoline-free future for the U.S. auto industry. We will be watching and analyzing this battle and its implications for the energy business.

Saudi Aramco And The Wild West, Emerald City and Oz

The prospectus laid out, for the first time in decades, details about the workings of Saudi Arabia's oil business people that had merely been speculated about

Some may have thought it was a late April Fools' joke when they saw the April 4th preliminary prospectus for a proposed $10 billion note offering by Saudi Arabian Oil Company, otherwise known as Saudi Aramco, the national oil company of Saudi Arabia. The prospectus was not a joke, and it quickly became a focal point of energy investors, analysts, executives and the media. The prospectus laid out, for the first time in decades, details about the workings of Saudi Arabia's oil business people that had merely been speculated about. The document may be a precursor for the long-rumored initial public offering (IPO) of the oil company.

The prospectus may provide clues to the future for the global oil industry, including maybe its eventual end. Instead of donning silver shoes and walking the yellow brick road, our trip to the Emerald City and Oz merely follows the details in the prospectus.

Saudi Aramco states it is the "world's largest integrated oil and gas company [IOC]." It points to having "produced 13.6 million barrels per day of oil equivalent, including 10.3 million barrels per day of crude oil (including blended condensate)," which equates to roughly one in every eight barrels of oil produced globally during 2016-2018.

The company listed its proved liquids reserves, which it notes "were more than five times the combined proved liquids reserves of the Five Major IOCs."

The company listed its proved liquids reserves, which it notes "were more than five times the combined proved liquids reserves of the Five Major IOCs." The reserve calculation was based on the SPE-PRMS definition, and totaled 256.9 billion barrels of oil equivalent (BOE) at December 31, 2018. That reserve figure was down slightly from the 260.2 billion BOE reported for year-end 2017. As often happens in documents such as prospectuses, there is never as much detail as readers would like – merely enough to legally spell out the key information an investor needs in order to judge the credit worthiness of the borrower. In this case, we couldn't apply traditional measures to convert natural gas data into BOEs, but trust the experts preparing the prospectus.

Exhibit 12 (next page) shows that the traditional translation of the company's natural gas reserve estimates into BOEs doesn't quite work. The prospectus lists Saudi Aramco's total BOE reserves for 2018 and 2017, and separately the amounts for its crude oil and condensate, as well as its natural gas liquids (NGLs) reserves. The document also provides the proved reserves of natural gas, measured in trillions of cubic feet (Tcf) for 2018 and 2017: 185.7 Tcf

and 181.0 Tcf, respectively. Using the oil and NGL figures and the total reserves number for each year, we are left with an estimate of natural gas reserves in BOEs for 2018 and 2017 of 30.1 and 29.4, respectively.

Exhibit 12. How Saudi Aramco's Reserves Stack Up

Category	2018 Proved Reserves (bn bbls)	2017 Proved Reserves (bn bbls)	Change	2018 Production (mm bbls/day)	2018 Annualized Production (bn bbls)	
Crude oil & Condensate	201.4	204.8	-3.4	10.5	3.8	
NGLs	25.4	26.0	-0.6	1.1	0.4	
Natural gas equivalent	30.1	29.4	0.7	1.6	0.6	
TOTAL	256.9	260.2	-3.3	13.2	4.8	
Natural Gas (Tcf)	185.7	181.0	4.7	9.9 mcf/d	3.61 Tcf	
BOE at 5.6:1	33.2	32.3	0.8		0.6	bn bbls
BOE at 5.8:1	32.0	31.2	0.8		0.6	bn bbls
BOE at 6:1	31.0	30.2	0.8		0.6	bn bbls
BOE at 6.16:1	30.1	29.4	0.8		0.6	bn bbls

Source: Saudi Aramco, PPHB

Our challenge was squaring the estimated BOE numbers for natural gas for the two years against the numbers generated when we apply traditional gas-to-oil conversion measures used in the industry and by Wall Street analysts. The results of this exercise are shown in Exhibit 12.

A BOE is a unit of energy based on the approximate energy released by burning one barrel (42 U.S. gallons) of crude oil

Exactly what is a BOE? A BOE is a unit of energy based on the approximate energy released by burning one barrel (42 U.S. gallons) of crude oil. It has been an easy way for oil and gas companies to present financial and operating statistics in one measurement. The problem with BOE is that while it is a measure of energy value, not all cubic feet of natural gas are equal. Those with substantial amounts of wet molecules – known as NGLs – can generate more energy per thousand cubic feet (Mcf) than a similar MCF lacking wet molecules, usually referred to as "dry gas." As a result, sellers realize different amounts per Mcf based on gas' heat content.

The price received will be higher if the Btu value is greater, or reduced if it is lower

Most natural gas prices reported are based on gas containing 1,000 British thermal units (Btus) of heat content. The price received will be higher if the Btu value is greater, or reduced if it is lower. This payment structure forces natural gas producers to assess the market for its output and whether it is more profitable to remove and sell separately the NGLs contained in a gas stream. If the combined revenue realized for the dry gas and the NGLs, less the cost to strip them out, is greater than the producer would receive just based on the value of the gas' higher heat-content, he will strip out the NGLs. Otherwise, the producer will leave the NGLs in the gas stream.

The details necessary to understand the true value of the natural gas reserves and production of a company are complex and usually

confidential. Importantly, these details are not necessary for Wall Street analysts to arrive at a rough valuation of a company's assets. Analysts have developed various rules of thumb for estimating the value of natural gas. While the heat content ratio for gas relative to oil is 6:1, traditionally natural gas in the U.S. has sold at a discount to that ratio. In fact, the discount is officially recognized by the Internal Revenue Service as a 5.8:1 ratio.

As we can see, to reach the prospectus' gas reserve BOE estimates for 2018 and 2017, the conversion ratio must be close to 6.2:1

Wall Street analysts have often used 5.6:1 as the ratio to translate gas to oil to be able to value the total BOEs of a company. If the natural gas is "rich" (has embedded NGLs), the conversion ratio may range as high as 6.1:1. In Exhibit 12 (prior page), we show our estimates of Saudi Aramco's natural gas BOE conversion based on these various ratios. As we can see, to reach the prospectus' gas reserve BOE estimates for 2018 and 2017, the conversion ratio must be close to 6.2:1. Saudi Aramco comments in the prospectus about how rich its gas reserves are, so we will accept the higher heat-content ratio.

Crude oil, NGLs and natural gas all showed small increases in reserves that exceeded the volumes produced during 2018

Exhibit 12 (previous page) also shows the 2018 production numbers for each fuel. By converting the natural gas figure and annualizing the data, we can see how much of the 2017 reserves would have been depleted. We can compare those estimates against the change in reserve totals between the two years. The result is that crude oil, NGLs and natural gas all showed small increases in reserves that exceeded the volumes produced during 2018. As the company is not truly in an exploration mode, we are not surprised that reserves grew by only a net 0.55%.

There was heightened interest in the details disclosed about Saudi Arabia's producing oil fields. This information has been a mystery for decades. The late energy investment banker Matt Simmons always questioned whether Saudi's oilfields were being depleted much more rapidly than anyone knew. That drove the Peak Oil fears that were rampant in the early 2000s.

Mr. Simmons' concerns forced Saudi Aramco officials to challenge him whenever they could

Initially, Mr. Simmons studied the oil production from giant fields, which he published in a paper in 2001. This study contributed to his focus on the health of Saudi Arabia's oil empire, much to the consternation of Saudi Aramco officials. His conclusion was captured in his 2005 book, whose title summed up his view: Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy. Mr. Simmons' concerns forced Saudi Aramco officials to challenge him whenever they could. We witnessed, before his book was published, one of those confrontations at a presentation at the Offshore Technology Conference in the early 2000s.

The prospectus, coupled with prior claims by Saudi Aramco officials, provides data suggesting that Mr. Simmons was closer to the truth about a weakening oil supply outlook than people understood. Not only does the prospectus discuss the history of the Kingdom's

Saudi Aramco's portfolio consists of 498 oil and gas reservoirs within 136 fields distributed throughout the Kingdom and its offshore waters

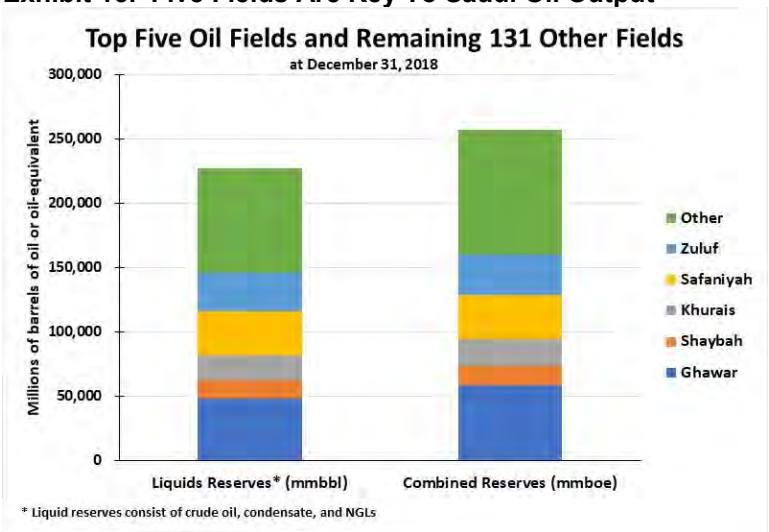
energy industry, but it also discloses details about its many fields, especially the top five producing oil fields, which form the backbone of Saudi Arabia's oil wealth and power within the global oil industry. As the document reports, Saudi Aramco's portfolio consists of 498 oil and gas reservoirs within 136 fields distributed throughout the Kingdom and its offshore waters. With a reserve-to-production ratio of 52 years, the Kingdom's oil will be producing at the current optimal rate of 12 million barrels per day for 3+ to nearly 6-times longer than that of the proved reserves of any of the Five Major IOCs.

The implication of the two field counts is that Saudi Arabia has discovered 35 fields over the past 18 years

An interesting data point was contained in Mr. Simmons book. Table B.1 in the book listed 101 discovered Saudi Arabian oilfields as of 2000. Included in the list were four fields in the Neutral Zone, an area between Kuwait and Saudi Arabia, in which production is shared 50/50. The implication of the two field counts is that Saudi Arabia has discovered 35 fields over the past 18 years, approximately two fields per year. What we don't know is how large and productive these new fields might be.

The prospectus reported the liquids reserves, combined reserves and the MSC for the country's largest five fields, as well as similar figures for the remaining 131 fields. As stated in the prospectus: "MSC refers to the average maximum number of barrels per day of crude oil that can be produced for one year during any future planning period, after taking into account all planned capital expenditures and maintenance, repair and operating costs, and after being given three months to make operational adjustments." In other words, this is the sustained production Saudi Aramco can deliver, although it does have some other supply options that can be employed temporarily.

Exhibit 13. Five Fields Are Key To Saudi Oil Output



Source: Saudi Aramco, PPHB

In terms of total liquids reserves and combined reserves, the top five fields account for 64% and 62%, respectively

Exhibit 13 (prior page) shows how these five fields contribute to the Kingdom's reserve picture and production outlook. In terms of total liquids reserves and combined reserves, the top five fields account for 64% and 62%, respectively. These five fields are even more important when it comes to the country's production target, representing 70% of Saudi Arabia's total MSC of 12 million barrels per day.

"It [Ghawar] has accounted for more than half of the total cumulative crude oil production in the Kingdom but still maintained a MSC of 3.800 million barrels of crude oil per day as at 31 December 2018"

The most intently scrutinized information in the prospectus has been the details about the Ghawar field, the jewel of the Kingdom's oil empire. The company believes "the Ghawar field is the largest oil field in the world in terms of conventional proved reserves, totaling 58.32 billion barrels of oil equivalent" at December 31, 2018. Of the total reserve estimate, 48.25 billion barrels represent liquid reserves. The prospectus also states: "It [Ghawar] has accounted for more than half of the total cumulative crude oil production in the Kingdom but still maintained a MSC of 3.800 million barrels of crude oil per day as at 31 December 2018." This level of output shocked many analysts, who have assumed that Ghawar was producing closer to five million barrels per day, or possibly more. In Mr. Simmons "The World's Giant Oilfields," he estimated Ghawar was producing 4.5 million barrels per day (b/d) in 2001.

A significant discussion of Ghawar, its output and role in underpinning Saudi Arabia's oil industry and its economy was contained in a chapter of Twilight in the Desert. Everyone who has been involved with the oil business is familiar with Ghawar and its monumental role in the history of the industry, its ability to elevate Saudi Arabia to global oil power status, and its role in predicting the longevity of the oil industry with implications for future oil prices. Given its importance, people have clamored for data about the health of Ghawar.

Exhibit 14. Oil Production History Of Saudi Fields

Contribution of Sustaning Oilfields to Saudi Production Build, 1951-1981
(thousand barrels per day)

	Ghawar	Abqaiq	Safaniya	Berri	Zuluf	Other	Total
1981	5,694	652	1,544	504	658	786	9,839
1978	4,280	738	1,221	586	141	608	7,574
1975	4,205	762	827	334	82	365	6,575
1972	2,668	931	909	313		592	5,412
1969	1,427	568	407	19		400	2,821
1966	921	490	588			407	2,406
1963	780	380	289			143	1,592
1960	727	266	174			52	1,219
1957	506	295	27			66	894
1954	545	319				102	966
1951	126	438				107	671

Source: *Oil & Gas Journal,* various issues, 1950-1982, Simmons & Company International

Source: Twilight In The Desert

In his book, Mr. Simmons compiled a table showing the history of oil production from Ghawar and other key oilfields in Saudi Arabia, as well as their importance to the Kingdom's overall output. The table was based on *Oil & Gas Journal* reporting on global oil production by

Only three of the top five producing oil fields in the history table compiled by Mr. Simmons are currently in Saudi Aramco's top five fields today

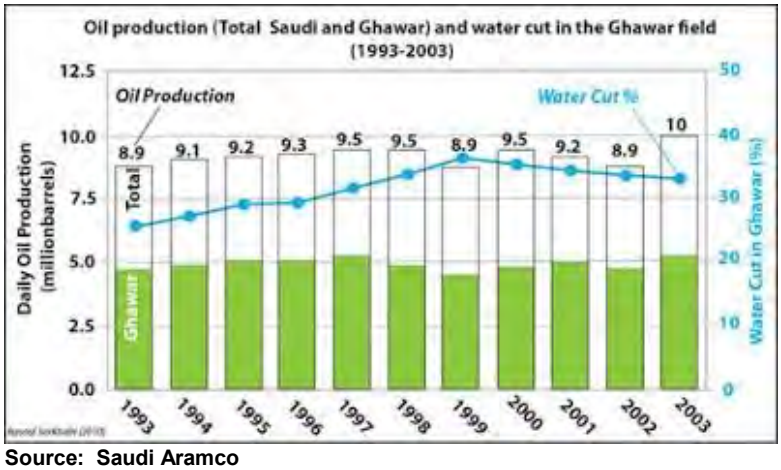
specific oil fields for 1951-1979. As the table shows, Ghawar's oil production was as high as 5.7 million b/d in 1979. It may have gone higher in subsequent years, but issues with water intrusion began to mark most discussions about the field's output, starting about that time. A note of interest is that only three of the top five producing oil fields in the history table compiled by Mr. Simmons are currently in Saudi Aramco's top five fields today.

As Mr. Simmons pointed out, Ghawar's production had been a state secret since 1982, until now. In researching his book, Mr. Simmons focused on technical papers about the Saudi oilfields published by the Society of Petroleum Engineers (SPE). Between the early 1980s and 2004, only one paper, published in 1999, mentioned field-by-field production volumes. Mr. Simmons wrote, "It stated that in 1994 Ghawar was still producing five million barrels of oil per day, or 63 percent of Saudi Arabia's total output." In late 2003, a *New York Times* article on Saudi Arabian oil production indicated that officials had responded to questions posed by the reporter, stating that Ghawar was still producing around five million barrels per day.

During that period, Ghawar's production had fluctuated around the five-million barrels a day level

More recent data came during a workshop on Saudi Arabian oil that was held in February 2004 at the Center for Strategic and International Studies in Washington, D.C. Mr. Simmons began the presentation with a report on his research. That was followed by a presentation by two of Saudi Aramco's top exploration and production officials. Their presentation included a chart showing Ghawar's total daily fluid output, which includes crude oil and water. The chart also showed the water cut percent (volume of water produced as a percentage of total field volumes) for 1993-2003. During that period, Ghawar's production had fluctuated around the five-million barrels a day level. Water production, however, had risen steadily from 1993 to 1999, with the water cut peaking in 1999 at over 36%. The water cut percentage then steadily declined as oil production increased.

Exhibit 15. Ghawar's Oil And Water Production



Source: Saudi Aramco

Conventional wisdom has been that the country's oil fields were declining at a rate closer to 6% to 8% per year, not the 1% to 2% rate the company estimates

From producing 5.2 million b/d in 2003, Ghawar's output is now only at 3.8 million barrels per day. That represents a 27% decline over the past 15 years, or a 2% annual decline. While the drop in Ghawar's production shocked analysts, the field's decline rate is consistent with what Saudi Aramco reported in the prospectus. That is significant because conventional wisdom has been that the country's oil fields were declining at a rate closer to 6% to 8% per year, not the 1% to 2% rate the company estimates. The prospectus included a statement that at year-end 2018, more than 80% of the Kingdom's proved crude oil reserves were in reservoirs that were less than 40% depleted. With such a production decline rate, it is likely that Saudi Arabia can sustain 50 years of high oil output. The challenge, and fear, for the Kingdom is that the Age of Oil peaks and begins a steady decline before it runs out of oil reserves. While Ghawar was always assumed to be the world's largest and most prolific oil field, those honors now belong to the U.S.'s Permian Basin, which currently is producing about 4.1 million b/d.

The Ghawar production history may reflect a recognition by Saudi Aramco that it needed to shift its investment focus away from aggressively boosting the field's output and instead find new fields to offset the aging field's inevitable decline

Despite the apparent health of the Saudi Arabian oil industry, some analysts shocked by the rapid decline in Ghawar's output are worried that the world is heading for a future supply crisis. We believe these analysts are missing the low production decline rate and extensive use of secondary recovery to sustain output. Furthermore, they fail to focus on the additional 35 fields Saudi Arabia has brought into production over the last 15 years. In some regards, the Ghawar production history may reflect a recognition by Saudi Aramco that it needed to shift its investment focus away from aggressively boosting the field's output and instead find new fields to offset the aging field's inevitable decline.

Secondary recovery explains why the company can state that approximately 80% of its crude oil reserves had a recovery factor between 41% and 80%, which it attributes to the high quality of its reservoirs

Sustaining Saudi Arabia's oilfields' production has involved its early and heavy reliance on secondary recovery techniques, in particular water flooding. Secondary recovery explains why the company can state that approximately 80% of its crude oil reserves had a recovery factor between 41% and 80%, which it attributes to the high quality of its reservoirs. We have talked with a senior Saudi Aramco production official who said that Ghawar had boosted its recovery factor close to 70%, and the company believes it may increase that recovery factor to 80% or more. What we don't know from the prospectus is what ultimate recovery factor has been used in estimating the remaining reserves in Ghawar. Based on the 48.25 billion barrels of proved reserves and the MSC of 3.8 million barrels per day, the field has a remaining life of 34.7 years. We guess we should all be grateful for those dinosaurs congregating in that region of the planet.

We were also impressed by the description of the range of qualities of the oil under Saudi Aramco's control. The bulk of the reserves are in the heavy and light oil categories, but the quality of the country's oils ranges from super light to heavy, with sulfur content ranging from less than 0.5% to more than 2.9%, and API gravities of

Exhibit 16. Saudi's Oil Gives It Operating Flexibility

	API Gravity	Sulphur Content	% of Crude Oil Reserves
Arabian Super Light	More than 40	Less than 0.5	0.8
Arabian Extra Light	36 – 40	0.5 – 1.3	12.3
Arabian Light	32 – 36	1.3 – 2.2	34.3
Arabian Medium	29 – 32	2.2 – 2.9	17.7
Arabian Heavy	Less than 29	More than 2.9	34.9

Source: Saudi Aramco

less than 29 to more than 40. As the company states, this range of crude oil qualities provides it with flexibility to meet customer needs. This will prove invaluable as the nature of the global oil market shifts in response to the shale boom and decarbonization efforts.

The Saudi Aramco prospectus has provided a range of information that has allowed analysts and reporters to focus on bits of data to expand into discussions of greater global impact. One analyst focused on the company's financial results to opine about Saudi Arabia's future oil policy. While media headlines focused on the company's 2018 profits reaching $111 billion, nearly double the $59.4 billion earned by Apple (APPL-Nasdaq), which was the world's most profitable company until this disclosure. Saudi Aramco's profits were over five times the nearly $21 billion earned by Exxon Mobil Corp. (XOM-NYSE). But the analyst, relying on *Bloomberg's* noting that Saudi Aramco's "funds flow from operations" was $26 per barrel in 2018, below the $38 and $31 per barrel results of Royal Dutch Shell (RDS.A-NYSE) and Total (TOT-NYSE), respectively, commented that it may be the most profitable company, but not the most efficient. He then pointed to 2016's results showing Saudi Aramco struggling to break even. Saudi Aramco reported net income of $13 billion and free cash flow of a mere $2 billion that year, when Brent crude oil prices averaged about $45 per barrel. Actually, the company reported in the prospectus that its realized price per barrel of oil in 2016 was $40.70. The analyst suggested the lack of profits in 2016 forced the Kingdom to alter its market share strategy and back a production cut to boost oil prices.

The analyst suggested the lack of profits in 2016 forced the Kingdom to alter its market share strategy and back a production cut to boost oil prices

While the 2016 analysis was contrasted with the huge profits made in 2018 when Brent average over $71 per barrel, it is important to note that several structural changes were made in 2017 to the government's regime under which Saudi Aramco operates. For example, prior to 2017, while the company was required to supply crude oil, kerosene, diesel, heavy fuel oil and gasoline to the local economy, it was not compensated for those sales. Assuming those volumes were comparable to 2017 and 2018, this represented an estimated $40 billion in additional revenue, with no additional expense. Why would Saudi Arabia make such a change? It likely helped sustain the Kingdom's case for raising fuel prices.

For example, prior to 2017, while the company was required to supply crude oil, kerosene, diesel, heavy fuel oil and gasoline to the local economy, it was not compensated for those sales

Another issue in 2016 was the $3.6 billion impairment taken for a petrochemical refinery under construction and two existing domestic

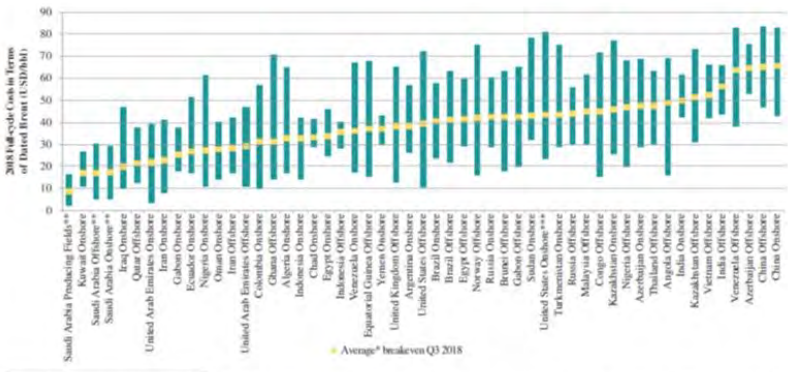
refineries. Lastly, the corporate tax rate was changed in 2017. It was reduced from 85% to 50%, although beginning in 2018, a 20% tax rate was applied to taxable income related to certain natural gas activities. These adjustments suggest that profitability in 2016, which also had high exploration expenses, was likely better than the reported financials suggest. What we don't know is how much the 2017 and subsequent regime changes were done in recognition that the earlier operating structure was placing too severe a burden on Saudi Aramco without adequate compensation. Whether the reported 2016 financial results drove oil policy changes is pure speculation. That argument helps the case for those who believe oil prices will never dip that low again. Finally, it is necessary to remember that since Saudi Aramco, as well as the Kingdom, still maintains positive cash balances, it can weather brief periods of very low oil prices without damaging the financial strength and operating integrity of the company.

What we don't know is how much the 2017 and subsequent regime changes were done in recognition that the earlier operating structure was placing too severe a burden on Saudi Aramco without adequate compensation

Another important consideration from the prospectus is Saudi Arabia's low-cost oil. The company estimated that its production cost per barrel was $2.80 and the capital expenditures per barrel were only $4.70 per barrel. To demonstrate how low-cost Saudi's oil is, there was a chart in the prospectus showing estimates of 2018 full-cycle costs per barrel for a number of countries, including fields both onshore and offshore. The chart shows Saudi's producing oil fields in the chart's far left bar. Saudi's offshore and onshore fields are the third and fourth bars on the left. The most-costly fields are in China, which is represented by the two bars on the far right-hand side of the chart. The yellow line running through the bars represents an estimate of the average of the cost of the fields. The extremely low yellow mark for Saudi's producing fields cannot be ignored in understanding the country's role in the global oil market.

The extremely low yellow mark for Saudi's producing fields cannot be ignored in understanding the country's role in the global oil market

Exhibit 17. Saudi Fields Have Low Breakeven Costs



(*) Average is not a weighted or arithmetic average but a selection of what a typical new oil project in that country would cost in today's market. New oil projects selected by country from 2018-onwards.

(**) The breakeven price for producing fields in Saudi Arabia is forward-looking and hence excludes all exploration and development costs. The break-even price for Saudi Arabia (for the three categories—producing fields, onshore and offshore) is calculated assuming an income tax rate of 50%. The analysis is carried out for typical new projects starting in 2018.

(***) The break-even for US Onshore excludes land acquisition cost.

Source: Saudi Aramco

While Saudi Arabia is well positioned given its oil empire and high-quality oil and gas assets, the country's dependence on the petroleum industry highlights its vulnerability to a peak and subsequent decline in oil consumption

For those of us who are 'data junkies,' the Saudi Aramco prospectus offers a wealth of insight into the workings of the Kingdom's oil empire. Instead of Toto pulling back the curtain hiding Oz, Saudi Aramco did it for us. We have a better understanding of why Saudi Arabia wields so much power in the global oil market. We knew it intuitively, but now we have some hard data to support our prior assumptions. While Saudi Arabia is well positioned given its oil empire and high-quality oil and gas assets, the country's dependence on the petroleum industry highlights its vulnerability to a peak and subsequent decline in oil consumption. It helps to explain why Crown Prince Mohammed bin Salman is pushing hard for his government to diversify the Saudi Arabian economy. The country's success in its second century will depend on a more balanced economy.

It's Hurricane Forecasting Season, But Should We Worry?

This group, operating as the CSU Tropical Meteorology Project (CSU) has produced seasonal storm forecasts for 36 years, or since the early 1980s

It is hard to believe it is hurricane forecasting time. One of the leading hurricane forecasts comes from the Department of Atmospheric Science at Colorado State University at Fort Collins, Colorado. This group, operating as the CSU Tropical Meteorology Project (CSU) has produced seasonal storm forecasts for 36 years, or since the early 1980s. CSU provides an early forecast in April, which is updated at the beginning of June, July and August. A wrap up of the season, including an analysis of the success or failure of the forecast, is produced in November. Over time, CSU has learned that different meteorological variables carry greater weight at different time when making forecasts. As a result, CSU has separate models used for each forecast.

We have always paid attention to hurricane forecasts, maybe because we grew up dealing with them. In studying tropical storm predictions, we follow multiple forecasters. In particular, we watch the forecasts from CSU, WeatherBELL Analytics and StormGeo. We also watch the forecasts coming from the scientists at the National Oceanic and Atmospheric Administration's (NOAA) Extreme Weather Forecasting unit.

Those relationships have pushed these forecasters to develop storm projection techniques to deliver storm tracts and outcomes considerably ahead of NOAA's forecasts

The three forecasters we follow most closely are willing to stray from the mainstream when they believe their models and knowledge indicate something different. WeatherBELL, who employs Joe Bastardi, an extremely knowledgeable meteorologist, as well as one known for his command of meteorological history that often helps explain weather events, and StormGeo are private companies who contractually support businesses reliant on weather intelligence. Those relationships have pushed these forecasters to develop storm projection techniques to deliver storm tracts and outcomes considerably ahead of NOAA's forecasts. They are not always correct, but in our view, their forecasting records are outstanding and they often provide significant additional information to assist in monitoring the paths of storms.

The 2019 CSU Atlantic basin hurricane forecast anticipates a slightly below-normal season

The 2019 CSU Atlantic basin hurricane forecast anticipates a slightly below-normal season. The current weak El Niño appears likely to persist, and possibly strengthen, through the summer and fall, the peak hurricane season. Other factors influencing CSU's forecast – sea surface temperatures and the Atlantic Multi-decadal Oscillation index – are combining to limit the development and eventual strengthening of tropical storms. Also, the CSU forecast calls for a slightly below-average probability for major hurricanes (Category 3-4-5) making landfall along the U.S. coastline and in the Caribbean, but the scientists warn people to always prepare for every storm.

In preparing its forecast, CSU goes through three analyses before averaging the results and then adjusting the averages to produce its final forecast. Exhibit 18 starts by showing the historical averages for 1981-2010 for each forecasted category, as well as setting out the results of each of the three forecasts. The forecasts are averaged and CSU then adjusts for its official forecast.

Exhibit 18. CSU Arrives At Its 2019 Hurricane Forecast

Forecast Parameter and 1981-2010 Average (in parentheses)	Statistical Scheme	Statistical/ Dynamical Scheme	Analog Scheme	Average of Three Schemes	Adjusted Final Forecast
Named Storms (12.1)	9.0	12.3	10.8	10.7	13
Named Storm Days (59.4)	40.1	64.3	48.2	50.9	50
Hurricanes (6.4)	4.8	7.3	5.2	5.8	5
Hurricane Days (24.2)	16.2	30.5	15.3	20.7	16
Major Hurricanes (2.7)	1.6	3.4	2.4	2.5	2
Major Hurricane Days (6.2)	3.1	8.5	3.0	4.9	4
Accumulated Cyclone Energy Index (106)	67	127	71	88	80
Net Tropical Cyclone Activity (116%)	75	135	87	99	90

Source: CSU

CSU boosted the number of named storms (the total universe of storms anticipated), but reduced the number of hurricanes and major hurricanes

We found it interesting when examining the adjusted final forecast that CSU boosted the number of named storms (the total universe of storms anticipated), but reduced the number of hurricanes and major hurricanes. We don't usually focus on the number of days forecast for each storm category, but all three categories differ from the results of the three forecast methodologies and the historical averages. We suspect CSU would say that this is the art of forecasting hurricanes that has come from 36 years of making forecasts.

Exhibit 19. Analog Years For CSU Hurricane Forecast

Year	NS	NSD	H	HD	MH	MHD	ACE	NTC
1969	18	92.25	12	40.25	5	6.50	166	182
1987	7	37.25	3	5.00	1	0.50	34	46
1991	8	24.25	4	8.25	2	1.25	36	58
2002	12	57.00	4	10.75	2	3.00	67	83
2009	9	30.00	3	12.00	2	3.50	53	69
Average	10.8	48.2	5.2	15.3	2.4	3.0	71	87
2019 Forecast	**13**	**50**	**5**	**16**	**2**	**4**	**80**	**90**

Source: CSU

One thing we are always interested in is CSU's selection of analog storm years. Use of analog years is a popular forecasting

technique, so we always research what information may be gleaned from focusing on those years. While the statistical data is contained in Exhibit 19 (prior page) for the analog years for the 2019 season, the true value of their selection comes from seeing what happened during those years. For example, 1969, at the time, was considered the most active hurricane season since 1933 and the fourth most active on record. For the Gulf Coast, that season was marked by Hurricane Camille, a Category 5 storm, that devastated the region.

For the Gulf Coast, that season was marked by Hurricane Camille, a Category 5 storm, that devastated the region

On the other hand, the 1987, 2002 and 2009 seasons were below-average due to El Niño conditions, with each year having only one notable hurricane. Another below-average year, 1991, produced Hurricane Bob, which up to that point was the 10th costliest storm in history. The year, however, is more noted for its first hurricane, Grace, which developed the energy in the Atlantic basin that created the nor'easter known as the Perfect Storm. That nor'easter actually absorbed Hurricane Grace, which added to it energy. A buoy located off the coast of Nova Scotia reported a wave height of 100.7 feet, the highest ever recorded in the province's offshore waters up to that point. Most people are probably familiar with the storm for its association with the novel, which became a popular movie, The Perfect Storm, in which the story of the sinking of the fishing vessel Andrea Gail, killing her crew of six, was told.

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The CSU report highlighted two meteorological conditions helping to shape its forecast. First was the condition of the ocean area where the majority of Atlantic Basin tropical storms form. CSU produced a chart showing the evolution during the course of the year of the accumulated cyclone energy (ACE) in recent years, for 2019 so far, and the averages for years rated by the level of ACE. As Exhibit 20 shows, 2019's ACE, so far, is below every other season tracked. It is especially noteworthy that 2019's ACE even falls below all the low-rated seasons.

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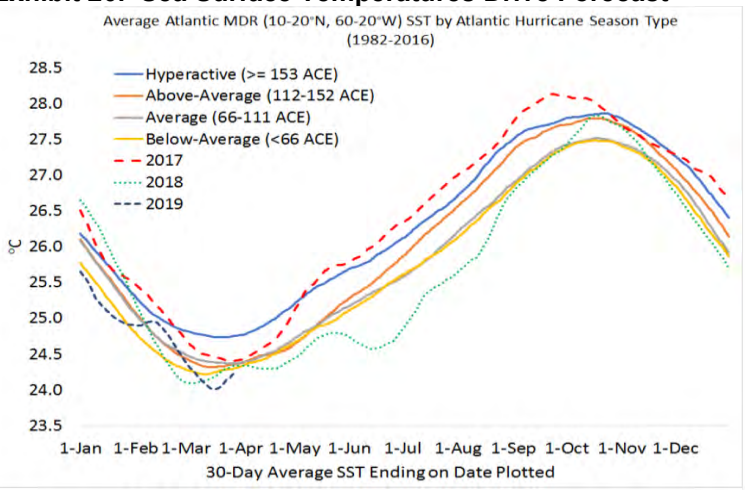
Exhibit 20. Sea Surface Temperatures Drive Forecast

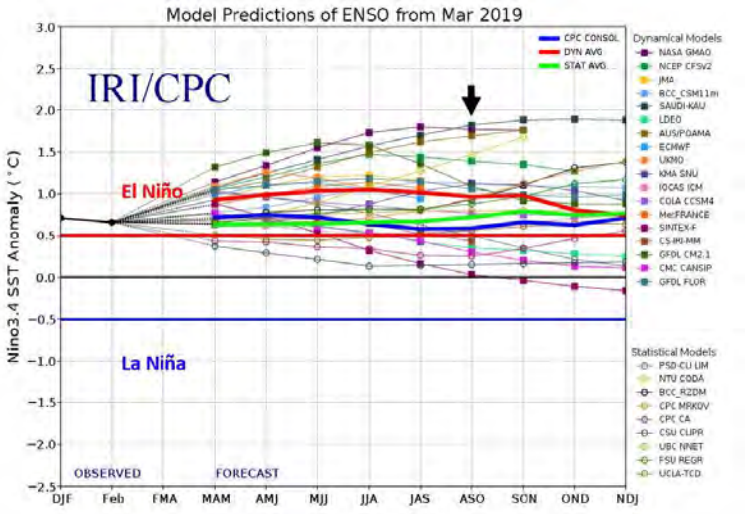


Source: CSU

Current sea surface temperature anomalies are tracking with the below-average Atlantic hurricane seasons

As CSU points out, while considerable uncertainty exists as to what the Atlantic Basin will look like in August to October, current sea surface temperature anomalies are tracking with the below-average Atlantic hurricane seasons. CSU also points to the near complete convergence of all the historical measures in late March, which adds to the uncertainty about how active this hurricane season may be.

Exhibit 21. El Niño Will Inhibit 2019 Hurricanes



Source: CSU

El Niño creates conditions (primarily wind shear) that suppresses the formation and strengthening of tropical storms

The second condition supporting the view of a below-average storm season is the existence of El Niño conditions and the likelihood they will exist through the August-October period, the heart of the hurricane season. El Niño creates conditions (primarily wind shear) that suppresses the formation and strengthening of tropical storms. These conditions also influence the weather patterns and precipitation levels in parts of North America. In fact, commodity traders are talking about a scenario where the U.S. winter wheat crop may be below normal, lifting wheat prices later this spring and summer, due to the wet weather coming from El Niño.

Exhibit 21 shows a large number of meteorological predictions of El Niño's existence and duration during the upcoming hurricane season. Only one forecast falls below the zero-line, and no forecast falls into La Niña conditions, which are favorable for the development of tropical storms.

StormGeo expects 11-13 named storms, 4-5 hurricanes and 1-2 major hurricanes

Shortly after the CSU forecast was issued, we attended a presentation by StormGeo about its hurricane season prediction. Based on the meteorological data outlined above, StormGeo's forecast was similar to CSU's. StormGeo expects 11-13 named storms, 4-5 hurricanes and 1-2 major hurricanes. The presentation covered virtually the same ground as CSU and reached a similar conclusion – a slightly below-average 2019 hurricane season.

Besides giving clients more lead time, rather than focus on the error cone projection technique of NOAA, StormGeo has developed a probabilistic forecast that has proven more reliable

More interesting details to emerge from the StormGeo presentation included how the firm now issues storm forecast seven days out versus NOAA's five-day forecasts. Besides giving clients more lead time, rather than focus on the error cone projection technique of NOAA, StormGeo has developed a probabilistic forecast that has proven more reliable. This forecast methodology last year enabled StormGeo to anticipate the shifts in the paths of Hurricane Florence in August/September and Hurricane Michael in October. Seven days out, the probabilistic forecast targeted Hurricane Florence's landfall to be within a 200-mile swath on the North Carolina coastline. This helped the firm's clients to better prepare for the storm and plan their recovery effort.

The difference between a 50-mile-per-hour wind and a 100-mile one is not two times, but rather a sevenfold increase in force

In the case of Hurricane Michael, StormGeo targeted landfall within a 70-mile wide swath centered on Mexico Beach, Florida, and within 15 knots of actual wind speed at landfall. The latter detail is significant, as the difference between a 50-mile-per-hour wind and a 100-mile one is not two times, but rather a sevenfold increase in force. Knowing wind intensity helps predict the magnitude of structural damage that will occur, which is critical for the insurance industry and first responders.

In the six analog years, only five of the 22 hurricanes made landfall on the U.S. coast

For its 2019 forecast, StormGeo presented a list of six analog years, with their named storms (NS), hurricanes (H), major hurricanes (MH) and storm energy (ACE). It was interesting that only one (1991) of their analog years was included in CSU's analog years. The StormGeo list showed lower storm activity than CSU's list, and much lower ACE measures. The 42 average ACE compared with CSU's analog average of 80. In the six analog years, only five of the 22 hurricanes made landfall on the U.S. coast. Of the five major hurricanes, Hurricane Andrew in 1992 was a Category 5, destroyed South Florida it crossed the peninsula and into the Gulf of Mexico.

Exhibit 22. Analog Storm Years For StormGeo's Forecast

	NS	H	MH	ACE
1968	8	4	0	45
1972	7	3	0	36
1977	6	5	1	27
1982	6	2	1	32
1991	8	4	2	36
1992	7	4	1	76
AVG.	7	3.7	0.8	42

Source: StormGeo, PPHB

Likely one of the most interesting bits of information gleaned from the StormGeo presentation was their discussion of new forecasting tools they are perfecting, utilizing machine learning. They have been able to pinpoint storm forecasts down to small geographic regions, enabling them to help T-Mobile Us, Inc. (TMUS-Nasdaq), a

StormGeo is now working with the insurance industry to develop flooding forecasts

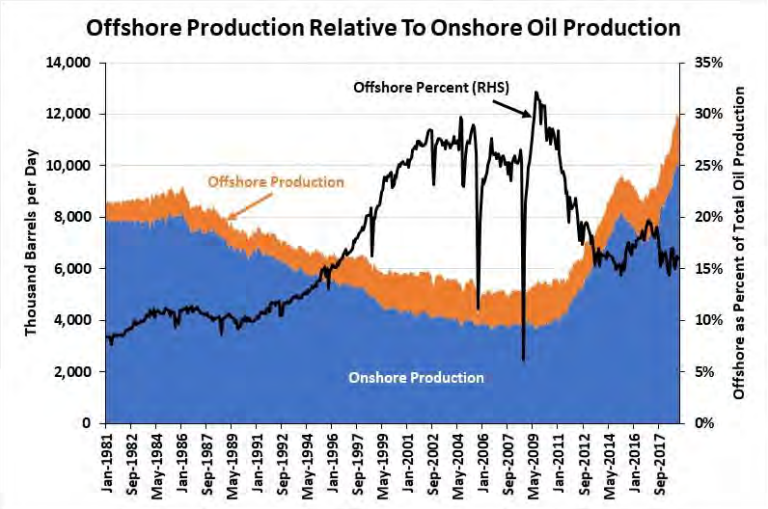
client, target the cell towers likely to be damaged. That targeting enabled T-Mobile to prepare to restore their system quicker, which they acknowledged contributed significantly to their earnings in 2018. StormGeo is now working with the insurance industry to develop flooding forecasts by predicting the amount of rain from cells as they move along a storm's track and matching it with years of insurance claim data. Predicting flooding involves other variables, but given time, the data could be collected and inputted to the models. The ramifications of this modeling for predicting storm damage and preparing for recovery efforts are significant for mitigating losses due to hurricanes.

The arrival of tropical storms in the Gulf of Mexico has always forced the energy industry to remove personnel from offshore facilities and shut in producing wells, cutting supply

For the energy industry, the key question is whether hurricanes in the Gulf of Mexico are as significant for operations as they have been in the past given the emergence of shale? The arrival of tropical storms in the Gulf of Mexico has always forced the energy industry to remove personnel from offshore facilities and shut in producing wells, cutting supply. Producers hope the storms are transient and do not inflict significant damage on offshore platforms or Gulf Coast proscessing facilities, which would extend disruptions.

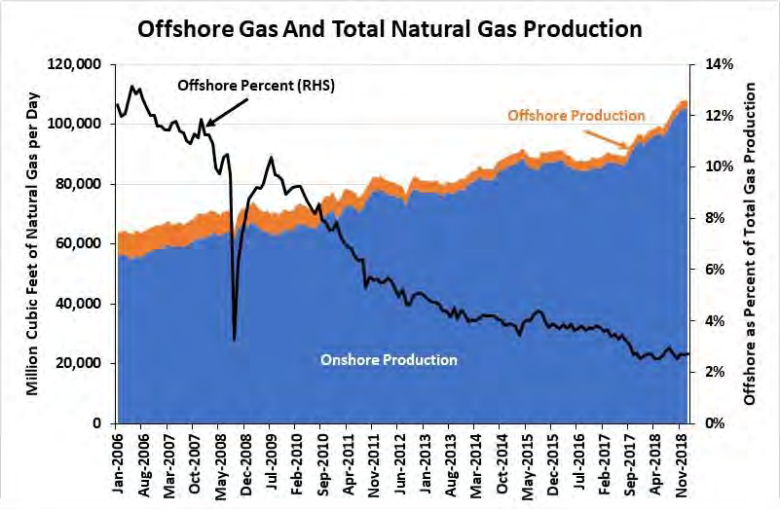
To understand the role offshore oil and gas plays in today's domestic energy business, we prepared Exhibit 23 and 24 (next page), showing onshore and offshore production of crude oil and natural gas, and the role of offshore output. In the two charts, the sharp drops in the share of offshore production reflects when hurricanes caused extended supply disruptions.

Exhibit 23. Offshore Oil Still Important For U.S. Energy



Source: EIA, PPHB

Exhibit 24. Offshore Natural Gas No Longer Key Source



Source: EIA, PPHB

Despite the shale boom, the Gulf of Mexico supplies 16% of our total oil production

As the two charts demonstrate, today the Gulf of Mexico is much more important for our domestic crude oil supply than for natural gas. Even now, despite the shale boom, the Gulf of Mexico supplies 16% of our total oil production. That is not the case with natural gas, where offshore volumes only represent about 3% of our total gas supply.

The other challenge for the energy business from hurricanes and potential infrastructure damage, is the possible impact on shipping operations. When storms threaten Gulf Coast ports, they are shut down, forcing oil tankers to wait offshore until ports reopen. This means oil supplies are not replenished on their normal schedule.

If ships cannot depart, or shipping facilities are damaged, these oil and gas exports could be interrupted, and possibly for an extended time period, which would have a disruptive effect on the domestic energy industry's operations nationwide

What the shale boom has done is change the energy shipping equation. While we continue to rely on oil imports, especially for certain grades of crude oil needed to maximize Gulf Coast refinery output, we are now exporting surplus oil. More importantly, we have a blossoming liquefied natural gas (LNG) export business, which relies on ships loading gas cargos for delivery worldwide. If ships cannot depart, or shipping facilities are damaged, these oil and gas exports could be interrupted, and possibly for an extended time period, which would have a disruptive effect on the domestic energy industry's operations nationwide. For example, if LNG exports are stopped, the gas pipelines bringing gas into the Gulf Coast terminals might have to cease taking gas from producing wells as far away as the Permian or Marcellus regions, with significant financial implications. Predicting if and how significant these disruptions might be is impossible at this time. Understanding that disruptions might occur, however, is critical. Energy companies need to develop plans for dealing with storm related disruptions.

As Hurricane Harvey demonstrated when 65% of the Houston area refining capacity was shut down, gasoline prices soared and supplies were impacted in other geographic regions

Hurricanes will continue to be a risk that cannot be forecasted, only acknowledged. We look to the oil and gas industry's long record of successfully managing operations while dealing with the challenges of Gulf of Mexico tropical storms. But, as Hurricane Harvey demonstrated when 65% of the Houston area refining capacity was shut down, gasoline prices soared and supplies were impacted in other geographic regions. There are unintended consequences from storms. We trust energy companies will continue to develop continency plans for dealing with the risks of hurricanes, no matter how severe or benign the upcoming season is projected to be. Keep watching the hurricane forecasts – they do matter!

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PPHB is an independent investment banking firm providing financial advisory services, including merger and acquisition and capital raising assistance, exclusively to clients in the energy service industry.