
MUSINGS FROM THE OIL PATCH

November 29, 2016

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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

The OPEC Agreement: Yes...But

Often the details and the execution are not what the public is led to expect at the time of the announcement

You read it here first – tomorrow the members of the Organization of Petroleum Exporting Countries (OPEC) will announce an agreement to limit its output. You will have to wait for the details, and more importantly you will have to wait to see whether OPEC members actually do what they say they will do. For those of us who have seen this show before (often with even greater drama/showmanship), the issues with every OPEC agreement are the details and then its execution. Often the details and the execution are not what the public is led to expect at the time of the announcement.

OPEC has little choice at this point but to attempt to salvage some degree of respectability

OPEC has little choice at this point but to attempt to salvage some degree of respectability, especially following the debacle of the Doha meeting last spring at which a preconceived agreement blew up at the last minute. We are not going to debate the viability of OPEC as a cartel – to us it has always been an excuse to travel to Vienna and Europe for shopping and partying. On the other hand, OPEC does play an important role in helping to corral a number of important crude oil producers into supposedly one voice, although the power of that voice has been diminished by the evolution of energy markets over the last 25 years, and especially in the last few years.

It is the result of economic discipline being restored to the oil market

The key factor for the oil market that OPEC understands is that it is in a recovery mode. That is not due to a miracle, or can be attributed to the efforts of anyone in particular. Rather, it is the result of economic discipline being restored to the oil market. Fewer uneconomic prospects are being drilled. Assets are moving from weak hands into stronger hands – hands that don't necessarily have to drill in order to generate revenue to attempt to keep the doors of the companies open. Additionally, companies are figuring out how to operate more efficiently – fewer employees, more efficient

The producers have driven oilfield service company prices down to levels that are not sustainable for the long-term

The question has been about the volume of supply

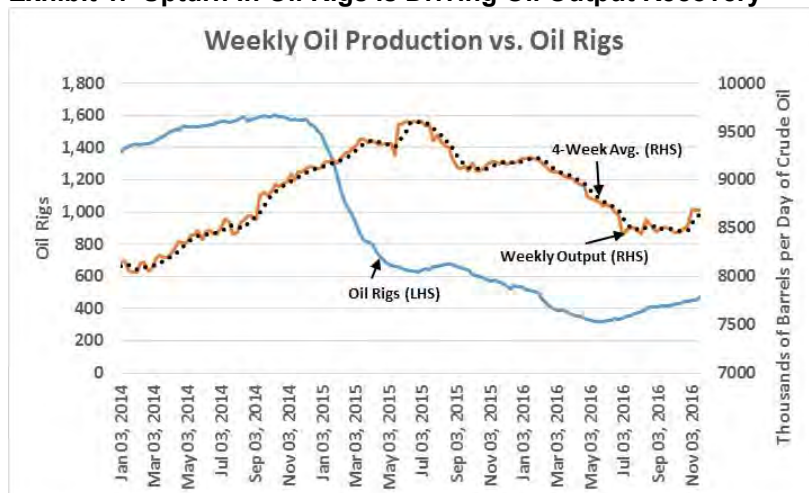
Since the May bottom, the industry has added 158 working oil rigs

operations and employing greater technology. Producers at the moment have benefited from destroying the pricing structure of the oilfield service industry, enabling the producers to lower operating costs. The producers have driven oilfield service company prices down to levels that are not sustainable for the long-term. Short-term gains for producers will have to yield to higher oilfield service prices if the producers wish to have the equipment, technology and employees that deliver the field services that they need. The question becomes how quickly oilfield service prices rise and how much of those increases can be offset by further efficiency gains.

At the end of the day, global oil demand continues to grow. It may not be growing as fast as forecasters previously anticipated, or history suggests it should, but with more people on the planet and improving standards of living worldwide, even with increased energy efficiency throughout the global economy, energy demand grows. The question has been about the volume of supply. With two years of low oil prices cutting into the profitability and cash flow generation of producers and restricting the amount of drilling they could do, the growth in new production volumes has not been able to offset the declines producers are experiencing in their current output. That situation is beginning to change in the U.S. as weekly production estimates by the Energy Information Administration (EIA) are showing an uptick in output consistent with the upturn in the oil drilling rig count.

Exhibit 1 shows the relationship between the weekly oil production estimate and a 4-week average of production gains versus working oil drilling rigs. As shown in the chart, the oil rig count turned up in the first week in June. The bottom in the oil drilling rig count was the week of May 27th at 316 working rigs. Since that bottom, the industry has added 158 working oil rigs as of November 23rd,

Exhibit 1. Upturn In Oil Rigs Is Driving Oil Output Recovery



Source: EIA, PPHB

Maybe even more important has been the growing belief that oil prices are not likely to fall back into the \$30-a-barrel range

a 50% increase. As the chart also shows, estimated weekly oil production has increased recently, leading to a rise in the 4-week moving average of oil production. All of this improvement has occurred since the oil market and industry leaders became convinced that the sector was recovering and that oil prices were heading higher, even though they didn't know to what level or how quickly. Maybe even more important has been the growing belief that oil prices are not likely to fall back into the \$30-a-barrel range, which would undercut the improving economics of the oil business.

Listen to what they say, but pay attention to what they do

With rising U.S. oil output and demands from OPEC members who are just now restoring their production volumes to historical levels, the issue of managing global supply will remain the critical balancing issue in the OPEC agreement. One might refer to this as the details. The admonition about OPEC has always been: Listen to what they say, but pay attention to what they do. December 1st will be an interesting day, but January 1st may be more important.

Are EVs Reaching The Take-off Point Or Doomed To Neutral?

The show is known for the wide range of vehicles shown, ranging from sexy will-never-build-'em concept cars to practical going-on-sale-soon production models

Jill Ciminillo, automotive editor of CBS12.com, recently captured three key news points about the global auto industry from among the glossy photos of cars at the 2016 Los Angeles Auto Show following the two-day media extravaganza leading up to its opening. The show is known for the wide range of vehicles shown, ranging from sexy will-never-build-'em concept cars to practical going-on-sale-soon production models. The three news stories Ms. Ciminillo highlighted involved two electric vehicle developments and the third involving diesel cars. The latter story seems surprising given the Volkswagen Group's (VLKAY-OTC) scandal involving emissions from diesel engines sold in Volkswagen and Audi cars.

Plans call for the production vehicle to officially debut during 2017 with the first I-Pace models hitting the streets in 2018

The luxury electric vehicle segment will gain a new competitor in 2018 as Jaguar, a subsidiary of Jaguar Land Rover Automotive PLC, which in turn is owned by Tata Motors Limited of India, announced plans to bring a fully electric car to market. The concept car at the show is known as I-Pace. Although the concept design will need to be modified slightly to accommodate safety requirements, the car will have up to 220 miles of range on one battery charge and will deliver 400 horsepower. Plans call for the production vehicle to officially debut during 2017 with the first I-Pace models hitting the streets in 2018. As Jaguar's first fully electric car, it will take direct aim at the Tesla (TSLA-Nasdaq) Model X. No price for the I-Pace has been announced, but the speculation is that it will fall below the Model X price of \$74,000, especially considering that the base price of the Jaguar F-Pace SUV is only \$40,900.

The second electric vehicle announcement dealt with South Korea's Hyundai Motor Company's (HYMTF-OTC) new Ioniq fully electric vehicle. Hyundai is testing car subscriptions, an alternative word for

The fee will include all electric charging costs, scheduled maintenance, and replacement of worn parts, as well as license and registration fees

leases, targeting Millennials. Under Hyundai's program called "Ioniq Unlimited," a buyer can get a 2017 Ioniq electric vehicle for either a two- or three-year period for a flat monthly fee. The fee will include all electric charging costs, scheduled maintenance, and replacement of worn parts, as well as license and registration fees. Key selling points for Millennial-buyers are that the Ioniq electric vehicle subscription does not require a down payment and there are no mileage limitations. This program will initially only be available in California, which is the center of the electric vehicle market.

For cash-strapped and debt-laden Millennials a subscription offers potentially a less-costly way to secure mobility

To further advance the Ioniq electric vehicle's success, Hyundai has recently teamed up with WaiveCar, a car sharing service that started up earlier this year. The car sharing service is currently restricted to Los Angeles, but it allows people, using an app, to reserve a vehicle, drive it for the first two hours free and pay \$5.99 per hour thereafter, and return the car anywhere within the service territory. For cash-strapped and debt-laden Millennials a subscription offers potentially a less-costly way to secure mobility.

The company's global web site states that the engine has 20% better fuel-efficiency than older models

In the diesel world, Japan's Mazda Motor Corporation's (MZDAY-OTC) announcement that it is putting its 2.2-liter Skyactiv-D diesel engine into the redesigned CX-5 is interesting given the poor image of diesel cars at the moment. The car will be in U.S. dealer showrooms by the end of 2017. Although Mazda didn't release any details about the engine, the company's global web site states that the engine has 20% better fuel-efficiency than older models due to its low-compression design and complies with global emissions regulations without NOx after-treatment. The European engine specs state that the CX-5 engine will deliver 173 horsepower and 310 pound-feet of torque. Given the Volkswagen diesel emissions scandal, one wonders what the American reception will be to a new diesel car model, especially after Mazda has delayed the engine's introduction several times.

Will he move to end the various renewables subsidies such as the \$7,500 tax credit for purchasing an electric car?

While these news stories are interesting in their own right, the key question is how will they fit in the new energy and automobile worlds under a Donald Trump presidency? Proponents of electric cars are concerned about their future given President-elect Trump's statements about climate change being a hoax during the campaign. Will he move to end the various renewables subsidies such as the \$7,500 tax credit for purchasing an electric car?

Those standards require the development of smaller, fuel-efficient cars, of which electric vehicles are designed to play a role

At the same time environmentalists are fearing cuts to their subsidies, the U.S. auto industry remains cautious about investment in all-electric vehicles due to persistent low gasoline pump prices. At the same time, the fuel-efficiency standards are up for review beginning next year. At the present time, those standards require the development of smaller, fuel-efficient cars, of which electric vehicles are designed to play a role, if the companies are to meet the fleet-wide standards. To date, electric vehicles have been a money-losing proposition for car manufacturers. On the other hand,

The company continues to promote the advantages of hydrogen fuel cell vehicles

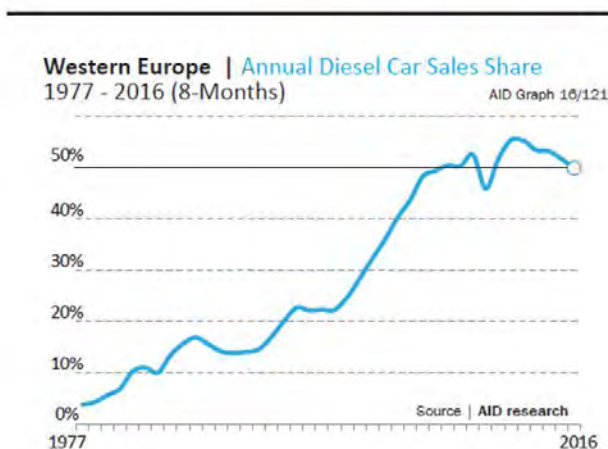
Toyota Motors Corporation (TM-NYSE), Japan's largest car manufacturer is shifting its green car strategy and launching a new unit to develop full-size electric vehicles for its global fleet. The company continues to promote the advantages of hydrogen fuel cell vehicles, but it recognizes that success for this technology is further in the future than full electric vehicles due to the lack of a refueling infrastructure and the tightening global fuel economy standards.

On its own, the resolution has no legislative effect

In Europe, the environmental movement has pushed the Bundesrat, the upper chamber of the Federal Republic of Germany that is populated by members from the 16 state governments in the country, and which acts mainly in an advisory capacity since political power resides in the popularly elected Bundestag, to ban the internal combustion engine starting in 2030. The resolution calls on the European Union Commission in Brussels to pass directives assuring that "latest in 2030, only zero-emission passenger vehicles will be approved" for use on EU roads. On its own, the resolution has no legislative effect. However, traditionally EU regulations have followed the lead of German regulations.

Exhibit 2. Diesel Sales Are Falling In Europe

AID NEWSLETTER | 1618



Source: AID Newsletter

The penetration rate of diesel cars in the fleets of the different countries within Europe varies from a low of 18% in the Netherlands to a high of 70% in Ireland

While the Germany Bundesrat is pushing to block internal combustion engines, the U.S. diesel emissions scandal blackened Volkswagen's reputation and has created an environmental firestorm in Europe. According to *AIG Newsletter*, a news service regularly read by German auto executives, diesel car sales plunged by 5% in August, while they fell more in France (-5.8%), Belgium and Luxembourg (-5.5%), and by the largest amount (-12.9%) in the Netherlands. The penetration rate of diesel cars in the fleets of the different countries within Europe varies from a low of 18% in the Netherlands to a high of 70% in Ireland. The main volume markets for diesel vehicles in Europe – Italy, France and Spain – have 50%

Diesel fuel was more expensive than gasoline, although diesel vehicles had greater fuel-efficiency making the per mile cost of the fuel slightly better than for gasoline, but the fuel's strong odor and lack of availability restricted its acceptance

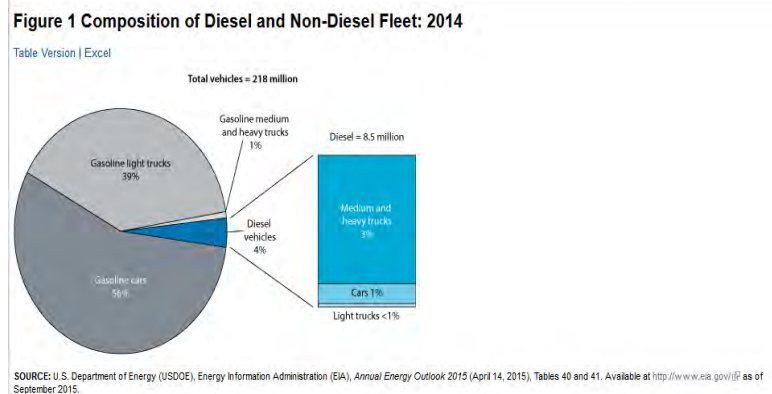
Volkswagen is now pushing its diesel car owners to look to the company for electric vehicles as their replacement vehicle

or greater penetration rates. With this high a percentage of the European fleet represented by diesel cars, and the favorable pricing of diesel versus gasoline fuel, it is highly likely that diesel cars will remain a prime component of the European automobile fleet for many years into the future.

In the United States, the story for diesel vehicles is quite different. For many years, diesel fuel had limited availability at gasoline stations. Additionally, diesel fuel was more expensive than gasoline, although diesel vehicles had greater fuel-efficiency making the per mile cost of the fuel slightly better than for gasoline, but the fuel's strong odor and lack of availability restricted its acceptance. What also bothered diesel car owners was the particulate emissions, often seen in clouds of black smoke pouring out of the tailpipe whenever these cars accelerated. The prospect of highly efficient, clean diesel engines from Volkswagen spurred greater acceptance of them on America's highways, or at least until the company admitted it had manipulated the environmental performance tests to skirt the emissions restrictions.

As shown by the 2014 data from the Energy Information Administration (EIA), diesel vehicles represented 4% of the American vehicle fleet, or 8.5 million of 218 million units. Of the diesel component of the fleet, cars represented 1%, light duty trucks (pickups) were under 1%, and medium and heavy trucks represented 3%. As diesel cars represented such a small portion of the fleet, any momentum gained as result of the successful marketing program by Volkswagen for its clean diesel engines has been dashed. Volkswagen is now pushing its diesel car owners to look to the company for electric vehicles as their replacement vehicle.

Exhibit 3. Diesel Vehicles Are Small Portion Of Fleet



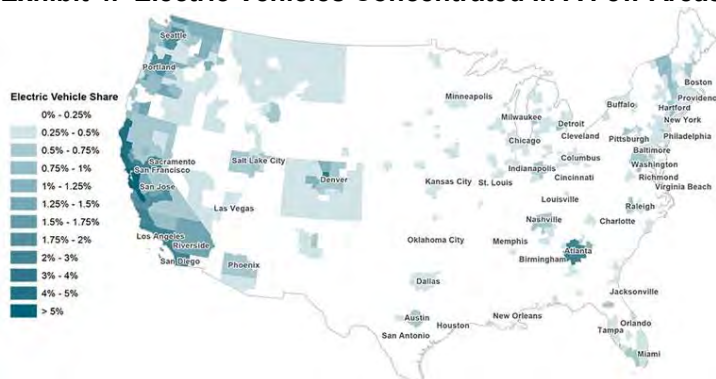
Source: EIA

What is interesting is seeing how the electric vehicle market evolves given the new models offered by an expanding number of car manufacturers along with the government incentive programs. We

The conclusion of the report is that local actions to promote electric vehicles are critical to their acceptance, which argues for more extensive and widespread incentives to foster the market’s growth

are helped in our understanding of this market by a new report from The International Council on Clean Transportation (ICCT). The report is an investigation into what is needed in order to sustain electric vehicle market growth in U.S. cities. The conclusion of the report is that local actions to promote electric vehicles are critical to their acceptance, which argues for more extensive and widespread incentives to foster the market’s growth. The authors of the report investigated the success, or lack thereof, in 50 major cities around the country. They found that in the 50 cities studied, the governments have undertaken at least 12 of the 33 distinct local actions identified for promoting electric vehicle sales and use. Collectively, these cities represent approximately 82% of total U.S. electric vehicle sales. Interestingly, these 50 cities have three times as many electric vehicle sales as the rest of the United States. Among those cities, the representation within California and the Pacific Northwest is greater than elsewhere.

Exhibit 4. Electric Vehicles Concentrated In A Few Areas



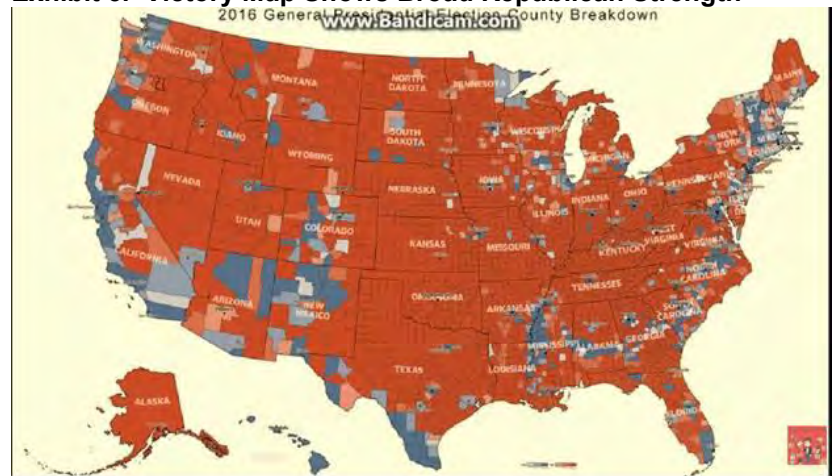
Source: ICCT

Those areas where electric vehicle representation is the highest happen to match areas where Hillary Clinton and the Democrats performed the strongest

While we know that California is the center of the electric vehicle industry as shown in the map in Exhibit 4, we found it very interesting to compare that map with the presidential election vote map from November 8th. Those areas where electric vehicle representation is the highest happen to match areas where Hillary Clinton and the Democrats performed the strongest. Many people won’t find that surprising since electric vehicles are closely associated with liberal political, social and environmental views. Those views drive governmental actions, especially in urban areas where overcoming infrastructure issues is easier than in rural areas.

Those cities with large electric vehicle markets tend to have the most extensive network of public charging stations and provide a mix of meaningful local and utility promotion actions

The ICCT study showed some interesting relationships that are important to the success of electric vehicle sales. Model availability proved to be statistically linked to the uptake of electric vehicles. Roughly 80% of the metropolitan markets had five or fewer electric vehicle models while the leading markets in California had about 20 models available. Those cities with large electric vehicle markets tend to have the most extensive network of public charging stations and provide a mix of meaningful local and utility promotion actions.

Exhibit 5. Victory Map Shows Broad Republican Strength

Source: Bandicam.com

Monthly electric vehicle sales for August through December were 90% lower than sales from January to July

If cancelled incentives are not replaced by state purchase incentives, there could be a negative impact on electric vehicle sales unless gasoline pump prices climb sharply

But what was most telling from the study was the significance of fiscal incentives on electric vehicle sales. In Atlanta there was a high sales incentive and a high market share. When Georgia suspended the sales incentive and instituted a new electric vehicle fee of \$200 per unit at mid-year 2015, sales dropped sharply. Car registrations confirmed that monthly electric vehicle sales for August through December were 90% lower than sales from January to July.

Obviously, outside of California, consumers are very sensitive to the economics of their vehicle purchase. This makes the question of what the new Trump administration will do with electric vehicle purchase incentives critical to the future of electric vehicles. If cancelled incentives are not replaced by state purchase incentives, there could be a negative impact on electric vehicle sales unless gasoline pump prices climb sharply. Under that scenario, electric vehicles would become more of a niche product until breakthroughs in battery technology and cost make the vehicles competitive with gasoline-powered vehicles.

The 2016-2017 Winter: Will It Be The Winter Of Our Despair?

The consensus is that this winter will prove to be slightly colder than normal marked by stormy periods of sharply colder temperatures and heavy snowfalls

We are now seeing early forecasts for this winter's weather, which is highly important for what happens to the domestic natural gas business over the next few months, and then next spring and summer. The consensus is that this winter will prove to be slightly colder than normal marked by stormy periods of sharply colder temperatures and heavy snowfalls. The problem with these predictions is that they are being made without true conviction, largely because the forces driving North American weather patterns are less well understood than traditional forces. In fact, it seems that the driving force for this winter's weather is a variation of La Niña that was only discovered and described in 2007.

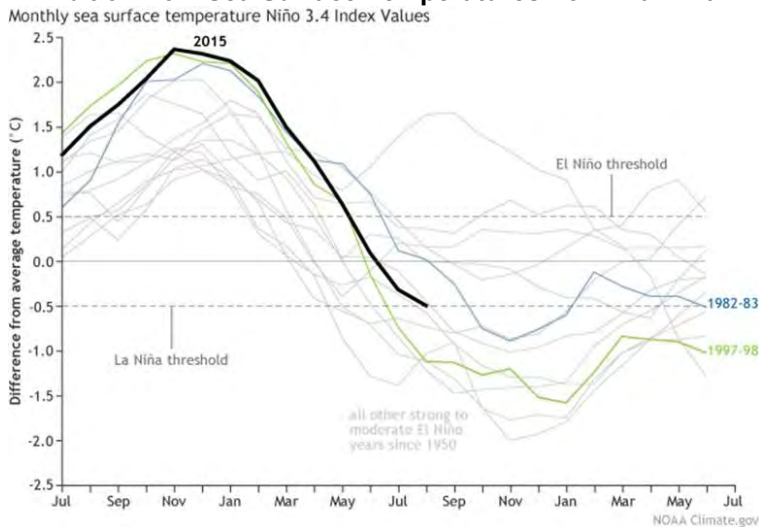
Now meteorologists believe we will experience a mild La Niña for the early and middle portions of winter, but by spring it will have no impact on our weather

The CP Modoki has little impact on North American weather, but it brings increased moisture to Brazil and northern portions of South America

Earlier this fall, the conventional view was that the super strong El Niño that had controlled weather patterns in the Northern Hemisphere and brought record warm temperatures to the region was waning and would be replaced by a La Niña. This shift would lead to cooler temperatures across North America and increased moisture, good for those portions of the United States that have been experiencing drought conditions. As we entered October, the consensus view changed to one of a very mild La Niña weather phenomenon suggesting a more normal winter, but that view has changed again. Now meteorologists believe we will experience a mild La Niña for the early and middle portions of winter, but by spring it will have no impact on our weather.

What has happened is that the waters of the South Pacific Ocean, the home of most weather-controlling forces, have cooled. That is the precursor to La Niña. However, in this case the cooling has concentrated in a small spot leading to the formation of a Central Pacific La Niña, or La Niña Modoki. Research published in China in 2013 shows that the CP Modoki has little impact on North American weather, but it brings increased moisture to Brazil and northern portions of South America. It has its major impact on the weather in Australia, Asia and Africa. Most particularly, this weather pattern impacts the growing seasons in these regions. As Evelyn Browning Garriss, editor of the *Browning™ World Climate Bulletin*, puts it, the fact that the CP Modoki has its primary impact on Asia and not North America, the interest in studying and understanding the weather phenomenon is higher in Asia than in North America.

Exhibit 6. How Sea Surface Temperatures Form La Niña



Source: NOAA

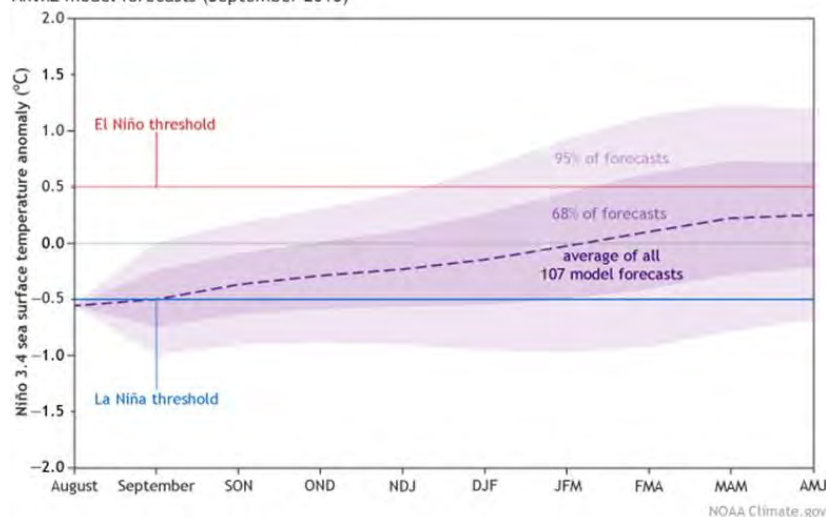
The National Oceanic and Atmospheric Administration (NOAA) published a report on the La Niña phenomenon because of the uncertainty it brings to forecasting this winter's weather. In the

Do you think the SST will stay below the threshold for the next several overlapping seasons?

presentation, and the blog maintained by some of its meteorologists, sea surface temperatures (SST) in the Niño 3.4 region (where all El Niño and La Niña temperatures are measured), are about -0.5°C below the long-term average. That is the first threshold measurement to determine the existence of La Niña. The second step is answering the question: Do you think the SST will stay below the threshold for the next several overlapping seasons? According to NOAA, and most forecasters, the answer to this question is no.

Exhibit 7. Cold Pacific Waters May Warm Ending La Niña

NMME model forecasts (September 2016)



Source: NOAA

Eventually you will get much greater rainfall over Asia and northern South America and Brazil

The blog showed the chart in Exhibit 7, displaying the range of SST forecasts for the subsequent three-month overlapping periods. The impact of these forecasts is reflected in the *Browning™* pictorial of the difference between a normal La Niña and a CP Modoki. The latter sees much greater amounts of cooler air sinking toward the ocean's surface over the cooler-than-average waters, while the perpetually warm waters near Indonesia warm further, and the overlying air becomes even more warm and buoyant than usual, leading to more vigorous rising air. This leads to stronger-than-average winds blowing east to west at the surface and in the upper atmosphere the winds are much stronger blowing west to east. Eventually you will get much greater rainfall over Asia and northern South America and Brazil.

The North American winter will be determined by the battle of the air masses

What this likely means is that drier conditions will exist for California and Florida, although potentially much wetter conditions along the Gulf Coast. The Pacific Northwest and Western Canada should have cooler temperatures and more moisture. In general, however, the North American winter will be determined by the battle of the air masses, as Ms. Garriss terms it. This battle is also shaped by the lingering fallout from Icelandic volcano activity. When these eruptions occur, they tend to cool the North Atlantic sea surface

Exhibit 8. Variations Of La Niña Shape Our Winter

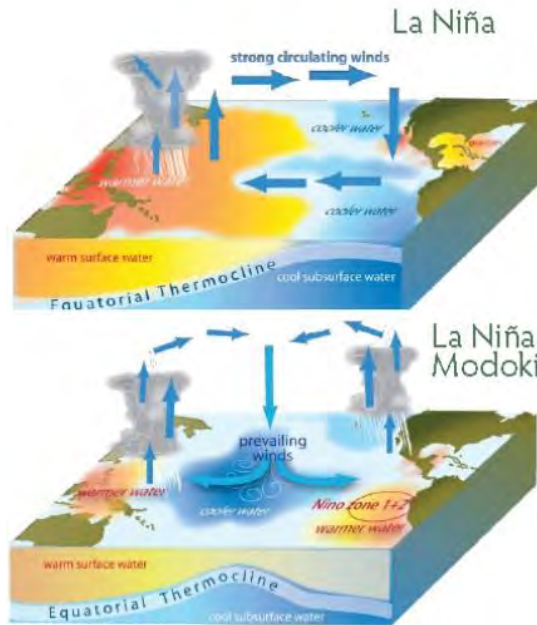


fig. 3A-B La Nina Modoki's are warm near South America which is good for supplying tropical rain to Peru and the Gulf of Mexico.

© Evelyn and James Garriss

Source: *Browning™ World Climate Bulletin*

The current weather is following the pattern of the years following active volcanic activity in Iceland

rapidly, which alters the air above it and changes the pressure and wind patterns in the area. It seems, given the recent formation of a “Cold Atlantic Blob” that the current weather is following the pattern of the years following active volcanic activity in Iceland.

Exhibit 9. Volcano And Jet Stream Will Determine Winter Cold



fig. 10A-B History suggests that positive NAOs are more common in the second winter following a large Icelandic eruption © Evelyn and James Garriss

Source: *Browning™ World Climate Bulletin*

When this cold weather meets the tropical warm and moist air heading north, you get violent winter storms with large snowfalls

In 60% of the years with a similar weather pattern, winter comes early in December

The gas market has responded to periods of colder temperatures with sharp price spikes

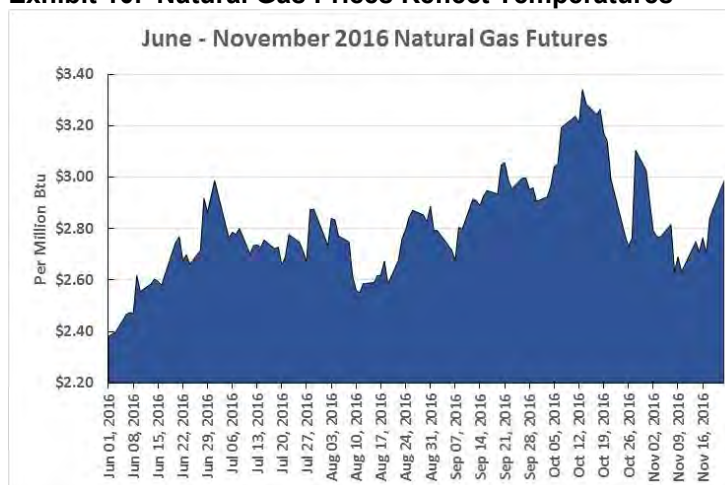
This pattern creates a situation where the strong jet stream that acts to keep the cold Arctic weather in Northern Canada can shift, or breakdown, allowing bitter cold air to sink into the U.S. When this cold weather meets the tropical warm and moist air heading north, you get violent winter storms with large snowfalls that can quickly disappear when and if the jet stream returns to its traditional pattern. Taking all of these weather phenomena into account, Ms. Garriss foresees the overall winter shaping up to be warm in the Midwest and Great Lakes, and stormy in the Northeast and Central South states and parts of the Pacific Northwest. It will be dry in the Southwest and Central states.

According to Ms. Garriss' research, in 60% of the years with a similar weather pattern, winter comes early in December and impacts the northern tier states and Southern Canada. She also expects periods of very stormy weather during the remainder of the winter, which will fade as we approach early spring.

What are the implications of this winter weather pattern, assuming it holds for the balance of the winter, for the natural gas market in the United States? Without focusing on the supply side of the equation, other than to note that with increased oil drilling, there may be more associated natural gas produced that would slow the output decline underway, we will pay attention to possible demand scenarios.

It appears that the more confused winter weather picture being reported by meteorologists has had an impact on natural gas prices and their outlook. We see how gas prices rose early in October in response to a brief bout of cold temperatures, but quickly fell when the cold weather wasn't sustained. Since then, the gas market has responded to periods of colder temperatures with sharp price spikes. In other words, the natural gas market is being driven almost totally by weather, something everyone hates but has come to live with.

Exhibit 10. Natural Gas Prices Reflect Temperatures



Source: EIA, PPHB

We combed the NOAA data base for information about three-month overlapping temperature anomalies with an eye to finding analog winters

The four analog years we selected are: 1995, 1997, 2000 and 2011

The volumes ranged from as little as 1,322 billion cubic feet (BCF) of gas used in the winter of 2011, to as much as 2,230 BCF consumed in the winter of 1995

To see what might happen to natural gas consumption this winter given the seasonal outlook set forth by Ms. Garriss, along with the other forecasts we have either read or heard presented, we combed the NOAA data base for information about three-month overlapping temperature anomalies with an eye to finding analog winters. That would then allow us to gauge how much natural gas was withdrawn from storage, which would impact natural gas prices not only during this winter, but more importantly in the spring and summer of 2017.

In making our analog winter year selections, we have drawn on information that Ms. Garriss set forth about weather patterns in years following heavy volcanic activity. After sifting through all the data, we have come up with four years – two of which were pointed out by NOAA bloggers, and two years based merely on the pattern of temperature anomalies. The four analog years we selected are: 1995, 1997, 2000 and 2011. Surprisingly, two of those years had very large gas storage withdrawals while the other two years experienced relatively small withdrawals. This pattern only adds to the confusion about weather patterns in trying to sort out natural gas market trends for the balance of this winter.

Besides looking at the four indicated analog years, we added the winter of 2012 for consideration because of Ms. Garriss' observation that the weather pattern we may see could be similar to that which appears two years following major volcanic activity in Iceland. Since the large eruption of Bárðarbunga in 2014-2015, a significant volcano on Iceland, determining what constitutes the weather two years' later is unclear. Therefore, we added the winter of 2012 to our analog year analysis.

In Exhibit 11, we show the beginning natural gas storage volumes for the respective winters and their season-ending amounts. The difference between the two figures is the volume of gas withdrawn from storage to provide fuel to deal with the winter cold. As can be seen, the range of starting volumes and ending volumes is wide, suggesting that the amount of gas from storage consumed in these winters varied greatly. The volumes ranged from as little as 1,322 billion cubic feet (BCF) of gas used in the winter of 2011, to as much as 2,230 BCF consumed in the winter of 1995.

Exhibit 11. Analog Winter Starting, Ending And Volumes Used

(BCF)	1995	1997	2000	2011	2012
Start	2987	2886	2713	3794	3908
End	757	1206	738	2472	1687
Withdrawal	2230	1680	1975	1322	2221

Source: EIA, PPHB

You should also note the differences in the amount of natural gas consumed during the winters of 2011 and 2012, as it relates to the

Our sense is that the upcoming winter will not be like either of those two winters

volcanic activity of 2014/2015. The difference goes from one of the warmest winters with the least gas consumed in 2011 to the very cold and high gas use winter of 2012. Our sense is that the upcoming winter will not be like either of those two winters. Therefore, we prepared an analysis by looking at how much natural gas would remain in storage at the end of the 2016/2017 winter season if we experienced withdrawals (due to winter temperatures) similar to the winters of 1995 and 2011 – the coldest to the warmest winters of our analog years. We also included the middle winter of the five examined, which is the winter of 2000, as a possible compromise outlook. Exhibit 12 shows the outcome of the analysis.

Exhibit 12. Analog Winter Results For 2016/2017

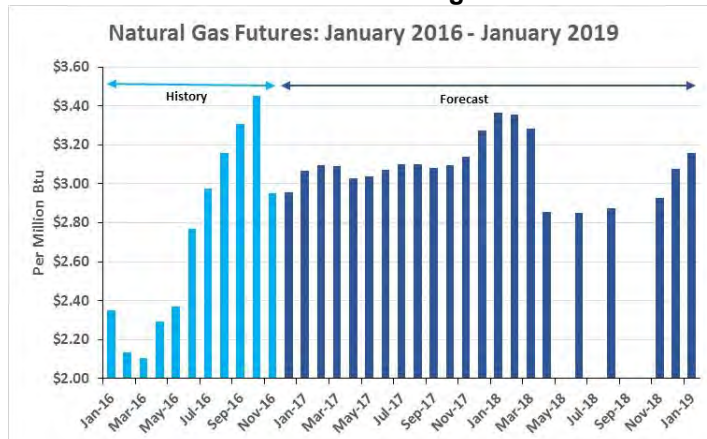
(BCF)	1995	2000	2011
Start – 2016	3909	3909	3909
Withdrawal	2230	1975	1322
Est. Storage	1679	1934	2587

Source: EIA, PPHB

Based on the futures prices, gas traders are much more optimistic about higher prices during next year’s winter

Based on the prices for natural gas futures, it appears traders are assuming a normal to slightly colder winter. That would be consistent with what they are hearing from the meteorologists preparing long-range winter forecasts. What is instructive in Exhibit 13 is that while the gas traders are expecting a modest upward bounce in natural gas prices during the upcoming winter months, following a flat December, they also believe gas prices will be higher next summer. Some of that optimism reflects expectations for falling gas supplies due to a lack of new well drilling over the past two years. Based on the futures prices, gas traders are much more optimistic about higher prices during next year’s winter. Futures prices after the winter of 2017/2018 would seem to reflect very bearish bets about the long-term trends for natural gas demand in 2018 and into 2019.

Exhibit 13. Gas Futures Reflect Slight Winter Price Bump

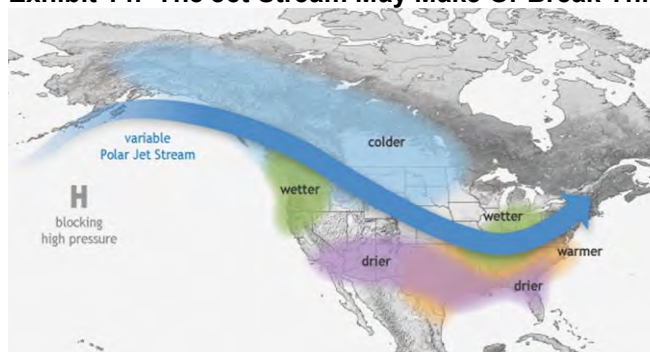


Source: EIA, CME, PPHB

“So, prepare yourself. Winter is coming and it’s going to be weird.”

Ms. Garriss, in her November *Browning™ World Climate Bulletin*, stated at the end of her discussion about the upcoming winter: “So, prepare yourself. Winter is coming and it’s going to be weird.” That may be an understatement given the inability of the weather forecasting fraternity to agree on exactly what kind of winter we will have. And with high variability for winter weather the likely scenario, an extended change in the jet stream flowing across North America, a not unheard of event, could significantly alter any forecast for energy use.

Exhibit 14. The Jet Stream May Make Or Break This Winter



Source: NOAA

If this winter does turn out to be “weird” as Ms. Garriss suggests, it will be in keeping with how the entire year has unfolded

When we examine the three analog winter gas use projections in Exhibit 12 (previous page), we would love for the winter to be like 1995, but we certainly hope it is not like 2011. Therefore, we should focus on what if we had a winter like 2000? We would end this winter withdrawal season with 1,934 BCF of gas in storage, or about 20% less than when we ended the winter of 2015. However, it would be nearly a third more gas in storage than when we ended the 2014 winter, having consumed 95% of the gas used that winter. We would be in a similar use-situation as experienced in 2012 – 90% of the gas consumed and 40% more gas in storage. While those two years didn’t translate into great years for natural gas prices, they were also characterized by years with steadily rising output throughout the year. In contrast, this year we are now entering the winter season with a shrinking output of natural gas as the drilling downturn has finally caught up with supply. If we had to guess, we think the futures market for natural gas may have a reasonable handle on where gas prices might go over the next year. With that caveat, slight changes in La Niña could lead to sharply higher or lower natural gas prices. If this winter does turn out to be “weird” as Ms. Garriss suggests, it will be in keeping with how the entire year has unfolded. As Yogi Berra said, “It ain’t over till it’s over.”

Renewables And Battery Technology Breakthroughs

We recently saw an article with the headline: Imminent Breakthrough in Battery Technology. The headline caught our attention, especially

At that point we realized that our interpretation of the word “imminent” was considerably different from that of the headline writer

in light of other articles we had read about batteries. The first paragraph of the attention-gaining article suggested there would be a technological breakthrough resulting in lighter, more powerful and less costly batteries within the next 5-8 years. At that point we realized that our interpretation of the word “imminent” was considerably different from that of the headline writer. We know that headline writers are usually not the authors of articles, and the roles are different. The former is interested in grabbing a reader’s attention, while the article’s author is interested in imparting factual information to the reader.

Five to eight years, in our mind, doesn’t equate to the present or as being ready to take place

According to the online version of the Merriam-Webster dictionary, the definition of “imminent” is given as “ready to take place.” Moreover, as the dictionary points out, the word “imminent” is derived from the Latin word “imminens” meaning “present.” Five to eight years, in our mind, doesn’t equate to the present or as being ready to take place. However, what we understand is that anything projected to happen in 5-8 years appears to be close enough for people to imagine significant developments occurring. Likewise, 5-8 years is so far out that people forget if the forecast is wrong.

Matt Ridley said of electric vehicle batteries that “their cost is still huge, and their Achilles heel is the long time it takes to recharge”

There is no question, however, that the “holy grail” for renewables is a technological breakthrough in batteries that enables them to hold larger charges, charge faster and discharge more frequently, be less costly, and not present health risks when discarded. Lowering the cost of batteries, and potentially their weight, while at the same time improving their performance will go a long way to improving the range and use in electric vehicles, and their popularity. In a column published in *The Times*, Matt Ridley, a British journalist, businessman and author of popular science books, said of electric vehicle batteries that “their cost is still huge, and their Achilles heel is the long time it takes to recharge.” Chris Goodall of Carbon Commentary said, in a rebuttal to the column and after acknowledging that electric vehicles are more expensive, that a BMW electric vehicle “will fill from empty to full in less than 40 minutes at a fast charging point in the UK.” We don’t remember the last time we spent 40 minutes at a gasoline station refilling our vehicle. It can usually be completed within 10 minutes, and not having to spend the time finding a recharging location.

In the UK, we found a service, Zap-Map.com, which offers a smartphone app for locating recharging points

In the UK, we found a service, Zap-Map.com, which offers a smartphone app for locating recharging points. According to the explanation on its web site, “There are three main EV charging speeds: Slow charging (up to 3kW) which is best suited for 6-8 hours overnight; Fast charging (7-22kW) which can fully recharge some models in 3-4 hours; and Rapid charging units (43-50kW) which are able to provide an 80% charge in around 30 minutes. Rapid chargers also come in two charge point types – AC and DC – depending on whether they use alternating current or direct current.”

There are 2,165 Rapid connectors, the kind of recharging device that meets Mr. Goodall’s charging time claim

The site listed the following information as of November 24, 2016: 11,864 connectors at 4,230 locations, with 261 new ones having been installed within the last 30 days. There are 2,165 Rapid connectors, the kind of recharging device that meets Mr. Goodall’s charging time claim. An important point is that recharging locations often have multiple connections. Simple division of the number of connectors by the number of locations suggests 2.8 connections per location.

The Zap-Map.com web site shows a map of recharging locations throughout the UK, which would appear on a subscriber’s smartphone. As one would expect, the concentration of recharging locations are centered in and about metropolitan centers of the country.

Exhibit 15. Electric Recharging Stations In The UK



Source: Zap-Map.com

If the UK used Tesla Powerwalls, at \$3,000 each, the cost to equip the country with its battery storage capacity would cost £8 (US\$9.97) trillion.

Mr. Ridley estimated it would take 400 gigawatt-hours of batteries to turn the country's 14 GW of wind capacity into 4GW of electricity on demand

In a recent interview, he said that the this technology still remains in the early stages of development and is not ready for practical use even after nearly 20 years of work

Mr. Ridley, in his column, challenged a number of assumptions about the status of batteries as a way to improve the performance of renewables for generating power in the UK. His argument centered on the economics of batteries. He pointed out that "Britain uses about a terawatt-hour of electricity during an average winter day." Based on a calculation method developed by German physicist Clive Best, Mr. Ridley estimated that the UK would need nearly 10-times the number of car and truck batteries on the entire planet in order to provide the country with two days of power storage. If the UK used Tesla (TSLA-Nasdaq) Powerwalls, at \$3,000 each, the cost to equip the country with its battery storage capacity would cost £8 (US\$9.97) trillion.

Mr. Ridley went on to discuss the cost to turn a fleet of wind turbines into baseload electric power based on the work of the late David MacKay, formerly the chief scientist at the UK Department of Energy and Climate Change. Based on Mr. MacKay's methodology, "a terawatt-hour of storage would be needed to turn 33 gigawatts of wind capacity into a reliable source." Using that calculation, Mr. Ridley estimated it would take 400 gigawatt-hours of batteries to turn the country's 14 GW of wind capacity into 4GW of electricity on demand. That system would cost north of £130 (US\$162.2) billion. Both of Mr. Ridley's cost estimates might come down due to reduced costs for batteries, but the declines have not been sufficiently large enough to materially alter the magnitude of the cost for backup power systems.

While batteries for wind and solar backup power are the much-discussed alternative that will drive increased use of renewable energy, the economics for batteries depend on some form of technical breakthrough to bring their cost down meaningfully. Earlier this year, researchers from Cambridge University claimed a breakthrough in an article published in the journal *Science*. The researchers engineered a "lithium-air" (Li-air) battery that uses oxygen from the atmosphere as one of its components. Li-air batteries hold promise of being lighter, longer-lasting and cheaper than lithium ion batteries. Interestingly, two teams of researchers, one of which included the inventor of the Li-air technology, penned dissents that were also published in *Science*. The Li-air technology was developed by K.M Abraham of Northeastern University and publicized in 1996. In a recent interview, he said that this technology still remains in the early stages of development and is not ready for practical use even after nearly 20 years of work. After studying the claims made by the Cambridge University researchers in their *Science* article, the dissenters pointed out that the claims about the chemistry did not appear to be sound science. The dissenters believe that the original claims involved changes to a lithium-iodine battery, which is another high-energy rechargeable battery, but does not offer the potential breakthroughs of Li-air technology.

The key advantage of hydrogen cell engines, besides no carbon emissions (only water vapor), is that they scale easily – just add additional cells

In the transportation field, a debate is raging over whether battery-electric is a better power source than hydrogen cell powered engines. For years, the leader in hybrid vehicle technology, Toyota Motor Corp. (TM-NYSE) has been pushing hydrogen fuel cells. The company recently announced it was establishing a new unit to develop fully electric larger vehicles, while also promoting the development of universal battery powered cars for the worldwide market. Does this mean that the company is giving up on hydrogen fuel cells? No. In fact, Toyota has created a new leasing program for its Mirai vehicle so techies can participate in helping the company perfect the car and its technology. Toyota has partnered with BMW Group (BMV.DE) in developing concept vehicles, and importantly has the support of Royal Dutch Shell plc (RDS.B-NYSE), French oil company Total SA (TOT-NYSE) and Austrian company OMV AG (DE.OMV) who are building 400 hydrogen stations in Germany over the next ten years. The key advantage of hydrogen cell engines, besides no carbon emissions (only water vapor), is that they scale easily – just add additional cells.

The greatest improvement in the technology has occurred in the past few years as it has been able to reduce the amount of platinum used in the polymer fuel cell

The Mirai is Toyota's seventh generation fuel cell vehicle with the first having been a RAV4 in 1996. The greatest improvement in the technology has occurred in the past few years as it has been able to reduce the amount of platinum used in the polymer fuel cell. That move has enabled a doubling of the power density of the fuel, and the company believes there is further room for improvement. Although they do not have enough miles on their existing fleet to have the data to extrapolate the reduction in pollutants measured as if the entire U.S. passenger car fleet ran on fuel cells, their research shows a 60% reduction in carbon-emissions compared to a gasoline vehicle. The hydrogen fuel cell's emissions come from how the fuel is produced – primarily natural gas at the present time.

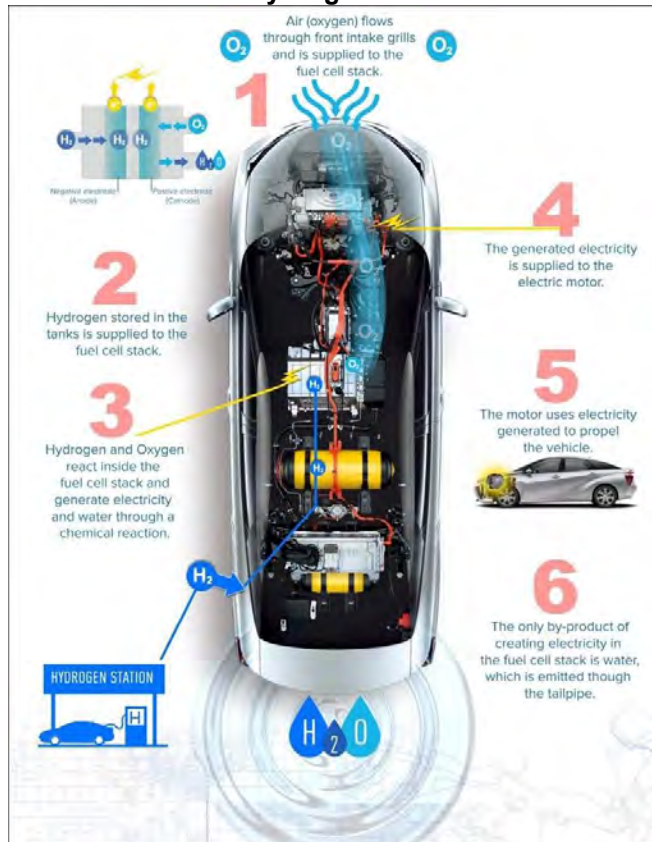
The latest generation fuel cell car cost 95% less than earlier versions, which admittedly involved significant amounts of hand-developed parts

Toyota has a solid reputation in creating breakthroughs in the development and manufacturing of vehicles that lower their costs. The latest generation fuel cell car cost 95% less than earlier versions, which admittedly involved significant amounts of hand-developed parts. We would not bet against Toyota, especially given its partnership with BMW, in making fuel cell vehicles a successful niche product with the potential to become more ubiquitous in the long-term.

The study's conclusion was that battery powered cars would be the better option

That conclusion comes despite a recent study by researchers from Stanford University and the Technical University of Munich, with some support from BMW, about whether battery or fuel cell cars were cheaper and better at reducing emissions. The study targeted California, the leading electric vehicle market, and the only state where fuel cell vehicles are available currently. The study's conclusion was that battery powered cars would be the better option. Of course, the study concluded that fuel cell cars would be sold at higher prices in the near and medium term and that hydrogen fueling

Exhibit 16. How A Hydrogen Fuel Cell Car Works



Source: Toyota

The cost issues are all related to near-term considerations, something that we know change over time

stations are more expensive to install than battery charging stations. We have not read the study, but conclude from the media articles that the cost issues are all related to near-term considerations, something that we know change over time. As battery powered vehicles are not now profitable, their future is totally based on subsidies and projected lower costs in the future. We'll keep watching Toyota and hydrogen cell cars.

Watson And The World Of Big Data In Energy

He focused on how his company has been employing Watson to improve its operations and project planning

We recently attended a presentation by IBM Corporation (IBM-NYSE) highlighting the progress of its Watson technology in helping energy companies become more efficient and profitable. The core of the first session was a presentation by Russ Potapinski, Head of Cognitive Science with Woodside Petroleum Ltd. (WPL-ASX). He focused on how his company has been employing Watson to improve its operations and project planning. Watson is computer technology for dealing with large masses of unstructured data, contrary to the normal manipulation of large masses of structured

Watson can be taught to become a personal assistant that can deal with all sorts of data, but importantly it never sleeps, is sick or on vacation

data. While it was noted that Watson requires training that is no different than training young engineers, according to Mr. Potapinski.

The point was made that people spend 80% of their time looking for an item and then 20% of their time acting on it. With Watson, Woodside found that this time allocation was reversed, meaning that executives and engineers can become more productive and help to lower operating and project costs. Watson can be taught to become a personal assistant that can deal with all sorts of data, but importantly it never sleeps, is sick or on vacation. While highlighting the power of Watson in helping to streamline offshore platform maintenance, we were impressed with the company's development of a system to assemble data about all drilling incidents by well depth that then could be queried and examined in greater detail. The ability to ask about a specific issue and then have presented all the original data and reports enabling in-depth reviews in a matter of minutes appears to be a powerful management tool.

With better use and application of the data might lead to a possible doubling of the projected increase in their rig count forecast, rising from a 35% gain to as much as a 70% increase over the next couple of years

The publisher of *Oil & Gas Journal*, Jim Klingele, suggested in his presentation that the technology that enabled the shale revolution involved the collection of substantial amounts of data and put pressure on all companies competing in the sector. Mr. Klingele further suggested that with better use and application of the data might lead to a possible doubling of the projected increase in their rig count forecast, rising from a 35% gain to as much as a 70% increase over the next couple of years. There is little doubt that the ecosystem of the oil and gas industry can be changed with the cognitive use of industry data.

Big data and cognitive solutions will become an important part of the energy business

The data-intensity of the oil and gas industry has increased steadily over time. It will continue to grow, especially with the shale revolution and the need to assess greater volumes of data about formations, facilitate the location of wells, plan the completions and monitor their performance. These trends help to explain the underlying business strategy shift of Schlumberger Ltd. (SLB-NYSE) and the roots of the merger between GE Oil & Gas (GE-NYSE) and Baker Hughes Corporation (BHI-NYSE). Big data and cognitive solutions will become an important part of the energy business, and topics that will become more important for monitoring industry trends developments in the future.

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