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## 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

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### Offshore Wind Presented As Future But Cost Is A Problem

**The history of wind power is tied very closely to federal tax policy, something not prominently mentioned**

At the recent National Ocean Industries Association (NOIA) meeting, the Offshore Renewables Committee hosted a presentation by Tom Kiernan, chief executive officer of the American Wind Energy Association (AWEA). With him was research analyst Celeste Wanner who presented a rundown of the status of offshore wind projects. As one would expect, Mr. Kiernan presented all the positives for wind energy – its cost has declined to where it is now competitive with coal and natural gas generated electricity, there are no emissions since there is no fuel burned to generate electricity, and the cost of wind power can be fixed for 20 years. These benefits are well known, but the history of wind power is tied very closely to federal tax policy, something not prominently mentioned.

**The AWEA also lists it top priority for keeping the industry humming as insuring stable and predictable tax credits**

Listed on the AWEA's web site is a discussion about why Americans of all political persuasions should be clamoring for more wind power, which highlighted the positive qualities cited above. The AWEA also lists it top priority for keeping the industry humming as insuring stable and predictable tax credits. It also says that a national standard for renewable electricity and transmission policies to improve the nation's power grid along with "prudent siting policies" are key to this electricity source's growth. The reality is, and the AWEA acknowledges, that federal tax policy has been the predominant driver of wind energy development over the last decade.

There are two forms of tax incentives for developers of wind farms – the Production Tax Credit (PTC) and the Investment Tax Credit (ITC). The primary tax incentive has been the PTC which provides a credit worth 2.3 cents for every kilowatt-hour (kWh) of electricity generated for the power grid for the first ten years of operation of a wind turbine. The ITC, which is similar to the tax incentive offered to

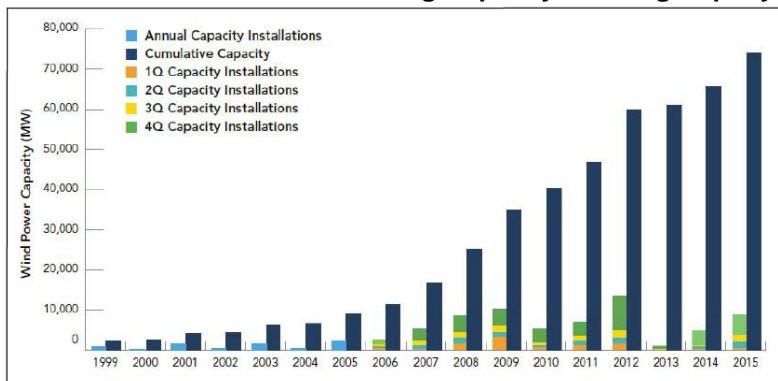
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**Whenever it appeared that the PTC might end, however, there was a falloff in new capacity additions such as seen in 2010 and again in 2013**

regular businesses for capital investment in their enterprises, is also offered to wind farm developers in the amount of 30%. Wind farm developers can only select one of these two tax policy alternatives.

The history of the PTC has been volatile with the credit usually being a temporary incentive that has been allowed to die during tax legislation battles in Washington, only to be resurrected later. Since most wind farms opt for the PTC, its impact on the investment decisions of wind project developers has produced periods of high investment followed by non-existent investment. That pattern can be observed in Exhibit 1, where both annual additions for wind generation capacity along with the cumulative trend for 1999-2015 is shown. An examination (sorry but the chart is tough to view) shows almost no wind generation capacity added in 2000, 2002 and 2004 as the annual PTC expired for those years. In more recent times, the PTC had a multiple-year life. Whenever it appeared that the PTC might end, however, there was a falloff in new capacity additions such as seen in 2010 and again in 2013.

**Exhibit 1. Wind Power Generating Capacity Growing Rapidly**



Source: AWEA

**In the 2014 extension, language was added to allow projects that commenced construction before the end of 2014 to still receive the tax credit**

It is the uncertainty about federal tax incentives that causes the AWEA to target a stable and predictable tax policy for wind projects. The PTC and ITC for renewable fuel power projects expired at the end of 2014. In the 2014 extension, language was added to allow projects that commenced construction before the end of 2014 to still receive the tax credit. That language led to extensive discussion over what represented “commenced construction” in order to be eligible for the credit. The energy legislation that was enacted at the end of 2015 included a five-year retroactive extension of the previous bill but steps down the value of the tax credits through December 31, 2019.

Now, wind projects that begin construction in 2017 will receive an ITC of 24% or a PTC of 1.84 cents per kWh. For projects that begin construction in 2018, the ITC will be 18% while the PTC will be 1.38 cents per kWh. The ITC will be cut to 12% for 2019 projects with a PTC of 0.92 cents per kWh. While the AWEA was happy to have an

**When Ms. Wanner presented the state of the offshore wind business, there was no mention of 20-year fixed costs**

extended tax credit life, it was hoping that the credits would not be reduced. The push to cut the tax credits in the latter years was an effort to force renewable power to become economically sustainable without tax subsidies. But as Mr. Kiernan was quoted saying at the time the 2015 legislation was passed, “The later years of this agreement will provide some challenges that the wind industry will work to overcome with our employees, partners and champions.”

While the discussion about onshore wind energy was interesting, we continued to be puzzled with Mr. Kiernan’s repeating the claim about 20-year fixed cost for wind power. The argument he was making was that since there was no fuel cost associated with wind, its cost wouldn’t increase. We are not sure that is true of the various power purchase agreements (PPA) signed between onshore wind project developers and utility buyers. When Ms. Wanner presented the state of the offshore wind business, there was no mention of 20-year fixed costs. There have been four offshore wind PPAs signed – two associated with the Deepwater Wind project off Block Island, Rhode Island and two associated with the Cape Wind project in Nantucket Bay off Cape Cod and Martha’s Vineyard, Massachusetts. The Cape Wind project remains on life-support as its cost has soared to an estimated \$2.5 billion, well above initial estimates, and residents continue to battle over the issuance of permits for the project. As a result, the two utility PPAs have been cancelled.

**The economics for Deepwater Wind have been based on the 50 cents per kWh that Block Island residents currently pay for power**

All four offshore wind PPAs were priced initially well above current power costs for residents in the respective states and they all carried 3.5% annual guaranteed price escalations, a point almost never acknowledged in the media accounts of these projects. In the case of Deepwater Wind, its PPAs call for an initial price of 24.4 cents per kWh that will reach 50 cents in 20 years. The economics for Deepwater Wind have been based on the 50 cents per kWh that Block Island residents currently pay for power. That cost is because all power on the island is generated by diesel-powered generators. Because the wind farm will produce more power than island residents will use, the surplus will be transmitted to shore over a \$107 million underwater power line. When the wind doesn’t blow, island residents will be able to get their power from shore over the same cable. Onshore retail power costs in Rhode Island are around 16.5 cents per kWh, however the actual fuel charge is only 8.8 cents per kWh due to low natural gas prices. Once Deepwater Wind is generating power this fall, the utility bills of onshore residents will rise as the high-cost wind power at three times the current fuel cost is averaged into the state’s fuel mix.

An analysis of the choice of PTC or ITC for offshore wind projects prepared by Constance McDaniel Wyman, a graduate student at the University of Texas at Austin, for online magazine *North American WindPower* last year shows why the ITC choice was critical.

**We would point out that the capacity utilization figures of 30% to 40% are seldom mentioned when the low cost of wind power is touted, which means other power sources need to be maintained that increase the overall cost for consumers**

The analysis involved two hypothetical wind farms – “Project 1 was a 500 MW project consisting of 5 MW turbines, and Project 2 was a 300 MW project containing 3 MW turbines. Each project featured monopile foundations. The hypothetical project sites were located six nautical miles offshore in 22.5 meters (75 feet) of water, and the projects’ expected lifetimes were 20 years.” The analysis was designed to generate a net present value (NPV) for the two projects utilizing five variables: capacity factors; average mean wind speed; electricity price; capital cost; and operating and maintenance expenses. The assumptions are listed in Exhibit 2. A third project was also analyzed with variable factors falling midway between the Mean and High Values. We would point out that the capacity utilization figures of 30% to 40% are seldom mentioned when the low cost of wind power is touted, which means other power sources need to be maintained that increase the overall cost for consumers.

**Exhibit 2. Wind Power Tax Consideration Inputs**

Table 1: Input Value Range and Mean

	Low Value	Mean	High Value
Capacity Factor (%)	30	35	40
Wind Speed (m/s)	7.5	9.5	11.5
Electricity Price (\$/kWh)	0.08	0.13	0.18
Project 1 CAPEX (Mill\$)	1,464.64	1,723.105	1,981.57
Project 1 OPEX (Mill\$)	452.54	532.4	612.26
Project 2 CAPEX (Mill\$)	761.26	895.6	1,029.94
Project 2 OPEX (Mill\$)	234.09	275.4	316.71
Project 3 CAPEX (Mill\$)	1,464.64	1,723.105	1,981.57
Project 3 OPEX (Mill\$)	452.54	532.4	612.26

Source: Constance McDaniel Wynnen

Source: *North American WindPower*

**The point of the study was to highlight exactly how important the ITC is for offshore wind project economics**

The researcher modeled each project 1,000 times in order to develop the results shown in Exhibit 2. The results show the percentage of the models that produced positive results. It also shows for cases involving no tax credit, the PTC and the ITC, the average NPV, the Minimum NPV and the Maximum NPV. As the researcher notes, no one would build a project with a projected negative NPV. With specific site selection and other variables factored in, real project economics would also change. The point of the study was to highlight exactly how important the ITC is for offshore wind project economics, while the PTC is more meaningful for onshore wind projects.

**All the other projects or possible projects are living on government grants**

The bulk of Ms. Wanner’s NOIA presentation was designed to show how many and diverse are the offshore wind projects under way. Other than Deepwater Wind and the likely dead Cape Wind projects, all the other projects or possible projects are living on government grants and/or remain little more than speculative research projects. Mr. Kiernan acknowledged that the problem for offshore wind is its cost, likely three to five times that of onshore wind projects. The

**Exhibit 3. ITC Becomes A Key Profit Driver For Offshore Wind**

Table 2: Percentage of Positive Outcomes and NPV Data (in millions of dollars)

	% Positive	Average NPV	Min. NPV Value	Max. NPV Value
<b>Project 1</b>				
No Tax Credit	26.9	-396.53	-2,013.31	1,196.00
PTC	43.8	-111.97	-1,893.59	1,635.27
ITC	57.3	117.66	-1,464.72	1,642.78
<b>Project 2</b>				
No Tax Credit	31.7	-161.83	-1,071.50	722.54
PTC	41.3	-81.83	-1,059.34	866.04
ITC	54.2	35.01	-836.73	860.75
<b>Project 3</b>				
No Tax Credit	44.1	-80.122	-1,285.6	1,121.58
PTC	62.9	206.95	-1,160.27	1,582.75
ITC	79.2	433.85	-703.33	1,560.47

The results in Table 2 include results with negative mean NPV, which are included to illustrate the difference between results with no credit, a PTC and an ITC only. The author realizes that developers will not build projects with negative NPV. However, the purpose of publishing these results is to report the effect of no tax credit, a PTC and ITC on project NPV.

Planned real-world projects would have higher percentages of positive NPV results because of site selection and project-specific planning decisions that would eliminate poorer choices.

Source: Constance McDaniel Wyman

Source: *North American WindPower*

**You will gain a greater appreciation of the real winners of expensive renewable energy projects**

cost issue is further challenged by the fact that most of the U.S. coastline borders on water too deep to install fixed foundations necessitating floating wind turbines that will prove not only very expensive but potentially less efficient, too. For anyone interested in more about the history of how Deepwater Wind came into existence, the strong-armed legal battles in Rhode Island, and the financial windfall for its developer, D. E. Shaw, we suggest reading an article about the wind farm in the May 10, 2016, issue of *Forbes* magazine. You will gain a greater appreciation of the real winners of expensive renewable energy projects.

**The Future Of Saudi Arabia Without Oil – A Possibility?**

**Half way around the world in Saudi Arabia, a 30-something, confident and aggressive son of the current King has been handed the keys to the Kingdom and told to reform key parts of the military, the government and the economy**

Much like the political prognosticators viewing the current struggle to select the Democratic and Republican presidential nominees, we are struggling to understand the changes underway in the Kingdom of Saudi Arabia. Think about how different the political world has been over the past 18 months. In the United States, a 74-year old, self-avowed independent Socialist senator from Vermont has given the presumptive left-of-center iconic Democratic nominee a run for her money and as a result has forced her to move much further to the left than she ever wanted to in order to defeat her opponent. On the other side of the isle, a large stable of experienced, main-stream political leaders has been upstaged by a billionaire, self-funded businessman campaigning with bluster and abuse. Half way around the world in Saudi Arabia, a 30-something, confident and aggressive son of the current King has been handed the keys to the Kingdom and told to reform key parts of the military, the government and the economy. He has now unveiled a vision for a new Saudi Arabia that has been blessed by the royal leadership. The plan is as radical as one climbing off a camel and then sliding behind the wheel of a new Mercedes-Benz. In January 2015, none of these scenarios were on

**Those changes and their success or failure will be meaningful for the future of the energy business**

anyone's radar screen! And in each case, the ultimate success is questionable.

Skipping the U.S. presidential election drama may be easy, but its outcome will likely further reshape relations between the United States and Saudi Arabia – a relationship that has deteriorated under the presidency of Barack Obama. Speculating on how that relationship may change is fruitless at the present time. Rather, we believe it is better to spend our time trying to understand what may be driving the changes in Saudi Arabia. Those changes and their success or failure will be meaningful for the future of the energy business. The Kingdom is not only the world's largest oil producer, it is among the top three oil exporters in the world, and is largely directing OPEC's oil policy today. That last point was demonstrated by how the tentative oil output freeze agreed to among OPEC members, Russia and Mexico was undone by one phone call from Riyadh. Without the participation and agreement of Saudi Arabia's number one nemesis in the Middle East, Iran, there could be no output freeze.

**Despite the oil glut continuing, the fundamental laws of physics are working in the oil fields and slowly shrinking output**

Amazingly, after a brief drop in oil prices following the announcement of the failed agreement at Doha, global oil prices have rallied steadily higher and are now at levels thought only possible in late 2016. The quick oil price recovery was helped by a wildcat strike by Kuwaiti oil workers who temporarily removed nearly two million barrels a day of supply from the world market. The immediate impact of the strike was to shift investor focus from near-term to long-term factors. Despite the oil glut continuing, the fundamental laws of physics are working in the oil fields and slowly shrinking output. The production decline is speculated upon daily but reported weekly by the U.S. Energy Information Administration (EIA). Since the peak in 2015, domestic production is down nearly 500,000 barrels per day. Given the low level of domestic drilling and the sharp cuts in petroleum industry capital spending, it is impossible to comprehend domestic oil production not continuing to fall despite a jump from new production coming on stream from the Gulf of Mexico.

**Oil companies who are partners with those governments and/or the service companies working there are being forced to cut back their activities due to a lack of payment**

Around the world, the cash shortfalls among OPEC member governments will result in eventual reductions in their nation's output, in particular in countries such as Venezuela and Nigeria. Oil companies who are partners with those governments and/or the service companies working there are being forced to cut back their activities due to a lack of payment. The decline curve is at work and, coupled with increased oil use, will restore balance between global supply and demand leading to improved oil prices. In fact, the current sharp rise in oil futures signals conviction about the power of the underlying industry fundamentals.

So was it wise for Crown Prince Mohammad bin Salman (MBS), the son of King Salman and the overseer of the state oil company, the

### **His youth and rise to power has upset many within the royal family**

head of the national investment fund, the person in charge of economic policy and the Ministry of Defense, to have made that phone call? Time will tell. But the call would seem to be consistent with the more independent policies of the Kingdom with a new, third-generation leadership beginning to assume power.

We have learned as Prince Mohammad grants interviews to leading journalists that his rise to become the most powerful prince since his grandfather founded Saudi Arabia, was difficult but ultimately was directed by his uncle, the late King Abdullah. A recent article in *Bloomberg Business Week* based on several interviews with Prince Mohammad recounted the challenges he faced in finding his role in the royal family's business. His youth and rise to power has upset many within the royal family. They are partially upset because of how differently he operates and manages compared to his many uncles. The article described how MBS struggled while serving in the government initially after graduating from law school. His performance even resulted in his promotion being denied by King Abdullah to prevent any appearance of nepotism. That denial prompted MBS to leave the government and go to work for his father and reorganize his father's foundation. MBS even started his own nonprofit to foster innovation and leadership among the Saudi youth. During that period he oversaw his father's court and improved its functioning.

### **King Abdullah assigned Prince Mohammad the task of cleaning up the Ministry of Defense over MBS's objections**

In recognition of his successful management performance, King Abdullah assigned Prince Mohammad the task of cleaning up the Ministry of Defense over MBS's objections. His success there was probably partially responsible for why he was able to begin planning a major restructuring of Saudi Arabia's government and economy with the help and support of King Abdullah. Following King Abdullah's death in January 2015 and the elevation of King Salman, MBS saw his profile increase leading ultimately to his appointment as Deputy Crown Prince.

### **Prince Mohammad also has already begun altering the historic compact between the royal family and its subjects**

The plan for a radically changed country, begun two years ago, was finally unveiled on April 25<sup>th</sup>. Vision for the Kingdom of Saudi Arabia envisions creating the world's largest sovereign wealth fund planned to reach \$2 trillion in assets and turning the state oil company, Aramco, into a publicly traded company by offering 5% of its shares to investors and listing them on the Saudi stock exchange along with another international stock exchange. Based on estimates of the possible worth of Aramco, the IPO would deliver \$100 billion to the government. Prince Mohammad also has already begun altering the historic compact between the royal family and its subjects. In exchange for absolute rule, the royal family has provided generous spending on its 21 million subjects. Now, the government has raised the cost of living by reducing the subsidies for gasoline, electricity and water. Gasoline prices were boosted by 50% from 60 cents per gallon to 90 cents. The government says it plans to impose a value-added tax and other levies on luxury goods and sugary drinks and to

**People are questioning how a modern country can operate with such a social policy**

cut back spending for students to attend colleges abroad, but not all of these taxes have been put in place. To cushion the financial blows, the government will pay out direct cash subsidies to low income citizens.

Probably the greatest changes for the Kingdom have yet to be unveiled, although Prince Mohammad has signaled his intent to confront the conservative religious establishment over things such as granting greater freedoms for women in the country. While a growing proportion of the female population is becoming educated, women are banned from driving cars. They are forced to resort to hiring cars and drivers or turning to Uber for transportation. People are questioning how a modern country can operate with such a social policy. At the same time, the Kingdom's religious police are having their powers somewhat restrained. Social changes will be important if the plan to attract businesses to Saudi Arabia is to be successful. According to this plan, investments will become the primary source of the government's income and not its oil, although that asset will provide the money to fund the country's transformation. As Prince Mohammad was quoted in the article, "So within 20 years, we will be an economy or state that doesn't depend mainly on oil." Note he acknowledged oil will still be important.

**The need to transform the country is driven by a recognition that the end to the Age of Petroleum is on the horizon**

There are many naysayers both within and outside Saudi Arabia who predict this economic and social transformation will fail. One columnist predicted that the plan will leave Saudi Arabia as just another failed Middle East country. What has become clear from Prince Mohammad's few interviews and his actions is that the need to transform the country is driven by a recognition that the end to the Age of Petroleum is on the horizon. The question is just how far out that day may be.

**The common theme among energy transitions has been a steady increase in the energy content per pound of material**

Earlier this year we appeared on a panel discussing what comes after oil and gas. Preparing for the talk forced us to conduct extensive research into past energy transitions – wood to coal, coal to oil, and now oil to natural gas. But those transitions were within the fossil fuel family, and the big question now is why not renewables? The common theme among energy transitions has been a steady increase in the energy content per pound of material. Unfortunately, although carbonless, renewables fail to advance that theme. Nuclear fits the theme as likely will fusion, also. The technologies and economics of these fuels are not as well refined for them to begin pushing the next energy transition.

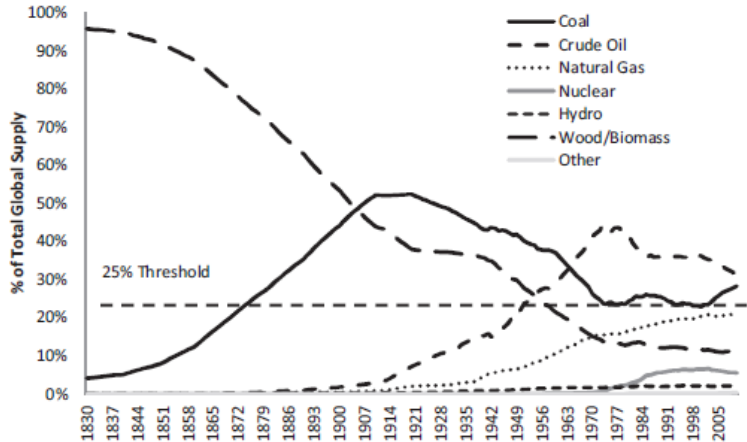
**Once petroleum's growth curve is bent, the question becomes how quickly before it turns down?**

From Saudi Arabia's viewpoint, the growing strength of the environmental movement and its legislative power will erode petroleum's growth. Once petroleum's growth curve is bent, the question becomes how quickly before it turns down? A new academic paper investigating the question of the dynamics of the time necessary for energy transitions offers some interesting insight. The article is a review of the academic literature and is structured to



promote future analysis of what it will take and how long to bring about the next energy transition.

**Exhibit 4. The History Of Long Energy Transitions**



Source: Smil

**Most people are familiar with how long it took to transition from wood to coal and coal to petroleum**

Most people are familiar with how long it took to transition from wood to coal and coal to petroleum as documented by scientist Vaclav Smil. While considering these long-term transitions, the paper's author examines other less massive, but equally as significant transitions that have occurred in much shorter time frames, often in as little as two decades.

**Exhibit 5. Energy Infrastructure Transition Times**

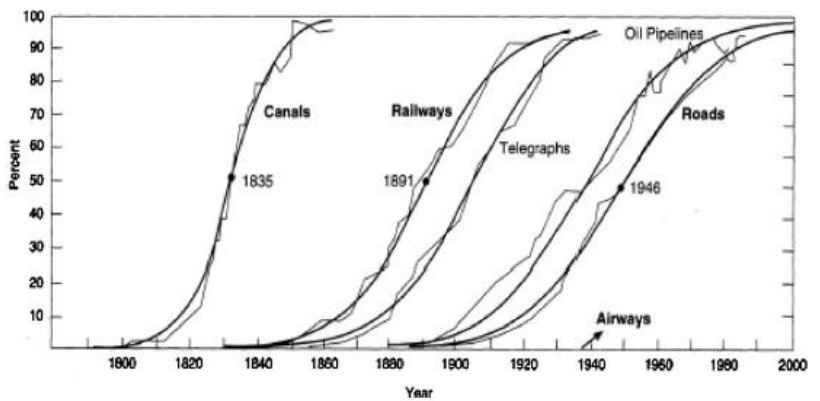


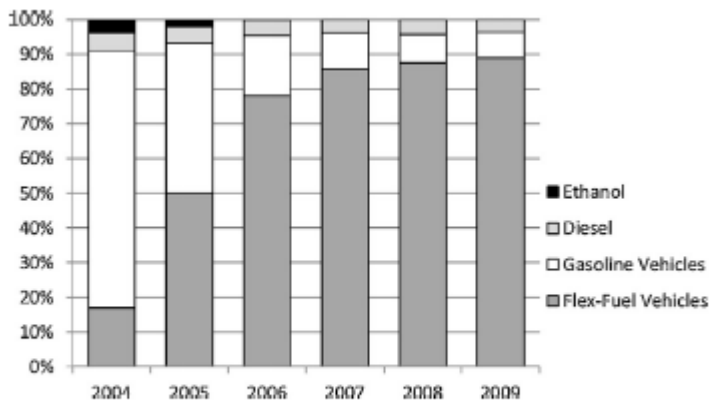
Fig. 1. Growth of Infrastructures in the United States as a Percentage of their Maximum Network Size.

Source: Sovacool

Another example cited in the paper was the government of Brazil's policy promoting the use of biofuel made from indigenous sugar cane in an attempt to reduce the cost of importing gasoline and to minimize the long-term environmental impacts of burning fossil fuels. By taxing gasoline, but reducing vehicle taxes, Brazil was able to

dramatically shift the mix of new flex-fuel vehicles in the country's car-buying to where it was the primary engine purchase.

**Exhibit 6. Growth Of Flex-Fuel Vehicles In Brazil**



**Fig. 4. Flex-Fuel Vehicle Sales as a Percentage of Overall New Car Sales in Brazil, 2004-2009.**

Source: Sovacool

**Coal consumption globally continues to grow because it remains one of the cheapest sources of energy for generating power in less developed economies**

The point of focusing on some of these other smaller transitions within the energy infrastructure is to demonstrate that it often takes numerous transitions to make up a larger energy shift. In the same vein, it was pointed out that even with massive energy transitions earlier energy sources are not completely eliminated. While the author pointed out that muscle power, animal power, wood power and steam power still remain in use, their dominance has been supplanted by newer power sources. One should also note that while coal as a source of power is being phased out in the United States due to legislation against its use, coal consumption globally continues to grow because it remains one of the cheapest sources of energy for generating power in less developed economies.

**Lack of success will leave Saudi Arabia a failed state and create a geopolitical void in the Middle East**

For Saudi Arabia, they know that the transition from the Age of Petroleum to another power source will take time. Just how much is unknown. That uncertainty, after considering how quickly other transitions have occurred, exerts a certain amount of pressure on Prince Mohammad. He understands how difficult implementing the Vision plan will be. Moreover, he understands how challenging the hurdles are for the Vision plan to be successful, but how critical it is be for the long-term future of his generation and that of his children and grandchildren. Lack of success will leave Saudi Arabia a failed state and create a geopolitical void in the Middle East. The rest of the world should be hoping for Prince Mohammad's success, but that success also means there will be an anchor tied to the upward trajectory for global oil prices.

## Does Hope For The Natural Gas Market Depend On Weather?

**Not that many years ago, energy analysts confidently assumed the nation, and the world, was headed into a golden age for natural gas as the fuel was targeted to become the bridge taking the world from dirty fossil fuels to a cleaner energy environment**

The domestic natural gas market remains one of the great frustrations for the energy business. Not that many years ago, energy analysts confidently assumed the nation, and the world, was headed into a golden age for natural gas as the fuel was targeted to become the bridge taking the world from dirty fossil fuels to a cleaner energy environment. Somewhere along that road, natural gas was shunted aside as the push for an even cleaner world decided that carbonless renewable fuels, despite their cost, was preferable. There are multiple explanations for how this shift occurred, but key reasons include the fact that global political leaders became more receptive to arguments supporting climate change as an immediate environmental problem that necessitated the suppression of fossil fuel use as the solution. Natural gas was also hurt by its then high and volatile pricing that made consumers leery of the impact on their utility bills. Add to those concerns was the fear of poisoning drinking water from the application of hydraulic fracturing technology to gas shale formations that were being tapped for new gas supply. These shale formations that underlay most oil and gas producing basins emerged as a new, bountiful source of natural gas, which had previously been considered unable to be tapped for their trapped hydrocarbons. Lastly, the environmental movement started targeting the development of new infrastructure required to support increased use of natural gas, especially in the populous Northeast and Mid-Atlantic regions of the country. Last winter, the El Niño weather event brought extremely warm temperatures to North America that reduced heating demand for natural gas.

**Exhibit 7. Weekly Natural Gas Output Has Peaked**  
**Total dry gas production in the Lower 48 states**



eia Source: Bentek Energy  
 Source: EIA

**Early on in the gas shale boom, weak wellhead economics were ignored because of the universal belief in the new age of natural gas that would eventually bring untold wealth to gas producers**

The surge in natural gas production that overwhelmed gas prices during the past five years has lifted output to record levels in this country. But with natural gas prices falling to extremely low levels, the attraction of drilling and developing more supply has moderated. The gas shale exploration boom was initially driven by high gas prices, a belief in unlimited gas resources, and the expectation that demand growth would cause low gas prices to soar. Since, the boom unraveled because new gas volumes were uneconomic. Early on in the gas shale boom, weak wellhead economics were ignored because of the universal belief in the new age of natural gas that would eventually bring untold wealth to gas producers. Weak gas prices failed to slow output growth despite producers drilling fewer wells because they were targeting more productive shale formations. The use of new technology enabled producers to boost well output and ultimate well recovery enticing them to believe they could achieve profitability despite low current prices.

**Exhibit 8. Natural Gas Prices Continue To Slump**  
**Natural gas spot prices (Henry Hub)**



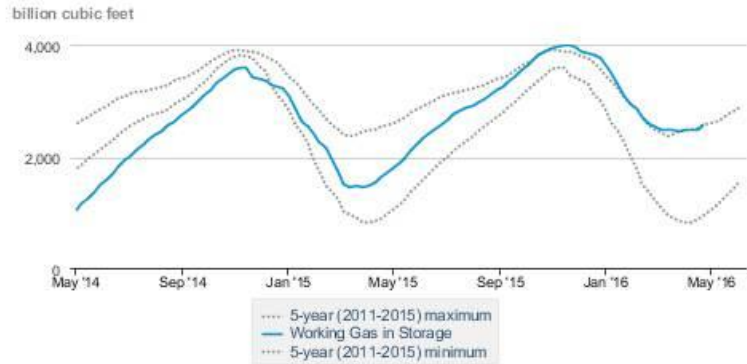
eia Source: Natural Gas Intelligence  
 Source: EIA

**The collapse of drilling over the past 18 months in response to the downturn in global oil prices has begun to reign in the growth in natural gas supply**

The output of natural gas was also helped by the growth in tight oil drilling, which became the new shale target following the natural gas price collapse. Many of these tight oil wells produced large volumes of natural gas liquids and associated natural gas, further adding to the gas glut. The collapse of drilling over the past 18 months in response to the downturn in global oil prices has begun to reign in the growth in natural gas supply. Reservoir decline rates, absent any recovery in drilling in the near term, should ensure that gas output will fall in the future. Higher gas prices will come once inventories of natural gas begin to show rapid declines. People are now concerned about how quickly production will fall and demand will rise in order to draw down the substantial volumes of natural gas in storage.

**Exhibit 9. Gas Storage At 5-Year Highs**

Working natural gas in underground storage

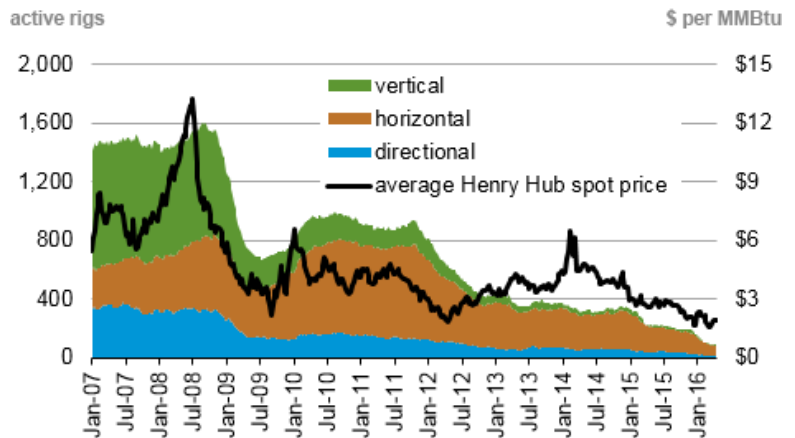


Source: Form EIA-912, "Weekly Underground Natural Gas Storage Report"  
 Source: EIA

**For the week ending April 29, there were only 87 drilling rigs targeting natural gas in this country compared to a peak of 1,606 during the last week of August 2008**

The latest weekly natural gas storage survey showed that volumes are at the 5-year average maximum, where they have been since last summer. This high storage level is depressing gas prices and impacting producers' desire to drill for more supply. The total Baker Hughes (BHI-NYSE) rig count is at all-time lows. For the week ending April 29, there were only 87 drilling rigs targeting natural gas in this country compared to a peak of 1,606 during the last week of August 2008. At that time, natural gas drilling accounted for 79% of all the rigs working. Today, gas drilling is barely 20%.

**Exhibit 10. Gas Drilling Has Fallen In Step With Gas Prices**  
 Weekly natural gas rig count and average spot Henry Hub



Source: Baker Hughes  
 Source: EIA

While natural gas production is starting to fall and will likely continue declining in the absence of more drilling, the question facing the

**The brightest area for natural gas demand is electricity generation, which is benefiting from the push to shut down coal-fired power plants**

**This uncertainty was evident in the recent hurricane forecast prepared by the scientists at Colorado State University**

market this summer is demand. A demand increase will limit increases of gas injections into storage that will depress a recovery in gas prices. The weak economic recovery continues to hamper demand growth from the industrial sector. Commercial demand remains fairly stable and reflects overall economic activity. Residential gas demand is tied more to home heating needs, which are absent during the summer. The brightest area for natural gas demand is electricity generation, which is benefiting from the push to shut down coal-fired power plants. It would really benefit if the U.S. experiences a hot summer that increases air conditioning loads and drives electricity demand up. So once again, the natural gas market's fortunes are likely to swing on the basis of the weather this summer and expectations for the upcoming winter.

The El Niño weather feature that contributed to the very warm winter appears to be evaporating. Whether it shifts into a La Niña event is unknown, which has weathermen in a quandary about their upcoming forecasts. This uncertainty was evident in the recent hurricane forecast prepared by the scientists at Colorado State University. In their forecast, they examine analog years – past seasons with similar shifting weather features. Because the scientists are not sure what will become the next weather driver, they selected a group of years that had shrinking El Niño events and then either La Niña or neutral weather conditions.

The uncertainty about El Niño was discussed in earlier issues of the *Browning World Climate Bulletin*. In the April edition, they presented their outlook for United States weather for parts of the spring and early summer. They commented on how weather conditions had

**Exhibit 11. Late Spring May Help Boost Gas Consumption**



Source: *Browning*

***Browning* sees the U.S. being mostly warm during late spring with the Midwest and Northeast potentially being hot**

contributed to the early arrival of spring temperatures. Because they see a struggle underway between a cooling Pacific Ocean and a hot Atlantic Ocean, North America becomes the “punching bag between them.” As a result, *Browning* sees the U.S. being mostly warm during late spring with the Midwest and Northeast potentially being hot. They define warm as 2-4° C or more higher than normal temperatures. Hot is 5° C or more higher than normal temperatures.

#### Exhibit 12. Early Summer Will Barely Help Gas Demand



Source: *Browning*

**If the *Browning* forecast proves accurate, there is hope that gas demand will be greater than normal**

If the *Browning* forecast proves accurate, there is hope that gas demand will be greater than normal and coupled with declining production could lead to a shrinking of gas storage volumes and a lifting of gas prices. The latter conclusion is based on the assumption that producers will need higher natural gas prices in order to justify any increase in drilling.

**Temperatures were average to slightly below average across the nation**

To further examine the range of possible weather outcomes this summer, we examined the analog years that the Colorado State University hurricane forecast selected. The six analog years were: 1941, 1973, 1983, 1992, 1998 and 2003. Unfortunately, there is limited weekly or monthly natural gas production, consumption and storage data. One wonders how we survived without the data.

In looking at articles about the weather for some of the most recent analog years, the summers were a mixed bag. The summer of 2003 was an active hurricane season with 16 named storms and seven became hurricanes with three major ones. Temperatures were average to slightly below average across the nation. In contrast,

1998 was tied with 1934 for being the warmest years in U.S.

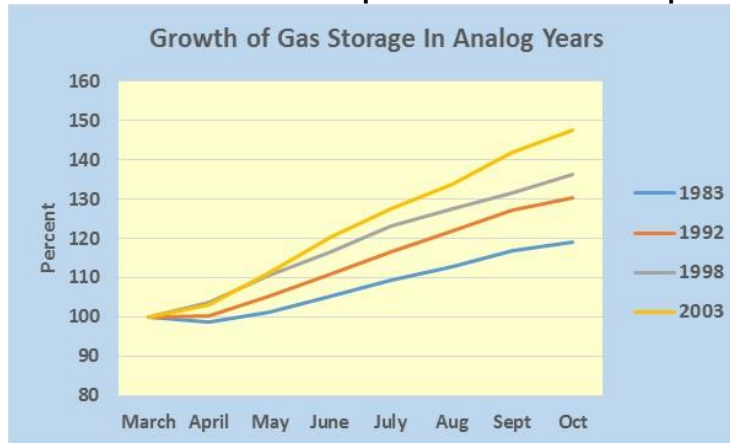
**The summer of 1992 was very cool, partially caused by the eruption of volcano Mount Tambora in Indonesia the previous summer that put substantial volumes of ash into the atmosphere**

**Based on this data, natural gas price bulls should be hoping for a summer with above normal temperatures, which would more closely follow the 1983 seasonal growth pattern**

temperature records. It was also a very active tropical storm season with 14 storms including three that developed into hurricanes and caused extensive damage in the Caribbean. The summer of 1992 was very cool, partially caused by the eruption of volcano Mount Tambora in Indonesia the previous summer that put substantial volumes of ash into the atmosphere. Areas around the Great Lakes and northern New England had temperatures in the 30s in late July. Around Boston in 1983, the summer was generally slightly warmer than normal with a number of days seeing temperatures reach 98° F, which for the Northeast is considered hot.

Because of the lack of good natural gas data, we attempted to gain a picture of what happened to demand by measuring the change in monthly storage volumes over the summer injection season. When we look at the four summers' growth in gas storage indexed to their March volumes, there is no clear pattern. The lowest summer injection growth (+19%) was experienced in 1983 when we know temperatures were above normal, at least in the Northeast. On the other hand, the second largest seasonal gain (+36%) was experienced in 1998, which was one of the warmest years on record in the U.S. It is very hard to discern any pattern for the 1992 (+30%) and 2003 (+47%) summers as temperatures for the latter year were slightly below average and the former was an abnormally cool summer. Based on this data, natural gas price bulls should be hoping for a summer with above normal temperatures, which would more closely follow the 1983 seasonal growth pattern. The *Browning* forecast suggest that might actually happen.

**Exhibit 13. No Clear Gas Impact From Summer Temperatures**



Source: EIA, PPHB

The combination of a lack of natural gas drilling, accelerating gas shale reservoir decline rates, less associated natural gas output and growing gas demand possibly helped by a warmer summer should eventually return the gas market to a more normal storage balance. That will be the key to higher natural gas prices. The closing of

more coal-fired power plants will boost natural gas-powered



electricity generation. That will be the key to eventually relieving the natural gas market from being totally weather-driven as it will be this summer. Pray for a hot summer!

## Will Driverless Trucks Impact More Than Autonomous Cars?

**The promise of autonomous vehicles has evolved into at least two possible future models**

Most of us have been fascinated with the efforts of the automobile and technology companies vying for leadership in the race to be first with a fully-autonomous vehicle. The claims of success of these self-driving cars in navigating city streets have brought forth images of a future in which all individuals in vehicles are merely passengers able to be totally disconnected from the task of driving, yet safe. The promise of autonomous vehicles has evolved into at least two possible future models. One in which individuals become more productive, or possibly better rested, while in transit. We also see the potential for children, the handicapped, the elderly and others not able to drive to suddenly be commuting alone. In this model, people would continue owning their vehicles and even possibly offering them for rent as a way to supplement their income.

**They would view the car as a “mobility service”**

The other model envisions a world where a shared fleet of autonomous vehicles would exist for citizens to be able to summon at their pleasure. These autonomous vehicles would take the passenger from point A to point B and then proceed to pick up another passenger for his trip. Since the people involved in this model would not own their vehicle, they would view the car as a “mobility service.”

**If cities allow delivery trucks to double-park while making a delivery, how will an autonomous vehicle know that the truck in front of it is parked and not merely waiting for a traffic light to change?**

While the companies actively involved in autonomous vehicles are anxious to get governments to establish the protocols for testing them, the challenges for getting them on the road beyond limited applications are significant. The technology for a car to stay in a lane is quite different from it knowing which lane on a five-lane highway it is in and how close a desired exit is. If cities allow delivery trucks to double-park while making a delivery, how will an autonomous vehicle know that the truck in front of it is parked and not merely waiting for a traffic light to change? In cities where jaywalking is a right and not a crime, how will self-driving cars progress? How will these vehicles deal with construction zones, temporary reductions in speed limits, road diversions, let alone taking directions from police officers directing traffic? The idea that when confronted with these unknown situations an autonomous car is going to pull over and signal to the driver to take over defeats the promise of self-driving vehicles taking people who can't drive? It would mean there would always have to be licensed driver in the vehicle. The list goes on and on, suggesting this revolution will become an evolution and that is where Europe may be making progress faster than the United States.

In Europe, the autonomous vehicle effort is taking a slightly different

**The economic impact of this development may be greater and arrive sooner than those for autonomous cars**

tact – driverless trucks. Swedish automobile and heavy-duty truck manufacturer AB Volvo (VOLVY-OTC) recently organized a convoy of self-driving trucks to drive across the continent of Europe with a final destination of the Port of Rotterdam. The economic impact of this development may be greater and arrive sooner than those for autonomous cars, largely because it will be easier to improve the benefits for the transportation of goods. For Americans, however, some of these benefits have already been achieved, but not in the sense of creating a uniform heavy-duty truck mandate.

**The lead truck dictates the speed and direction, while the rest of them steer, accelerate and brake in a closely spaced convoy**

The Volvo experiment involved about 30 truck drivers testing a new, automated driving technology called platooning. This involves linking the trucks via Wi-Fi, GPS, sensors and cameras so they can travel semi-autonomously behind one another. The lead truck dictates the speed and direction, while the rest of them steer, accelerate and brake in a closely spaced convoy. For Americans, the concept of a convoy conjures up the lyrics of the 1975 novelty song “Convoy” by C. W. McCall, a pseudonym for Bill Fries, honoring the citizens’ band (CB) radio fad that drivers, particularly truck drivers, used to communicate between vehicles while on the road. The truckers – initially three with “Rubber Ducky” at the front door (in the lead) driving a “Kenworth pulling logs” – were driving across the United States from west to east in a manner to protest the then-recently enacted 55 miles per hour speed limit instituted in response to the 1973 oil embargo and against the multitude of rules and regulations governing truck drivers. After forming near “Flagtown” (Flagstaff, Arizona), the convoy grew to include 85 trucks and several non-truck units as it approached “Tulsatown” (Tulsa, Oklahoma) where the “bears” (state highway patrol) set up a road block to slow them down.

**By following each other closely, the trucks behind the leader are able to draft in the wake of the air being shunted aside by the lead truck that is doing all the work**

In the U.S. convoys of heavy-duty trucks driving the interstate highways are not unusual as their drivers have learned it is a way to improve fuel economy. By following each other closely, the trucks behind the leader are able to draft in the wake of the air being shunted aside by the lead truck that is doing all the work. In Europe, the rules of the road for truckers are quite different depending on which country is being discussed. When humans are at the wheel, in certain European countries trucks must maintain a separation of about 150 feet from the vehicle in front to allow sufficient distance for stopping safely. With automation that distance shrinks to about 50 feet, which is still more than many U.S. truck convoys maintain.

**Driverless trucks, however, will do less passing, will brake quicker**

Drivers will still be needed in European truck automation, as by law they need to keep their hands on the steering wheel. Driverless trucks, however, will do less passing, will brake quicker, and should generate about 10% fuel savings for the second and other following trucks, while the lead truck will gain a smaller fuel-savings, according to Daimler AG (DDAIF-OTC).

Truck manufacturers expect platooning in Europe to take off by

**Adding automated steering and braking should not be too difficult**

2020, as most trucks on the road built in the past ten years already have sensors to alert drivers when they wander out of their traffic lane or get too close to the vehicle in front of them. Adding automated steering and braking should not be too difficult. Lori Tavasszy, a logistics professor at Delft University of Technology in the Netherlands estimates that about half the European fleet of heavy-duty trucks should be platoon-ready by 2025.

**They are also working on adopting standard rules about dissolving platoons at highway junctions**

The regulators for the European Union are already working to adjust country traffic rules to permit platooning. One example is standardizing the distance needed between trucks from the 164 feet in Germany and “a safe distance” in the Netherlands. They are also working on adopting standard rules about dissolving platoons at highway junctions. Several weeks ago, government transportation ministers, the European Commission and trucking industry representatives agreed to cooperate on connected and automated driving, focusing on traffic rules and making testing of the technology easier.

**You would be doubling the output of the trucking business at 25% of its current cost**

Analysts looking at the impact of platooning technology in the United States see it as a possible technology in the western states. These analysts are also assuming that the trucks will be truly driverless. They point out that of the estimated \$4,500 cost to move goods by truck between Los Angeles and New York City, nearly 75% is represented by the cost of labor. Not only would you reduce the cost by 75%, but without a driver a truck would not be subject to the mandatory rest periods for human drivers, enabling a doubling of the time a truck could be on the road. In effect, you would be doubling the output of the trucking business at 25% of its current cost.

**“For the first time, we put platoons on the road, in real traffic, across borders, and long distance”**

In the early April platoon-technology test, six convoys of two or three trucks each traveled to Rotterdam from Sweden, Germany and Belgium. Each of the convoys completed the trip as a unit, although the sponsors recognize that the mix of trucks could change once the technology is adopted as certain trucks would exit convoys in order to deliver goods to other locations and other trucks would join. As Odile Arbeit de Chalendar, an official of the Conference of European Directors of Roads, who helped set up the April test put it, “For the first time, we put platoons on the road, in real traffic, across borders, and long distance.” We wouldn’t be surprised to see platooning trucks in operation in Europe before we see driverless cars.

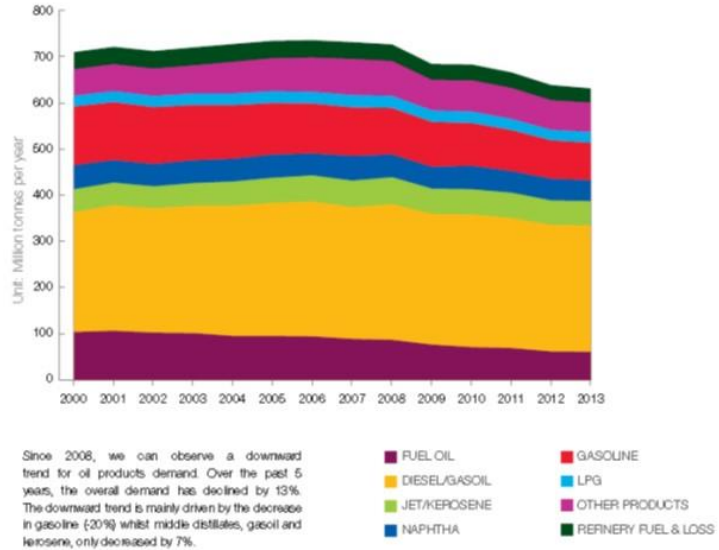
**The use of diesel increased in the early years of this century but has since declined**

What might platooning mean for the energy market? The trucks that are likely to be involved will be diesel-powered, so we looked at the significance of diesel fuel use in Europe. Diesel, which is also referred to as gasoil and is used for heating as well as vehicle fuel, is quite an important component of petroleum use in Europe. The use of diesel increased in the early years of this century but has since declined following the 2008 financial crisis and the weak economic recovery.

**Exhibit 14. Diesel/Gasoil An Important Fuel In Europe**

**FIG.7 DEMAND HISTORY OF OIL PRODUCTS IN THE EU**

Source: Wood Mackenzie



Source: EU

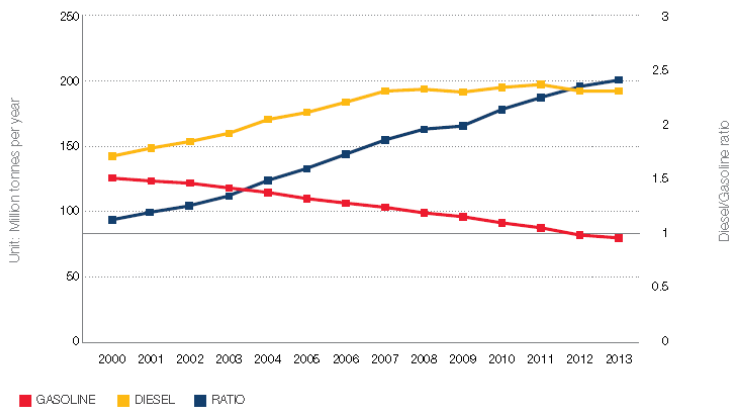
**Diesel demand climbed, then leveled off and has recently declined**

The impact of that economic weakness can be seen in the trend for road fuel usage in the European Union. Diesel demand climbed, then leveled off and has recently declined. At the same time, gasoline consumption has steadily declined, which may reflect the bias consumers have for diesel-powered cars since diesel is usually taxed less than gasoline.

**Exhibit 15. Diesel Use Up, Gasoline Use Down**

**FIG.9 ROAD FUEL DEMAND IN THE EU IN 2013**

Source: Wood Mackenzie



Source: EU

Due to the difference in tax incentives, diesel demand use has

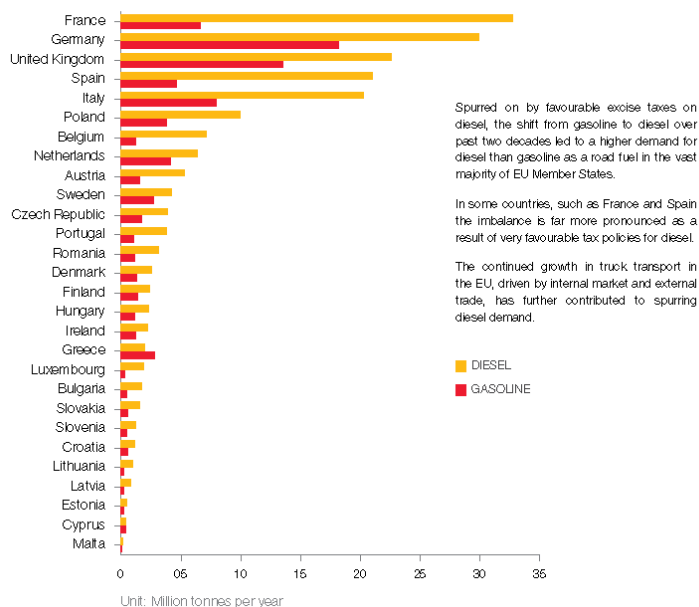
grown to be more significant in certain European countries as shown in Exhibit 16. The impact of the tax incentives for diesel fuel show up clearly when its consumption is matched against that for gasoline in particular countries.

**Exhibit 16. Diesel Is Use More In Certain Countries**

**FIG.10 ROAD FUEL DEMAND BY COUNTRY**

IN 2013

Source: Wood Mackenzie



Source: EU

**Europe has been such a strong market for diesel as compared to the United States**

The last major consideration of the long-term impact of a decline in European diesel demand will be on the global market for the fuel. Because Europe has been such a strong market for diesel as compared to the United States where gasoline is the primary motor fuel, there is active trade of gasoline from Europe for diesel from the U.S. That trade balance could shift and have an impact on the output slate for U.S. and European refineries along with hurting foreign trade balances.

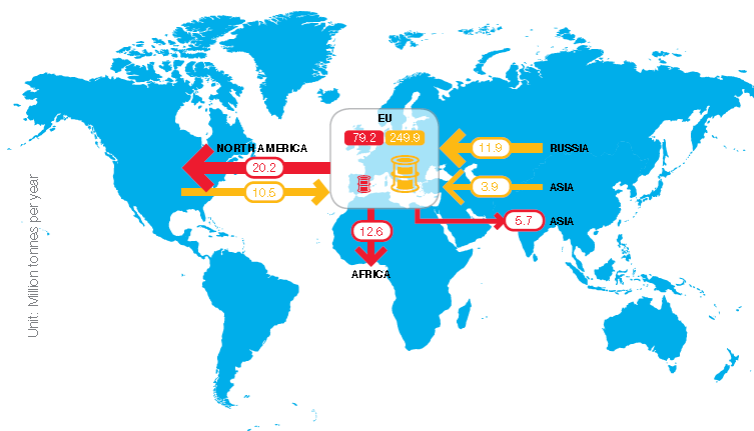
**Platooning is sort of a half-way step to fully-autonomous vehicle technology**

We would not be surprised to see platooning technology emerge as a reality much sooner in Europe than for autonomous vehicles in the United States. Platooning technology could also be adopted for cars desiring to travel between certain cities in Europe or even within certain regions of a country. Platooning is sort of a half-way step to fully-autonomous vehicle technology. It is a technology that can be adopted while necessitating fewer structural changes to the continent's transportation infrastructure. As the technology is adopted, there will be a fuel demand shift. The magnitude of the

**Exhibit 17. Gasoline For Diesel Trade Could Suffer**

**FIG.12 MAJOR GASOLINE AND DIESEL TRADE FLOWS TO AND FROM THE EU IN 2012**

Source: Eurostat



As a result of the gasoline/diesel imbalance demand Europe has significant excess gasoline production capacity that need to be exported, while to meet regional demand for diesel and jet fuel, Europe became heavily reliant on other countries for import, especially from Russia, Middle East & USA.

North America was the traditional market for exporting gasoline surplus but the recent shale oil revolution, cheap energy and reducing demand have enabled US refiners to increase their supplies for the internal market and to compete on other export markets with EU refiners.

- GASOLINE DEMAND IN 2012
- DIESEL/GASOIL DEMAND IN 2012
- ← GASOLINE TRADE FLOWS IN 2012
- ← DIESEL/GASOIL TRADE FLOWS IN 2012

Source: EU

shift is impossible to know at the present time, but its potential impact should be kept in mind.

## Oil Bust Has Energy Execs Seeking New Business Models

**The 114 court-protected firms account for \$30.8 billion of secured and unsecured debt, with oilfield service companies representing \$8 billion of that total**

The energy bust is gaining steam as nearly 17 months of unusually low oil and gas prices have taken their toll on the industry. According to the energy bankruptcy tracking done by law firm Haynes & Boone, as of April 18<sup>th</sup>, 114 oil and gas producers and oilfield service companies have filed for protection under the bankruptcy laws of the United States and Canada since the start of 2015. Of the 63 oil and gas producers in bankruptcy, 21 have filed this year. On the oilfield service side, 12 companies have filed for protection in 2016 as of March 27<sup>th</sup>, out of 51 total in bankruptcy since the start of 2015. We know that these total bankruptcies have grown since the lists were published on the law firm's web site. Collectively, the 114 court-protected firms account for \$30.8 billion of secured and unsecured debt, with oilfield service companies representing \$8 billion of that total with the remaining balance held by oil and gas producers.

Expectations are this universe of energy companies will grow as 2016 unfolds just because the lack of cash flow in the industry will

not support current ongoing expenditures. Due to the leveraged

**The discussion was framed from the viewpoint of how the oilfield service companies could best assist their customers – the oil and gas producers – in recovering higher activity levels without creating an explosion in operating costs**

**In many oilfield product and service lines, prices are at cash operating-cost breakeven levels, meaning the companies are actually liquidating**

**The outlier from this view was Robert Dudley, CEO of BP Ltd, who first suggested that oil prices would be “lower for longer” and would require more serious adjustments for energy companies**

financial condition of many companies, we are often seeing pre-filing agreements for restructuring the balance sheets of the businesses. These pre-filing agreements reduce the time necessary to complete the restructuring, enable new financing to be put in place, and secure the agreement of the lenders and approval of the courts.

While substantial time is being spent on sorting out the survivors from the losers in this downturn, the energy company executives of the winners are turning their attention to how best to organize and manage their businesses for the future to avoid any re-occurrence of the problems that hurt them in the current cycle. We attended a dinner at which a handful of senior executives from various segments of the energy industry were present. The topic of business models came up. The discussion was framed from the viewpoint of how the oilfield service companies could best assist their customers – the oil and gas producers – in recovering higher activity levels without creating an explosion in operating costs. Of course the producers don't want service costs to go up, but without higher prices the service industry will not have sufficient cash flow to reinvest in their businesses, ultimately limiting their ability to serve their customers.

While no one has been able to quantify the impact of the downturn on finding and developing costs for oil and gas hydrocarbons, it is not unreasonable to believe that two-thirds to three-quarters of the cost reduction has come from price reductions by the service companies. In many oilfield product and service lines, prices are at cash operating-cost breakeven levels, meaning the companies are actually liquidating. At that rate, it will not take long before the entire service industry is decimated. In turn, it means the service companies will not be able to provide properly maintained equipment and trained crews to meet any activity uptick of producers. This condition has long-term implications for the entire energy business.

The discussion about new industry business models began over a year ago as the industry entered its initial phase. The talk didn't gain much traction because the conventional wisdom called for the downturn to be of a relatively short duration. The outlier from this view was Robert Dudley, CEO of BP Ltd, (BP-NYSE), who first suggested that oil prices would be “lower for longer” and would require more serious adjustments for energy companies. Schlumberger Chairman Paal Kibsgaard (SLB-NYSE) began discussing the need for the oilfield service industry to think about how it could improve its working relationship with its customers in ways that would help reduce costs and eliminate inefficiencies while mitigating the human and financial damage that always occurs during industry downturns. An ongoing area of interest for reducing field development costs and the time to bring them into production has been to increase equipment standardization rather than requiring every project to be unique. We have seen this approach

utilized with drilling rigs and marine vessels, both offshore supply,

**Shell's program worked until their drilling engineers began suggesting to service companies that someone else's product or service was better than theirs, so why not strike an agreement with that other supplier**

**The problem comes from producer procurement professionals who believe the service companies don't bring much to the engineering aspect of projects thus the only way the companies can be compared is by price**

**The procurement-driven model leads to suboptimal technical solutions and correspondingly poor project performance from both a design and executional standpoint**

tankers and LNG carriers. But when it comes to dealing with the design of an offshore field development project, every oil company has its own approach about how projects should be done. Furthermore, the nature of the hydrocarbons being produced often necessitates that production equipment be specially designed.

Coming out of the 1980s downturn, Royal Dutch Shell (RDS.A-NYSE) developed an efficiency program - Drilling in the 90s – designed to reduce the number of suppliers it had to deal with by pushing the service companies to offer packages of services and products, either wholly-owned or through partnership agreements. This program contributed to some consolidation within the oilfield service sector as larger companies sought to fill out the suite of products and service they could offer producers using this approach. Shell's program worked until their drilling engineers began suggesting to service companies that someone else's product or service was better than theirs, so why not strike an agreement with that other supplier for this particular bid even though the lead bidder had its own product. These patchwork partnerships eventually created challenging operating arrangements that diminished their effectiveness.

This time around, the discussion seems to be heading in a slightly different direction. Mr. Kibsgaard believes that the downturn will result in a "medium for longer" pricing scenario in which the national oil companies of OPEC can still generate significant returns for their owners due to the low cost base of their conventional resources. With this cost advantage and a desire to play for market share in a world of minimal demand growth, cost issues for producers will become very important. In his view, the procurement-driven contracting model is the main obstacle to creating the performance improvement desired by the customers. The problem comes from producer procurement professionals who believe the service companies don't bring much to the engineering aspect of projects thus the only way the companies can be compared is by price, which means comparing them on the basis of their more commodity-oriented products.

In Mr. Kibsgaard's view, the procurement-driven model leads to suboptimal technical solutions and correspondingly poor project performance from both a design and executional standpoint. That also means financial returns will be negatively impacted. In light of this outlook, Schlumberger has been undertaking a revamping of how it competes based on collaboration and commercial alignment between the operators and the largest service companies. This preparation can be seen through their acquisition strategy during the past few years as Schlumberger has filled holes in its technology suite and extended its ability to do more of what was often contracted to others, which has become more important for retaining complete control of projects.

Schlumberger is close to putting five prototype drilling rigs into the



**By automating the drilling process based on the downhole intelligence, wells can be drilled faster, cheaper, safer and with a greater productivity outcome**

field to test its new drilling system that will capitalize on its downhole instruments to help guide and evaluate the formations being drilled and render information to the drilling equipment and the people at the surface. By automating the drilling process based on the downhole intelligence, wells can be drilled faster, cheaper, safer and with a greater productivity outcome. It is possible fewer workers will be needed on the rigs further reducing the cost of drilling wells and potentially helping both the operator and service company improve returns.

**If producers cannot grow production because of low industry growth, they will need to strive to become more profitable in order to be rewarded by investors**

Competitors will be watching Schlumberger closely. Initial successes will pressure competitor management teams to consider broadening their product and service offerings followed by how to make them more integrated and profitable. Producers will be watching the experiment as they wrestle with how to increase their profit margins if oil prices remain in the \$40-\$55 per barrel range for a number of years. If producers cannot grow production because of low industry growth, they will need to strive to become more profitable in order to be rewarded by investors.

**Old, traditional playbooks may no longer work**

While many people will focus on the efforts of the service industry and the operator segments to develop new business models, virtually every other energy sector is also struggling to develop better business models. That includes both mid-stream and utility companies. The changing flow of oil and gas in North America, the opening up of oil and gas export markets from the U.S., and the growing competitive power of renewable fuels – whether because they are mandated or merely by having a lower cost – is forcing executives to have to rethink their business models. Old, traditional playbooks may no longer work, a point Mr. Kibsgaard makes often. In fairness, we are not sure which Schlumberger business model iteration this effort is. What the new models should be is not clear. There is little doubt that the energy business is in a state of transition. The energy industry of the future will likely look very different from its current structure. Who makes the transition successfully should be well-rewarded. Everyone else may be on the menu for the others.

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