PPHB
ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

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

Will Oilfield Service Inflation Undo The Current Recovery?

The industry has crammed a year's worth of rig activity growth into a few months

The worst downturn in the history of the oil industry has been followed by the fastest drilling rig recovery in history. From massive layoffs and corporate restructurings, oil and gas and along with oilfield service companies have had to switch gears and figure out how quickly and profitably they can grow along with the current recovery. As someone mentioned, the industry has crammed a year's worth of rig activity growth into a few months – something that is creating a challenge for the oilfield industry.

Not only had investors and analysts bought into the recovery scenario, but so too had E&P company managements

As the energy companies are about to start reporting financial results for the January - March 2017 period, numerous oilfield service company managements have already signaled that the numbers will likely not reflect the levels of profitability Wall Street analysts had expected due to the costs of responding to the explosion in activity, especially following OPEC's surprise output cut to help drive a recovery in oil prices. From the rapid climb in the rig count, it is clear that not only had investors and analysts bought into the recovery scenario, but so too had exploration and production (E&P) company managements.

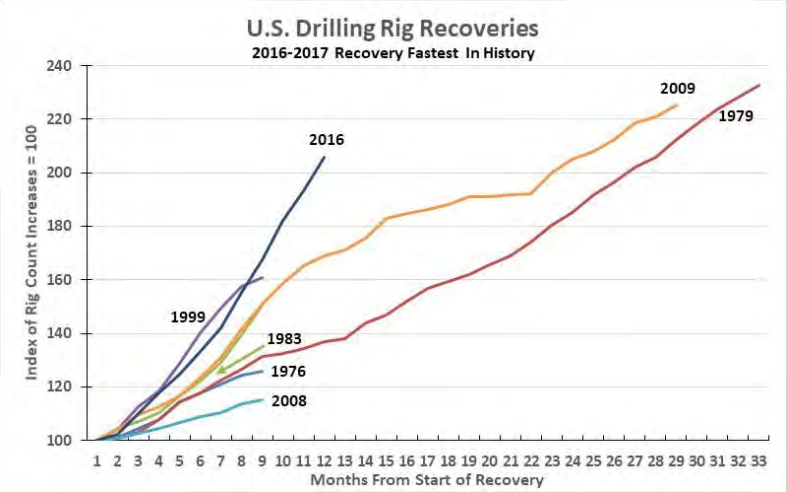
"The early bird gets the worm" is more appropriate to describe how people in the E&P business operate

There is an expression in English literature that "all things come to those who wait," but that isn't the case in the oil patch – especially if one wants to make money. In reality, the expression "the early bird gets the worm" is more appropriate to describe how people in the E&P business operate, but it is taking a toll on the pace of the recovery in oilfield service company profits. Service company managers have had to spend money to reactivate equipment and re-crew them before they can actually earn revenue. The more aggressive a company has been, or is, in ramping up its idle equipment, the greater are the costs incurred. At the present time, everyone is comfortable in the belief that the delay in gratification –

increased profits – will be worth the effort, and the wait. Whether that proves a correct assumption or not will depend on how the recovery continues unfolding and what happens to well costs, which is what is driving the increased activity. Everyone has to make money going forward for the recovery to be sustained. That doesn't mean, however, that everyone will enjoy the levels of profitability experienced during the era of $100+ a barrel oil prices. But, unless people make money, the industry will not be able to support additional activity, or possibly even support the current level of work. So where are we in this recovery?

Everyone has to make money going forward for the recovery to be sustained

Exhibit 1. Current Rig Recovery Is Record Pace



Source: Baker Hughes, PPHB

As Exhibit 1 shows, the current drilling rig recovery since May 2016 is the fastest in the history of the business, at least going back to 1968. It wasn't the fastest for the first seven months, as the 1999 recovery outperformed the recent rig count rise, but then that recovery faltered enabling the current recovery to seize the honor as the fastest recovery in history. In making that determination, we examined all past recoveries of note. Of the six substantial recoveries, four of them – 1976, 1983, 1999 and 2008 – lasted for only nine months, and all within the same calendar year. Three of those recoveries started in April and ended in December, while the 2008 recovery began in January and topped out in September.

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Although the current rig recovery has yet to celebrate its first birthday, its pace of increase has been impressive compared to prior recoveries. What this recovery has yet to do, however, is match the duration of the granddaddies of recoveries – 1979-1981 and 2009-2011. The earlier of those two recoveries lasted for 33 months, while the latter one extended for 28 months. As shown in the U.S. rig count history since 1968, the first extended recovery commenced in April 1979 and peaked in December 1981 at 4,521 rigs working. The later rig recovery extended from June 2009 until October 2011,

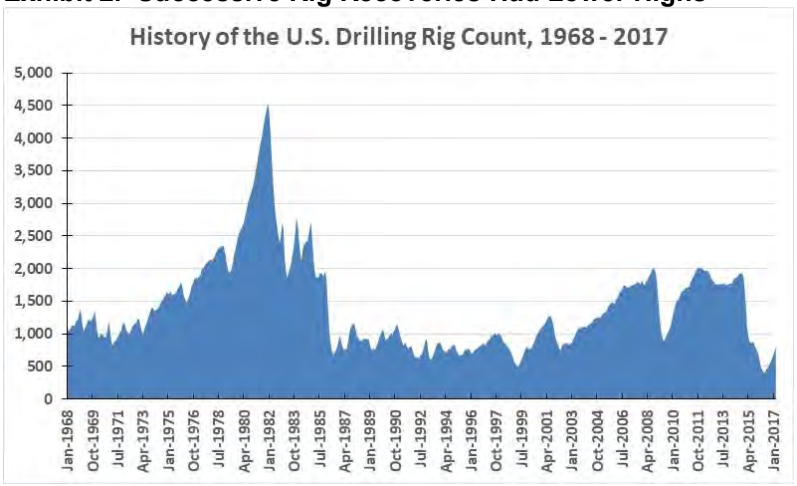
What this recovery has yet to do, however, is match the duration of the granddaddies of recoveries – 1979-1981 and 2009-2011

and peaked at 2,017 rigs. The earlier rig recovery, although lasting five months longer, saw 2,578 rigs added to the active fleet compared to only 1,122 rigs added during the 2009-2011 recovery. So far through March, this recovery has seen 381 rigs added to the active fleet. Bringing the active rig count current to last week adds an additional 58 rigs to the total.

How many rigs will be needed remains a question mark

An important consideration about the total number of rigs added in these long-term recoveries is how the nature of drilling and rig productivity has improved over the past 35 years. Just as we did not need over 4,000 rigs during the boom of the 2010s, we likely will not need more than 2,000 rigs as were needed in the last boom. How many rigs will be needed remains a question mark, but the embrace of pad drilling and multiple laterals from a common wellbore suggests there will not be as many drilling rigs needed in the future.

Exhibit 2. Successive Rig Recoveries Had Lower Highs



Source: Baker Hughes, PPHB

A key consideration about future rig activity relates to what proportion of cost reductions has come from improved drilling and well completion technologies versus reduced oilfield service prices

A significant factor underlying the current recovery has been the reductions in breakeven well costs in the various shale plays in the U.S. That effort has also been directed toward the offshore market, with what appears to be similar cost improvements as achieved onshore. A key consideration about future rig activity relates to what proportion of cost reductions has come from improved drilling and well completion technologies versus reduced oilfield service prices. The belief is that cost savings from the former may be sustainable, while those coming from lower service costs will prove transient. Therefore, understanding the relative contributions from these two factors is important in understanding how vulnerable currently improved well economics are to higher oilfield costs.

Virtually every investor presentation by an E&P company today contains slides showing how it has utilized technology to reduce shale well drilling times and boost hydrocarbon recoveries through better completions. There is little doubt that these efforts are

contributing to reduced well costs. But it is equally true that the industry downturn and resulting collapse in drilling and well completion work forced service companies to slash their prices in order to secure a share of whatever work was available. Even after nearly a year of recovery in drilling activity, the service industry continues to struggle to raise the prices of its services.

IHS to prepare a study of the changes in near-term oil and natural gas development costs during this period of challenging oil prices

To gain a better understanding of the changed economics in the oil patch, the Energy Information Administration (EIA) commissioned energy consultant IHS to prepare a study of the changes in near-term oil and natural gas development costs during this period of challenging oil prices as an aid to improve its oil and gas production forecasting accuracy. The study examined drilling and completion trends, and in particular, the changing complexity of wells drilled for five major onshore shale basins – Eagle Ford, Bakken, Marcellus, Midland and Delaware (collectively the Permian) – and the offshore.

IHS forecasted a continued decline in well costs of 7% to 22% over 2016-2018

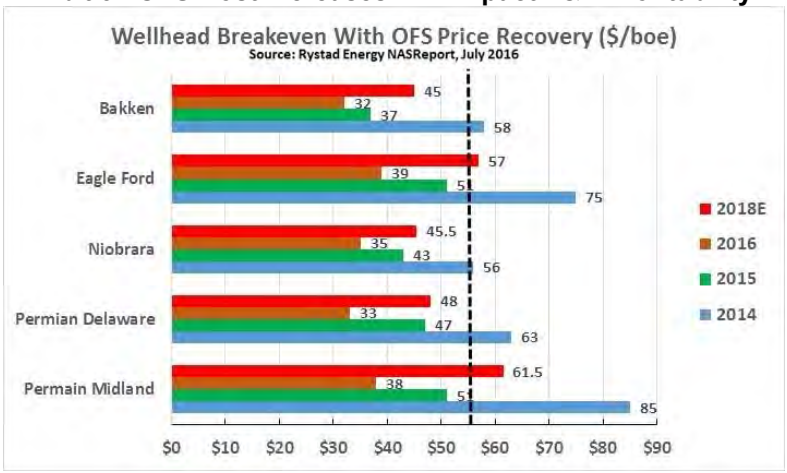
The report concluded: "Among the report's key findings are that average well drilling and completion costs in five onshore areas evaluated in 2015 were between 25% and 30% below their level in 2012, when costs per well were at their highest point over the past decade." Based on the continuing global oil oversupply situation in 2016, IHS forecasted a continued decline in well costs of 7% to 22% over 2016-2018 due to additional efficiencies in drilling rates, well lateral lengths, proppant use, multi-well pads, and the number of frack stages, despite higher drilling rig rates in 2017 and 2018.

If we assume all service cost savings are recaptured by the service industry by the end of 2018 and oil prices average $55 a barrel, the E&P industry is facing significant reductions in profitability

Trying to understand what is happening to well costs and the potential risk to higher future oil and gas output due to increased service costs is a challenge. In presentations, we have used the chart in Exhibit 3 (next page), showing estimates from oil consultant Rystad Energy of how breakeven well costs have fallen between 2014 and 2016 in key shale basins. Rystad Energy estimates that costs were reduced anywhere from 37% to 55%. Estimating the percentage contribution of technology improvements versus oilfield service cost reductions is key. Most people put the shares at 60%-70% for technology improvements since 2012 and 30%-40% for service cost reductions. If we assume all service cost savings are recaptured by the service industry by the end of 2018 and oil prices average $55 a barrel, the E&P industry is facing significant reductions in profitability. Moreover, in two basins – the Eagle Ford and Permian Midland – this analysis puts well breakeven costs above the oil price, signaling that activity would likely be curtailed. This analysis doesn't mean it will actually happen as there is the possibility that further technological improvements could reduce breakeven costs enough to offset higher oilfield service costs.

The EIA publishes data on the nominal and real costs for drilling wells. The problem is that this data is not current, primarily because it comes from the American Petroleum Institute's (API) Joint Association Survey of wells drilled and their costs. This survey data

Exhibit 3. OFS Cost Increases Will Impact E&P Profitability

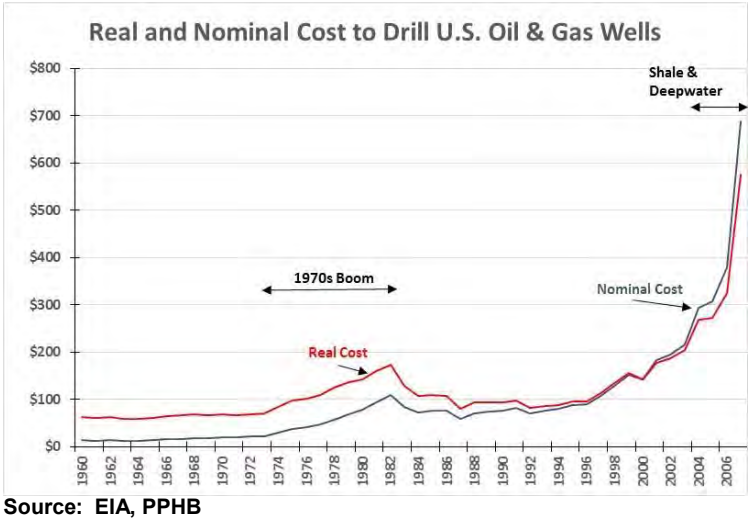


Source: Rystad Energy, PPHB

Well costs rose during the 1970s boom years and then again in the early years of the combined shale and deepwater drilling booms

is now controlled by IHS, so it is expensive to access more current information. So what we are left with is data that allows tracking nominal and real costs for drilling wells between 1960 and 2007. What we see in Exhibit 4 is how well-costs rose during the 1970s boom years and again in the early years of the combined shale and deepwater drilling booms.

Exhibit 4. Oilfield Inflation Of 1970s Matches 2000s Increase



Source: EIA, PPHB

Although the absolute dollars per well escalated between the two industry booms, the percentage increases in real terms were not materially different

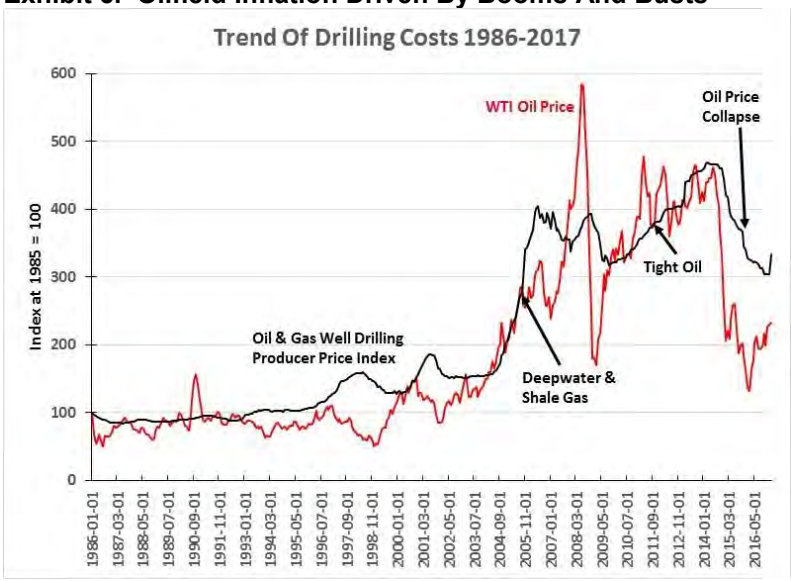
Comparing the two periods is enlightening. Between 1971 and 1982, the real cost to drill wells increased 250%, but the cost in nominal dollars increased 543%. These increases compare with the 2003-2007 boom when the real well cost rose 309% and the nominal cost increased 348%. Although the absolute dollars per well escalated between the two industry booms, the percentage increases in real terms were not materially different. The nominal

well cost increase in the recent boom was actually smaller than the industry experienced in the 1970s. Interestingly, the 1980s industry bust saw real well costs fall 53% between 1982 and 1987, as the nominal cost fell 46%.

What we do have, though, is a similar pattern (flat) between the mid-1980s and the late 1990s

Since we don't have more recent comparable data to assess current well costs, we need to consider another measure. We have information from the U.S. Producer Price Index (PPI), which tracks several measures of drilling costs. Unfortunately, the PPI for Drilling Oil & Gas Wells only starts in the mid-1980s, so it doesn't allow us a view of those costs during the 1970s. What we do have, though, is a similar pattern (flat) between the mid-1980s and the late 1990s, at which point the industry experienced the ramp up in activity in response to a perceived tightness in the oil market that was quickly undone by the Asian currency crisis. Given this comparison, we believe we can use the PPI as a measure of drilling cost inflation.

Exhibit 5. Oilfield Inflation Driven By Booms And Busts



Source: St. Louis Fed, Dept. of Labor, PPHB

When the deepwater and shale gas boom started in 2003, we then see the PPI rise from 150 to 400 before falling back as global oil industry activity was undercut by the 2007-2009 financial crisis and recession

What we see in Exhibit 5 is the increase in well costs experienced during 1996-1998 and then again during 2000-2001, immediately prior to oil price declines caused by geopolitical events. When the deepwater and shale gas boom started in 2003, we then see the PPI rise from 150 to 400 before falling back as global oil industry activity was undercut by the 2007-2009 financial crisis and recession that sucked liquidity out of the global financial system, a source of capital for the industry, and subsequently slammed oil demand. As those effects faded, the E&P industry commenced the tight oil drilling boom. That boom lifted U.S. oil output to record levels while also pushing the PPI index back above 400 and ultimately to a peak of 457 by the spring of 2014 before slipping and eventually crashing to 300 as the fallout from the oil price collapse cascaded through the

industry. We are now witnessing a return of oilfield price inflation as service companies respond to the drilling upturn by unstacking idle equipment and rehiring staff. To justify these expenditures, oilfield service companies are raising prices, which is reflected in the PPI. Since the November 2016 low of 303.6, the PPI has climbed to 332.8 in February 2017. At this point, we doubt oilfield service price increases will be rising until later in 2017, as the big jump so far this year reflects the surge in price increases to offset start-up costs and to recover some of the lost pricing from the downturn.

We doubt oilfield service price increases will be rising until later in 2017

The issue for oil and gas industry executives, however, is just how rapidly service companies attempt to raise their prices. The faster the pace of increases, the greater the pressure for producers to justify employing more technology and seeking increased operational efficiencies to help offset this service inflation. Randy Fouch, CEO of Laredo Petroleum Inc. (LPI-NYSE), in a recent presentation to industry executives, highlighted steps his company has taken to become more proficient at finding, developing and producing oil and gas. He began his talk by quoting former Saudi Arabia Oil Minister Ali al Naimi, who at the 2016 CERAWeek conference, stated that American shale producers could "lower costs, borrow cash or liquidate." Mr. Fouch commented that there was a fourth option, which his company seized, which was to become more proficient.

American shale producers could "lower costs, borrow cash or liquidate"

Mr. Fouch cited two specific actions as cost savers and value enhancers. First, with increased geologic data and an improved Earth Model the company has been able to drill longer well laterals. Using the same drilling rigs and crews, a rig that drilled 88,000 lateral feet in 2014 will today drill 175,000 feet in the course of a year. Thus, one rig is achieving the results of two, so unless rig rates were to double, there is a permanent cost savings. Second, Laredo has capitalized on a strategy of accumulating large contiguous acreage positions that enable the company to drill longer laterals. He cited the fact that there have only been 12 wells drilled in the Permian Basin with laterals longer than 15,000 feet and Laredo has drilled seven. By drilling a single 15,000-foot lateral rather than three 5,000-foot laterals, the company's proved developed finding and development cost has fallen by 35%, from $9.70 to $6.26 a barrel. Again, Mr. Fouch believes this will be a sustainable cost savings.

One rig is achieving the results of two, so unless rig rates were to double, there is a permanent cost savings

While each E&P company will offer its own example of how technology is contributing to its success, one cannot dismiss the benefits that have accrued to them from the collapse in oilfield service company costs. Many long-time successful E&P executives will tell you that their industry needs the service companies to be successful if they are to be successful. While true, we are often reminded of past industry downturns when oil and gas company CEOs extolled the need for a viable service industry only to fail to understand that his company's purchasing department was

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incentivized (rewarded with bonuses) for cutting vendor prices and lowering well costs. Walking the talk is more important than talking the talk. Oilfield service costs will rise and E&P companies will suffer margin squeezes. Those trends will contribute to the onset of the next industry cycle, just as in the past. What we don't know is the timing.

Shootout At The O.K. Parking Lot As Environmentalists Rally?

What is shaping up to be a classic confrontation between auto manufacturers and the Trump administration against the State of California and New York State over vehicle fuel-efficiency standards, having to do with carbon emissions, will likely not rival the fabled shootout at the O.K. Corral, regarded as the most famous shootout of America's Wild West era. For those who aren't familiar with this historical event, it occurred during a period when lawlessness was rampant in the western territories of the United States, before many of the territories became states. In those days, outlaws openly challenged the authority of lawmen attempting to bring them to justice for their crimes.

Outlaws openly challenged the authority of lawmen attempting to bring them to justice for their crimes

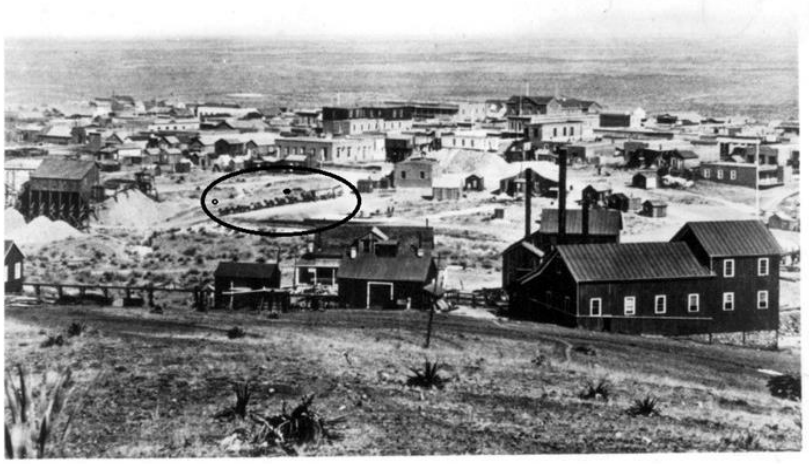
This particular event involved five members of a loosely organized group of outlaws known as the Cowboys. The five Cowboys - Billy Claiborne, Ike and Billy Clanton, and Tom and Frank McLaury - had a long-standing feud with the three Earp brothers, all lawmen, over their attempt to bring the outlaws to justice for the illegal activities. On the afternoon of October 26, 1881, in the town of Tombstone, Arizona, special policeman Doc Holliday joined with town Marshal Virgil Earp and Special Policemen Morgan Earp and Wyatt Earp, in a face-off with the five outlaws. While popular history says the shootout was at the O.K. Corral, it actually took place in a vacant lot next to C.S Fly's Photographic Studio. The shootout lasted 30 seconds, in which 30 shots were fired. When the smoke cleared, Billy Clanton and the McLaury brothers were dead. On the other side, only Wyatt Earp was not wounded. Billy Claiborne and Ike Clanton ran away, the latter claiming he was unarmed at the time of the shootout.

The shootout lasted 30 seconds, in which 30 shots were fired

We were fascinated to find a photo of Tombstone taken in 1881 by Mr. Fly. In the photo we circled an ore wagon being pulled by a team of 15 or 16 mules. The scene brought back memories of the television show, Death Valley Days that ran from 1952 to 1970, and dramatized true stories of the Old West. The show initially began on the radio in 1930, before moving to television in 1952. It was sponsored by the hand cleaner 20 Mule Team Borax. The sketch of an ore wagon being pulled by a team of 20 mules was on every box of the cleaner. It depicted how William Tell Coleman's company hauled borax from Death Valley, California to the nearest rail spur between 1883 and 1889.

The scene brought back memories of the television show, Death Valley Days that ran from 1952 to 1970, and dramatized true stories of the Old West

Exhibit 6. Tombstone, AZ: Scene Of Shootout At O.K. Corral

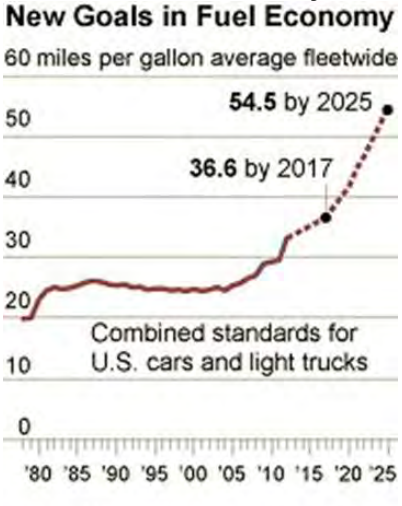


Source: ***Wikipedia***

It too will mark an historical event in the effort to significantly reduce carbon emissions

The modern shootout will likely not be either as dramatic or as deadly, but it too will mark an historical event in the effort to significantly reduce carbon emissions. At stake is the Trump administration's efforts to review, and potentially alter, the Obama-era fuel-efficiency standards put in place in August 2012. The then-existing Corporate Average Fuel Economy, or CAFE, program mandated that new car fleets average 29 miles per gallon (mpg), which would gradually increase to 35.5 mpg by 2016. The new rules call for vehicle fleets sold by auto manufacturers to average 54.5 mpg for the 2025 model year. The rules were seen as a victory for the environmental movement that has pushed for reduced fuel use as a way to limit automobile greenhouse gas emissions.

Exhibit 7. Fuel Efficiency Standard



Source: ***New York Times***

In real-world driving, the standard would be even lower – estimated to be closer to 40 mpg.

While the 54.5 mpg standard was hailed by then-President Barack Obama, his transportation secretary Ray LaHood and environmentalists, the attainment of the standards was questioned immediately. In the regulations was a credit for air conditioning vehicles, something that actually helps improve vehicle efficiency due to improved aerodynamic characteristics when windows are raised at high speeds. The impact of this credit reduced the standard's target to 49 mpg. The Environmental Protection Agency and the Transportation Department also acknowledged that in real-world driving, the standard would be even lower – estimated to be closer to 40 mpg.

Their weighting encourages auto manufacturers to sell more of these environmentally-friendly vehicles to help offset the lower mpg ratings of pickup trucks, SUVs

The purpose of the new fuel-efficiency standards is to put pressure on auto manufacturers to improve the fuel consumption of conventional engines, as well as push them to sell more zero-emission vehicles. The methodology for auto manufacturers to calculate their average fleet fuel-efficiency rating allows them to count zero-emission vehicles (battery or fuel cell powered) twice and hybrid vehicles one and half times. Since these types of vehicles will always be awarded substantially greater mpg ratings by regulators, their weighting encourages auto manufacturers to sell more of these environmentally-friendly vehicles to help offset the lower mpg ratings of pickup trucks, SUVs and other conventionally powered vehicles.

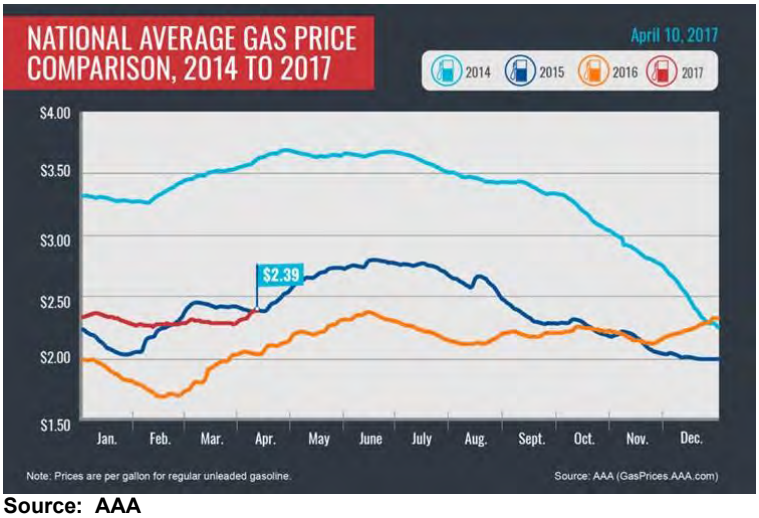
While different car builders were setting out different strategies, "American consumers have so far been slow to buy electric cars, despite gas prices that are near $4 a gallon"

The problem with this fuel standard is that it favors types of vehicles American auto buyers don't care about. What's funny is that this was happening at the very time the final rules were announced – on the first day of the 2012 Republican Party Convention at which Mitt Romney, son of the former president of American Motors and a vociferous critic of the cost of these new CAFE standards, was to be nominated as the party's presidential candidate against Mr. Obama. A *New York Times* article discussing the new standards pointed out that while different car builders were setting out different strategies, "American consumers have so far been slow to buy electric cars, despite gas prices that are near $4 a gallon."

Auto manufacturers are facing more difficult challenges as overall vehicle sales are dropping despite near record sales incentives and discounts

The article went on to point out that General Motors (GM-NYSE) was planning to temporarily shut down its production of Chevrolet Volt plug-in hybrid cars to reduce the backlog of unsold units. Today, with the national average regular gasoline pump price at $2.39 a gallon, auto manufacturers are facing more difficult challenges as overall vehicle sales are dropping despite near record sales incentives and discounts. The problems for the new car market include both a glut of young, used cars that is driving down resale and trade-in values, along with a shrinking automobile credit market making it harder for lower credit-worthy buyers to secure vehicle financing. After reaching a record of 17.6 million new vehicles sold last year, analysts had projected the annualized sales rate in March would reach 17.2 million units. Instead, the industry was only able to sell at a 16.6 million unit rate.

Exhibit 8. National Gasoline Prices Are In Line With 2015



Source: AAA

What appears to be selling are the high-end SUVs and smaller crossover vehicles

What appears to be selling are the high-end SUVs and smaller crossover vehicles. According to *Autodata*, in March, crossover vehicle sales, including the Honda CR-V, Chevrolet Equinox and Dodge Journey, were up 11%. On the other hand, smaller sedans such as the Honda Civic, Honda Accord, Toyota Corolla, Nissan Altima and Toyota Camry are all down between 6.5% and 13%. The Toyota Camry's decline of 13% can be partially explained by the fact it is due a significant re-working in the next model year, so buyers are often reluctant to buy the final model-year before a redesigned, and presumably better equipped, model is introduced.

One aspect of the new fuel-efficiency standard is that cars are costing more – partly due to the introduction of new driving and safety technology, but also because of the need to enhance the drive train

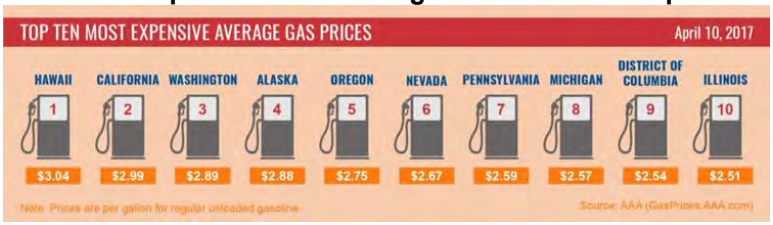
One aspect of the new fuel-efficiency standard is that cars are costing more – partly due to the introduction of new driving and safety technology, but also because of the need to enhance the drive train. The use of lighter-weight materials for constructing vehicles in order to improve their fuel-efficiency is also adding to costs. At the time of the announcement of the new standards, Governor Romney criticized them as being "extreme" and that they would eventually limit consumer choices. Countering those charges, Secretary LaHood said that the new standards would save Americans $1.7 trillion in fuel costs, for an average savings of more than $8,000 a vehicle by 2025. The fuel savings, he said, would easily exceed the estimated $2,000 to $3,000 price increase of more fuel-efficient vehicles that Americans would eventually be buying.

By the end of 2015, the U.S. was only about 40% of the way to meeting Mr. Obama's target

Long-term forecasts of the automobile market often seem to miss their target. Back in 2008, then-candidate Obama set forth a goal of America having one million plug-in electric vehicles (EVs) on the road by 2015, a goal he repeated in his 2011 State of the Union speech. By the end of 2015, the U.S. was only about 40% of the way to meeting Mr. Obama's target, as electric vehicle sales that year fell 6% from 2014's sales. Continued federal tax credits, along

with other state-sponsored incentives, have failed to fire-up the EV business, despite the growth in the number of models available and their improved range.

Exhibit 9. Top 10 States With Highest Gasoline Pump Prices

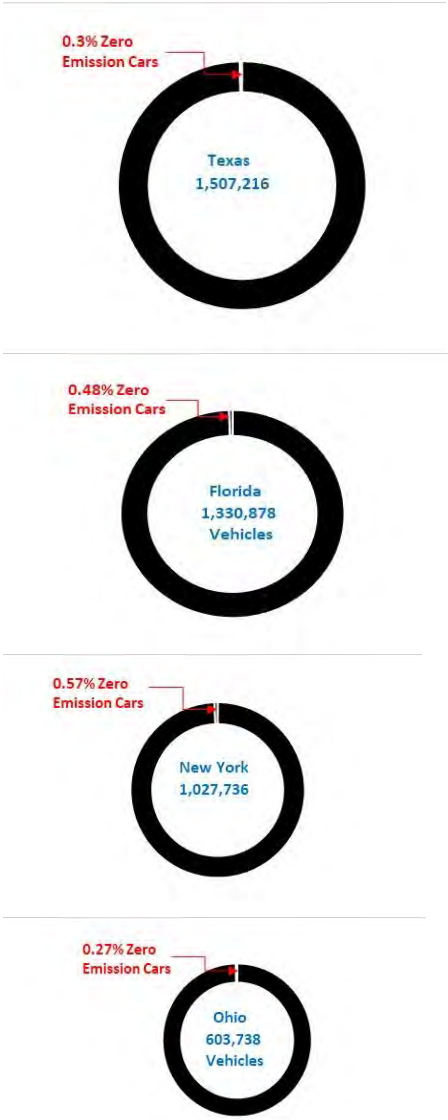


Source: AAA

California sold just over 73,000 EVs last year, while the remaining four states sold between 1,600 and 6,400 EVs, for a total of 18,400 cars

Due to its environmental policies, California has traditionally had the highest gasoline prices. In fact, the Governor Jerry Brown (Dem) is signing a bill to fund environmental activities that adds 12-cents to the price of a gallon of gasoline. The state has actively promoted zero-emission vehicles, and is planning to make them the only vehicles allowed in California down the road. Auto sales data shows that of the five top states, only California has created an EV market. Exhibit 10 shows that California sold just over 73,000 EVs last year, while the remaining four states sold between 1,600 and 6,400 EVs, for a total of 18,400 cars. Those sales will barely move the environmental needle. As a result, environmentalists are upset. They see EV sales dwarfed by the sales of fuel-thirsty pickups and SUVs. This is the prime reason why they are fighting any change in the fuel-efficiency standards as they know that rule is the only leverage they have to coerce auto manufacturers to build and sell EVs that the public clearly doesn't want to buy. Whether the public will want EVs in the next several years remains a huge unanswered question, especially if gasoline pump prices remain below $2.50 a gallon, nationwide. The outcome rests on cheap gasoline versus new, low-cost EV models from Chevrolet and Tesla (TSLA-Nasdaq), which will be priced at $28,000 after the $7,500 federal tax credit. Cheap EVs or cheap gasoline?

Exhibit 10. Clean Cars Are Small Percent



Source: Global Automakers, PPHB

Keeping the current fuel-efficiency standard may make the cost of failure to comply a motivator for auto companies to limit their sales of large, less fuel-efficient vehicles, even though these are the very vehicles generating the auto manufacturers' pro

Keeping the current fuel-efficiency standard may make the cost of failure to comply a motivator for auto companies to limit their sales of large, less fuel-efficient vehicles, even though these are the very vehicles generating the auto manufacturers' profits. If auto manufacturers restrict production of the large vehicles, it is possible that rather than having to offer discounts and incentives to sell them, they might be able to sell them at full or even premium prices, earning greater profits on fewer units sold. Continuation of the current fuel-efficiency standards means it is not inconceivable that in 2025, a buyer might walk into a car dealership and only be allowed to buy an EV since he hadn't planned ahead and ordered a pickup or SUV earlier in the model year when they were available for sale.

This scenario would be the auto industry's version of the Affordable Care Act with its mandate to buy health insurance, only in this situation the mandate would be a lack of alternative choices.

A prolonged legal battle with the possibility of dual fuel standards is not something the automobile industry desires as it puts its future in limbo

What is at risk here? There are multiple scenarios one can develop for how the domestic automobile industry will deal with the fuel efficiency standards. First, it can continue to operate as now: lobby the Trump administration to reassess the standards and possibly ease either the standard or its timing. That will entail a fierce battle as California, which has a waiver from the government allowing it to establish its own carbon emissions policy that is currently followed by about a dozen other states representing about 40% of the domestic vehicle market, has said it will not reduce its fuel-efficiency standards. Given the political posture of Gov. Brown toward environmental regulation, we would fully expect the state to lead the group's legal challenges to any changes. A prolonged legal battle with the possibility of dual fuel standards is not something the automobile industry desires as it puts its future in limbo.

Sales of battery and plug-in hybrid vehicles (40,379) in 2017's first quarter, represented 1% of total first quarter vehicle sales.

A major problem for auto manufacturers is understanding consumer desires and whether they can or will shift in favor of low- or no-carbon emission vehicles. Sales of battery and plug-in hybrid vehicles (40,379) in 2017's first quarter, represented 1% of total first quarter vehicle sales. The 45% year-over-year sales gain reflects the stepped up deliveries from Tesla and the initial deliveries of Chevy Bolts. The sales increase reflects pre-orders from EV enthusiasts and the sustainability of high sales rates will not be known for maybe a year.

Cars are lasting much longer than in the past

An additional problem for auto manufacturers is that due to improved vehicle quality, cars are lasting much longer than in the past. This has become a market overhang problem given the record sales of recent years. Many of the vehicles sold then were leased, meaning they are returning to the used car market at the end of the leases. That phenomenon is happening now, depressing used-car values. That market is also facing significant rental car fleet upgrades, also.

The issue for the subprime automobile credit market is that the decline in used car values has put many more borrowers "upside down" in their loans

The issue for the subprime automobile credit market is that the decline in used car values has put many more borrowers "upside down" in their loans. That means they owe more on the loan than the value of their vehicle. Additionally, despite an improved overall economy, credit quality has deteriorated as a greater percentage of low-credit borrowers are defaulting on their loans. With repossessed vehicles bringing less value, credit companies are forced to write off more of their loan portfolios, which has the buyers of auto credit company bonds pulling back on their purchases, raising the cost of capital for the auto credit companies.

Long-term trends could further adversely impact the auto credit market. First, the trend of more renters than car buyers, touted as the future by ride-sharing companies and urban lifestyle forecasters,

On top of that is the potential impact on auto sales and energy demand from the success of EVs

could reduce the market for new vehicle sales, and in turn, new vehicle loans. Second, the current credit cycle could be upended if the U.S. slips into a recession sometime in the foreseeable future, a scenario not being considered by many forecasters. The current economic recovery, albeit the slowest in modern times, is "long in the tooth," suggesting an increased potential for a downturn soon. That would impact auto sales and lending, while also boosting credit defaults and loan charge-offs. An economic downturn would likely cost jobs, which would reduce miles driven for commuting as well as leisure driving. All of these possible events would not be good for the automobile industry, nor for the energy industry. On top of that is the potential impact on auto sales and energy demand from the success of EVs.

An Alaskan Volcano, Hurricane Season And Gas Demand

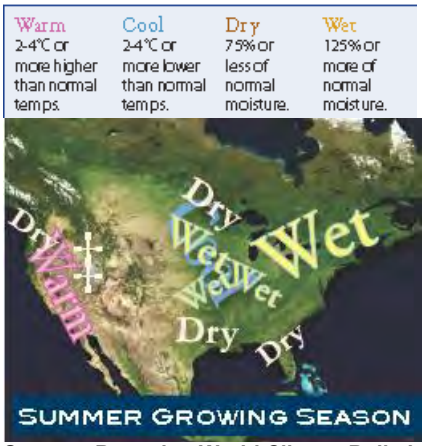
The Browning World Climate Bulletin, written by Evelyn Browning Garriss, daughter of Iben Browning, the founder of the publication, is devoted to understanding and predicting global weather patterns and, in particular, how those patterns may impact the agricultural sector. The byline of the bulletin refers to it as "World Reports Covering Climate, Behavior, and Commodities." The latest issue addresses the global weather outlook for this spring and summer, with commentary about how weather patterns might impact the plantings, growth and harvesting of various crops around the world.

This same weather forecasting has implications for global energy use

All of the weather forecasting presented in the Bulletin, which is done at very high levels and for extended time periods, is focused on the impact it will have on the agricultural industry. However, this same weather forecasting has implications for global energy use. It is with that aim that we consider the Bulletin's latest outlook for this spring and summer's weather.

While the details behind the weather forecasts are set forth in the explanation about meteorological trends, the outcome is normally presented in a series of maps with general comments about area weather trends such as shown in Exhibit 11. The Bulletin provides a table explaining the weather significance of the Wet, Dry, Warm and Cold descriptive terms.

Exhibit 11. Upcoming Weather Trends



Source: **Browning World Climate Bulletin**

The Bulletin coincided with the end of the winter natural gas withdrawal season and the start of the summer injection season

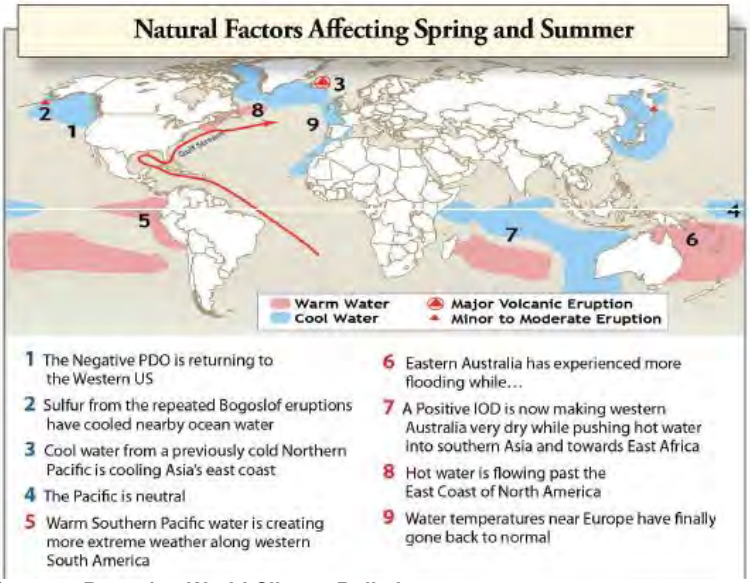
Our reading of the Bulletin coincided with the end of the winter natural gas withdrawal season and the start of the summer injection season, critical to natural gas futures prices. Coincidently, as we researched additional weather data, we discovered that the Colorado State University (CSU), Department of Atmospheric Science's preliminary outlook for the upcoming hurricane season had been posted literally two hours before we landed on its web site. Our purpose in checking the hurricane forecast web site was to examine historical data on the nature of the hurricane seasons in the two years Ms. Garriss suggested were most comparable to her spring and summer weather forecasts. While Ms. Garriss referenced five other possibly comparable weather years, she never identified them, keeping us from examining their hurricane seasons.

"The combination of volcano weather, northern ocean blobs and the still hot Western Atlantic is shaping a chaotic spring and a potential benign summer for crops"

Ms. Garriss summarized her weather outlook with the following statement: "The combination of volcano weather, northern ocean blobs and the still hot Western Atlantic is shaping a chaotic spring and a potential benign summer for crops." What does this portend for this summers' energy markets? To better understand the possibility, it is necessary to briefly discuss some of the climate trends Ms. Garriss highlighted in developing her outlook. A number of them were summarized in a map of the world with data points highlighted. If one grasps nothing else from the chart, it demonstrates that whatever weather one region of the world experiences, it has been influenced by climate developments and trends elsewhere.

Followers of meteorological trends are familiar with terms such as PDO (Pacific Decadal Oscillation) and IOD (Indian Ocean Dipole). They are long-standing climate trends in major regions of the world that move between positive and negative influences on weather patterns. Understanding the state they are in or the direction they are heading can aid forecasters in predicting the weather a region is likely to experience in the coming three, six, or nine months.

Exhibit 12. The Climate Factors Driving Upcoming Weather



Source: Browning World Climate Bulletin

For example, Ms. Garriss described the PDO and its weather impacts in the latest Bulletin:

"The giant Pacific has more than one cycle. One of the longest lasting is the roughly 50-year trend of the Pacific Decadal Oscillation (PDO), which shapes weather from the tropics to the Arctic Ocean. It especially controls temperatures and rainfall in western North America. It goes through roughly 25–30 years of warm conditions, interrupted by cold La Niñas, followed by 25–30 years of cool conditions, interrupted by warm El Niños. Since the warm El Niño conditions began in 2014, the PDO switched from its cool trend and is currently weakly positive."

It is important to pay attention to the developments of El Niños and La Niñas

When examining the long-term PDO trends, it is important to pay attention to the developments of El Niños and La Niñas that also change weather patterns in other regions. Last spring, Ms. Garriss was one of the first forecasters to predict the development of a weak La Niña, something officially recognized last December and declared over this February.

An important climate trend that receives little attention from meteorologists is volcanic activity

An important climate trend that receives little attention from meteorologists is volcanic activity. Ms. Garriss pays particularly close attention to this phenomenon, probably because it was a core analytical ingredient in her father's research and forecasts.

The eruptions of Mt. Bogoslof on the remote island of the same name located in the Aleutian Island chain off Alaska has impacted winter weather patterns in North America. The top of the volcano is underwater and the island and its nearest neighbor are uninhabited.

The first eruption probably cooled a passing cold front and contributed to the significant Nor'easter experienced by New England on March 12-13

Therefore, the monitoring of the volcanos eruptions has been done through satellite imagery and seismic measurements. The volcano never had a spectacular eruption, but rather between December 20, 2016, and March 13, 2017, there were 40 eruptions and minor gas escapes. However, there were two eruptions in March that sent sediments 35,000 feet into the air – the first lasting for hours and the second for 12 minutes. The first eruption probably cooled a passing cold front and contributed to the significant Nor'easter experienced by New England on March 12-13.

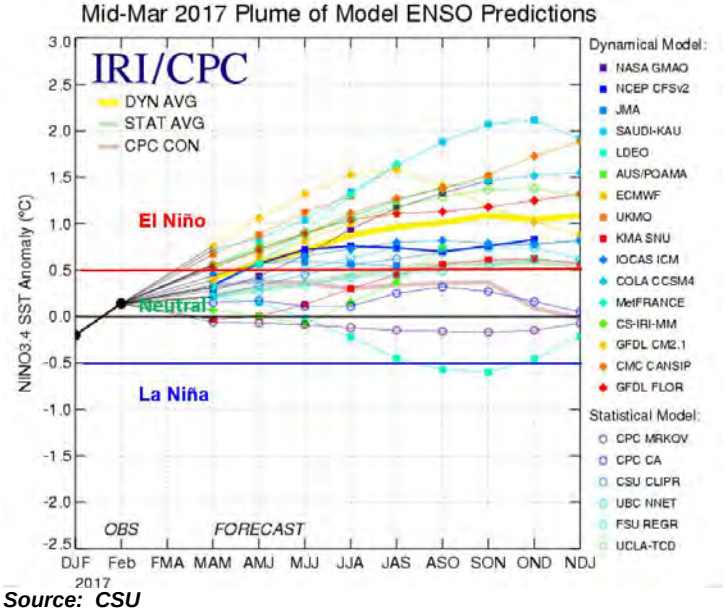
Although the sulfuric acid is highly diluted, it is shinier than the ocean water so not as much sunlight is absorbed, resulting in the cooling of the ocean waters

The Bogoslof eruptions have contributed to altered weather patterns in Western Canada and the western portion of the United States. It helped make Western Canada's winter temperatures colder and the U.S. West Coast wetter. It also contributed to periods of colder temperatures through the Plains and Central portion of the U.S. Additionally, the eruptions dropped sulfur emissions into the ocean off Alaska. These emissions created sulfuric acid. Although the sulfuric acid is highly diluted, it is shinier than the ocean water so not as much sunlight is absorbed, resulting in the cooling of the ocean waters, which cools the air and alters the air pressure directly above resulting in shifts in Pacific Ocean weather flowing into and across the Pacific Northwest and Western Canada.

Its eruptions have created a cold water spot that will have lasting repercussions on upcoming weather patterns

While it appears that the volcano is no longer active, its eruptions have created a cold water spot that will have lasting repercussions on upcoming weather patterns. These sulfur emissions have joined with those from the steady flow of volcanic activity on Russia's Kamchatka Peninsula to contribute to cooler Pacific Ocean temperatures.

Exhibit 13. Forecasts Calling For Likely Fall El Niño



Source: CSU

While an El Niño is good news for U.S. farmers, it also tends to blunt the worst of the early summer hurricane season

However, the Tropical Pacific Ocean appears to be warming and computer forecasting models are giving a 68% chance of El Niño conditions developing in August to October. National Oceanic and Atmospheric Administration (NOAA) scientists are surprised at the speed of development of a new El Niño, but rate current conditions as only neutral (50%) for this phenomenon to develop this summer. The last time such a trend evolved was in the 1960s. While an El Niño is good news for U.S. farmers, it also tends to blunt the worst of the early summer hurricane season. This is partially why the CSU hurricane forecast calls for a slightly lower-than-normal storm season this year. CSU is predicting 11 named storms, four hurricanes and two of them being major (Category 3 or stronger), compared to an average season that has 12 named storms, six hurricanes and two major hurricanes.

Severe hurricane damage to cities on our coasts can also reduce natural gas consumption

While we are interested in the likely hurricane season for its potential disruptive impact on natural gas output from the Gulf of Mexico and Gulf Coast wells, future hurricane activity might also have an impact on U.S. liquefied natural gas (LNG) exports – both ship movements and potential damage to the terminals. Severe hurricane damage to cities on our coasts can also reduce natural gas consumption.

They generally match conditions similar to those of an earlier period that are more similar to the currently developing El Niño

We were interested in what analog years the CSU forecasters used to adjust their computer model's predictions. The five years selected were 1957, 1965, 1972, 1976 and 2002. Those years are interesting in that they generally match conditions similar to those of an earlier period that are more similar to the currently developing El Niño than when that weather phenomenon emerged in recent years. Based on a 1982 paper, the warming currently developing in the eastern portion of the tropical Pacific Ocean, which then moves westward and creates associated trade winds, was more normal prior to 1980. It may explain why four of the five analog years are pre-1980.

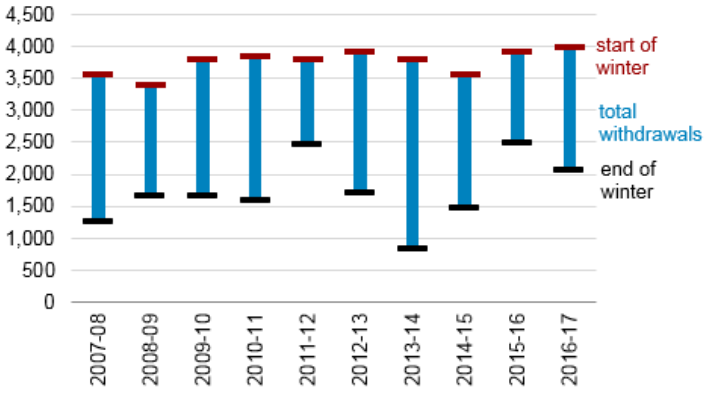
We examined all three years seeking a clue as to what they might portend in forecasting natural gas storage increases this summer

When Ms. Garriss went looking for comparison years for her weather forecast, she found only 2006 and 2009 had Alaskan volcano eruptions, El Niños and warm Atlantic Oceans. While CSU's 2002 selection didn't have the same climate conditions as Ms. Garriss' analog years, we examined all three years seeking a clue as to what they might portend in forecasting natural gas storage increases this summer. In 2002, during the summer injection season, the industry put 1,645 million cubic feet (MMcf) of natural gas into storage. In 2006, 1,750/MMcf of gas was injected into storage, while the volume injected in 2009 climbed to 2,159/MMcf.

If we add the three respective years' injection volumes, the industry would end the 2017 injection season with as much as 3,696/MMcf, 3,801/MMcf, or 4,210/MMcf of gas in storage

Of the 23 years we have studied for weekly gas storage injections, the three analog years represented the 9th largest (2009), the 17th largest (2006) and the 20th largest (2002) injections. As we are beginning this injection season with 2,051/MMcf of natural gas in storage, if we add the three respective years' injection volumes, the industry would end the 2017 injection season with as much as 3,696/MMcf, 3,801/MMcf, or 4,210/MMcf of gas in storage. In three

Exhibit 14. Will Large Gas Storage Impact Gas Prices
U.S. natural gas end-of-March working inventories, 2007-17
billion cubic feet



Source: U.S. Energy Information Administration, *Natural Gas Monthly* and *Weekly Natural Gas Storage Report*.
Note: Data for November 1, 2016, is an interpolated value, based on the *Weekly Natural Gas Storage Report*.

Source: EIA

The highest estimate could create problems for the industry, especially as total gas storage is estimated at only 4,100 MMcf

of the past five years, the industry began the withdrawal season with slightly under 4,000/MMcf of gas in storage, suggesting that the highest estimate could create problems for the industry, especially as total gas storage is estimated at only 4,100 MMcf. The challenge is to gauge what impact the starting storage volume and the weekly injection rates may have on natural gas prices. The historical price change and storage volume increases seem to show that the smaller the injection, regardless of the starting level, the greater the increase in natural gas prices over the injection season.

Supply is still below its peak of April 2015, but with increased oil drilling there will likely be more associated natural gas output

Our roughly calculated gross storage estimates for November 2017 represent little more than placeholders in a broader examination of the natural gas market. The idea that all three analog years for weather and hurricane forecasts produce storage volume estimates at the upper end of the industry's storage capacity means we must focus more intensely on natural gas supply and demand dynamics. Supply is still below its peak of April 2015, but with increased oil drilling there will likely be more associated natural gas output. At the same time, economics have improved in basins such as the Eagle Ford and Haynesville, so more supply will likely be forthcoming, and with a less than normal hurricane season, offshore gas supply may not be disrupted. This means greater attention needs to be paid to gas use, which may not get much help from a hot summer in the U.S. Therefore, LNG exports and gas versus coal price competition in the electric generation market will play a greater role in the market this summer. We plan to revisit the natural gas market as we get more weekly gas injection figures and can better track how this summer is comparing to our analog years.

Is Germany's Green Power Move A Warning For U.S. Users?

Higher power costs are a result and they are inflicting serious pain on the nation and its residents, raising questions as to whether Americans are ready to pay the price for such a transition

Americans are beginning to discover that the move to a reduced carbon economy will come at a cost. Just how much that cost will be is unknown, which makes examining other countries' efforts to make such a transition important. Based on the German experiment to evolve into a low-carbon economy, which reportedly is still supported by 52% of its citizens, higher power costs are a result and they are inflicting serious pain on the nation and its residents, raising questions as to whether Americans are ready to pay the price for such a transition, or even if they can afford it.

The average monthly electricity bill in Germany is about the same as in the U.S., but Germans use one-third the power consumed by Americans

The experiment of moving a highly-developed economy completely away from fossil fuels, as Germany is attempting to do, may be instructive as to the cost of such a move and the possible lifestyle implications of the shift for the United States, if it adopts a similar plan. Earlier this year, German household power costs reached a record high while the country's wholesale power prices are falling. The continued positive support among Germans for this transition is helped by the fact that spending for electricity as a share of disposable income has remained steady for years. Germany is tied with Denmark in terms of having the highest power price, but the average German bill is less than Denmark's because the average Germany customer uses about 12.5% less power. Germans are noted for their energy efficiency, but ultimately there is a limit on how much power consumption can be reduced. Over the past 20 years, German households have reduced their power usage by 10%. Interestingly, the average monthly electricity bill in Germany is about the same as in the U.S., but Germans use one-third the power consumed by Americans.

Exhibit 15. Germany's Power Bills Are Among The Highest

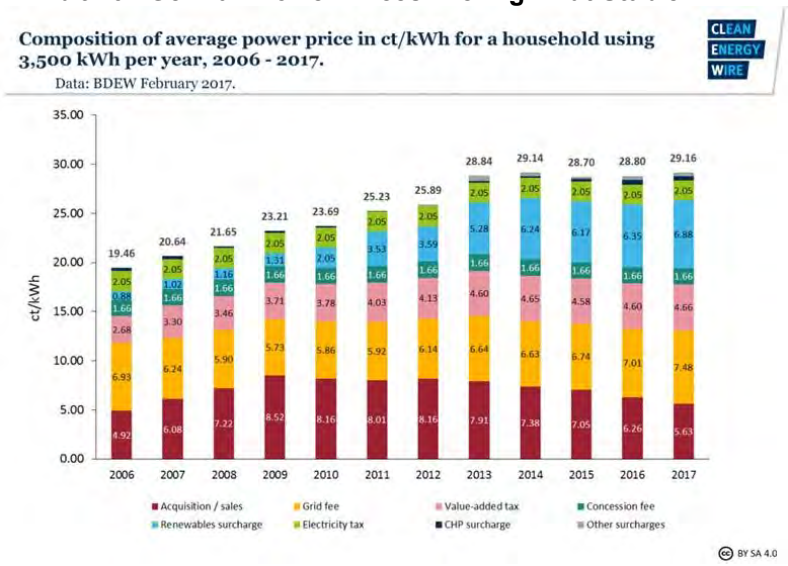
	Consumption (kWh)	Price (Ct/kWh)	Bill (EUR)
Denmark	4000	30	1200
US	11800	9	1060
Germany	3500	30	1050
Japan	5600	18	1010
Spain	4400	23	1010
Canada	10800	8	850
UK	4200	19	800
France	5000	16	800
Italy	2700	25	680
Source: Agora Energiewende/EI New Energy, Vol. III, No.			

Source: ***Clear Energy Wire***

As a share of power prices, the surcharge has climbed from 1% of the price in 1998 to 24% last year

Germany's experiment in shifting to carbonless power is coming at a steep cost. That cost is tied to the electricity surcharge for renewable energy, which has risen 10-fold since 1998. As a share of power prices, the surcharge has climbed from 1% of the price in 1998 to 24% last year. This surcharge represents the difference between the price for wholesale power and the higher, fixed price for green energy guaranteed by law to renewable power producers. Grid operators pass on this cost to household consumers, while high-volume commercial customers can negotiate it down or totally away. In 2016, although renewable power supplied 32% of the nation's power, consumers spent 23 billion Euros ($26 billion) on that power.

Exhibit 16. German Power Prices Are High But Stable



Source: Clean Energy Wire

As a result of the disconnection figures, 15.4% of households were issued disconnect notices, with 3.9% actually sent to the companies to be disconnected

One of the fallouts from the high cost of power is the growing energy poverty currently being experienced in Germany. According to the Bundesnetzagentur and the Bundeskartellamt (Federal Cartel Office) 2016 Monitoring Report, 359,000 German household customers had their power disconnected in 2015 for non-payment of bills. This total was down by about 20,000 customers from 2014. However, in 2015, 6.3 million disconnect notices for household customers were issued, but only 1.6 million were passed on to the relevant network operator for disconnection. Obviously, many customers were able to resolve their payment issues before the power was cut off, but we have no idea how they were resolved and whether it represented negotiated settlements. In 2015, according to government statistics, there were 40.8 million households in Germany. As a result of the disconnection figures, 15.4% of households were issued disconnect notices, with 3.9% actually sent to the companies to be disconnected. Some 0.9% of households actually had their power disconnected.

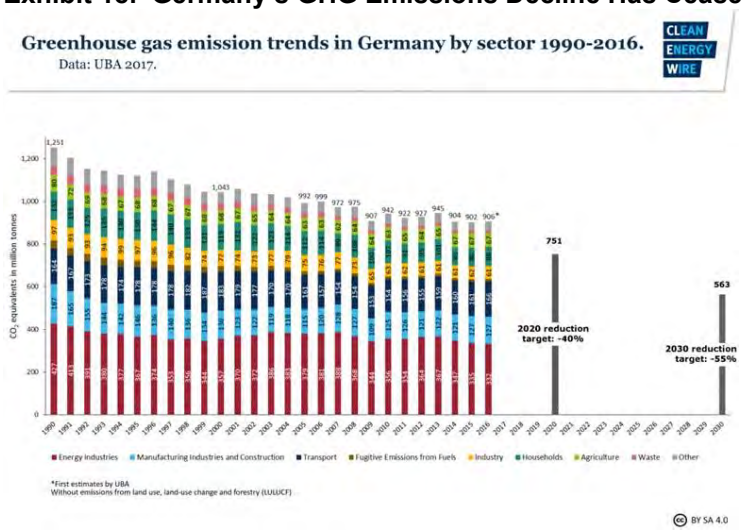
Exhibit 17. Renewables Represent 30% Of Germany's Power

Source: ***Strom-Report. DE***

Besides the cost impact of renewable power on customer bills, there remains the issue of its intermittency

Besides the cost impact of renewable power on customer bills, there remains the issue of its intermittency. A chart of power supply sources for eight days in mid-January of this year shows how wind and solar output was extremely limited, or in the case of wind, nonexistent for several days of that period. This meant that fossil fuel power plants were the primary source of power for the country during this time. Until renewable power has a broad battery backup system in place, or a way of distributing renewable power from other regions rapidly, fossil fuels will be the main backup source. This problem is highlighted by an examination of the electricity generation capacity mix of Germany.

Exhibit 18. Germany's GHG Emissions Decline Has Ceased

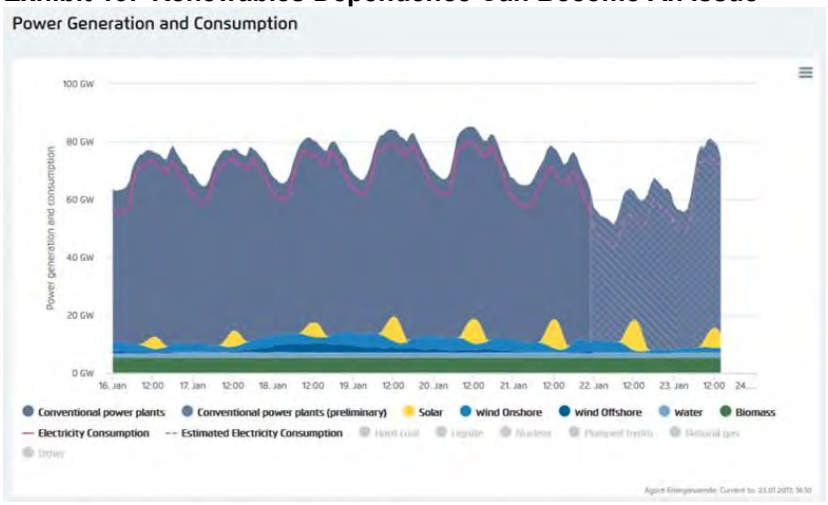


Source: ***Clean Energy Wire***

Given that increased dependency on conventional power plants, Germany's carbon emissions have remained flat for the past three years, or nearly 21% above the country's 2020 emissions reduction target

With 29.5% of the nation's power generating capacity coming from renewable sources, their inability to deliver consistent electricity supplies raises questions about what this experiment is costing Germany. So far, power outages have yet to become commonplace, suggesting that the investment in the nation's power grid has enabled better power management to offset the renewable intermittency issue, but one wonders at what point that relationship might change, and what the economic cost of power failures may be. To facilitate consistent power supplies, German utilities have been relying increasingly on imported coal and local lignite to fuel conventional power plants. Given that increased dependency on conventional power plants, Germany's carbon emissions have remained flat for the past three years, or nearly 21% above the country's 2020 emissions reduction target, which is 40% below 1990's level. In effect, over the past 26 years, Germany has only been able to cut its emissions by half its target, meaning it will likely not meet its emissions reduction target in the next four years.

Exhibit 19. Renewables Dependence Can Become An Issue



Source: ***Clean Energy Wire***

The world's initial energy source came from burning wood, something we are still doing today, including even using wood products to generate electricity

Germany is demonstrating that a shift to a carbonless energy economy is not an easy, quick or cheap step. Power costs have increased, inflicting pain on consumers/residents and a cost on the economy. These costs have taken a toll on the ability of Germany to reach its carbon emissions reduction target, a requirement for the country to meet its Paris agreement commitments. We would remind people that the world's initial energy source came from burning wood, something we are still doing today, including even using wood products to generate electricity. Without a new, carbonless fuel, the ability of any nation to completely divorce its economy from fossil fuels is not something that will happen anytime soon.

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