PPHB

ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

August 21, 2018

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Managing Director

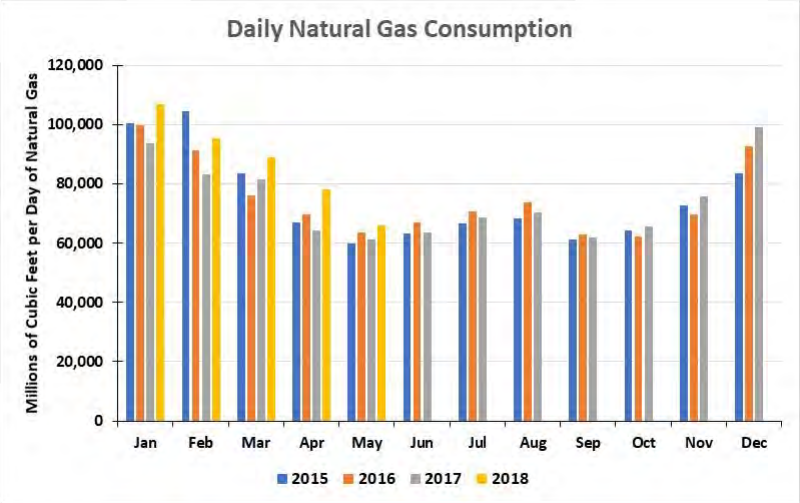
Note: *Musings from the Oil Patch reflects an eclectic collection of stories and analyses dealing with issues and developments within the energy industry that I feel have potentially significant implications for executives operating and planning for the future. The newsletter is published every two weeks,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

Natural Gas Use Curbs Injections And Lifts Prices

Based on low injection volumes during the past two weeks, we have witnessed natural gas prices moving higher in response

We've been watching natural gas weekly storage injections and gas futures price movements. Based on low injection volumes during the past two weeks, we have witnessed natural gas prices moving higher in response. With the National Weather Service lowering its prediction for the number of tropical storms this season and heat waves rolling over various portions of the country this summer, it appears both natural gas supply and demand are being helped. What we also know is that U.S. exports of liquefied natural gas (LNG) are up. If U.S. wellhead gas prices, as indicated by futures prices, remain low, LNG exports are likely to remain strong, only limited by export terminal capacity and ship availability.

Exhibit 1. Natural Gas Consumption Is Up In 2018



Source: EIA, PPHB

We believe the jump in natural gas futures prices, as well as weekly spot prices, reflects the market beginning to question just where winter storage volumes will be on November 1st. In light of the most recent weekly gas storage injections, we decided to revisit our forecast model. We did find an error in our formula, which caused us to re-examine the entire model. The result is a lowering of where gas storage volumes may be when the withdrawal season starts.

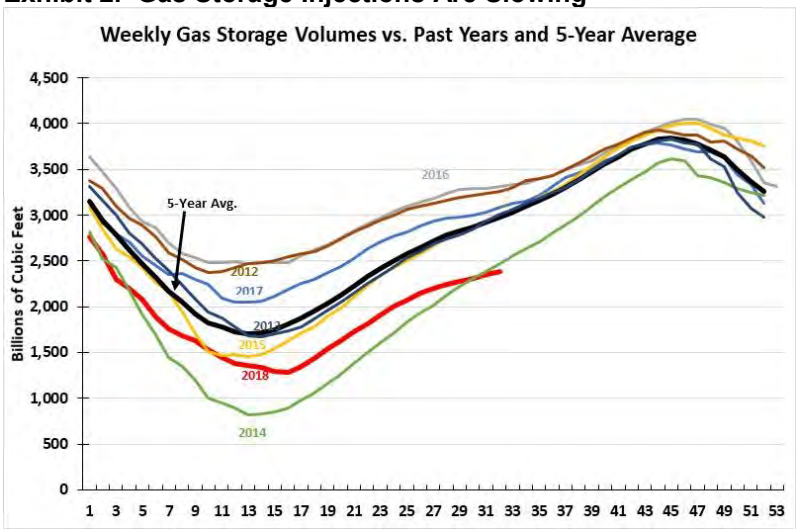
The 33 billion cubic feet (Bcf) injected was "in-line with predictions" and consistent with the 5-year average

The reporter on CNBC, announcing the Energy Information Administration's (EIA) weekly storage injection data for the week ending August 10, 2018, commented that the 33 billion cubic feet (Bcf) injected was "in-line with predictions" and consistent with the 5-year average. We know that the natural gas experts were looking for a 33-Bcf injection. They develop their forecasts by considering cooling-degree days (air condition demand) and gas consumption in other sectors, including LNG and international pipeline exports. Predictions also account for gas production estimates.

Total storage has suddenly begun trailing the 2014 injection season build

We weren't sure about the weekly injection being in-line with the 5-year average, since it looks to us from the data that last week's figure was only about 60% of that respective weekly figure. What we are seeing in the recent weekly injections is that total storage has suddenly begun trailing the 2014 injection season build.

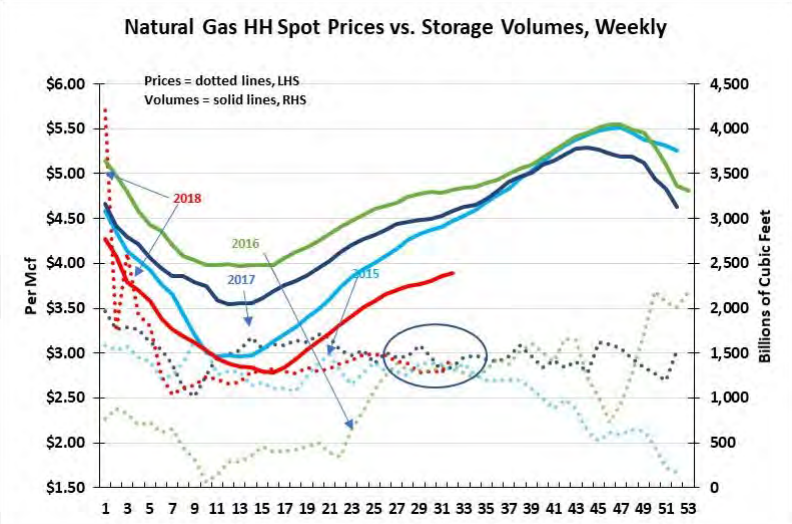
Exhibit 2. Gas Storage Injections Are Slowing



Source: EIA, PPHB

The sudden flattening in the rate of rebuilding gas storage is concerning, but has not yet reached a point where panic should set in for the industry.

Exhibit 3. Gas Storage Relates To Spot Gas Prices



Source: EIA, PPHB

That rise reflects prices moving from the $2.70-2.75 per thousand cubic feet (Mcf) level to $2.90-2.95/Mcf, judged necessary by the market to attract more supply

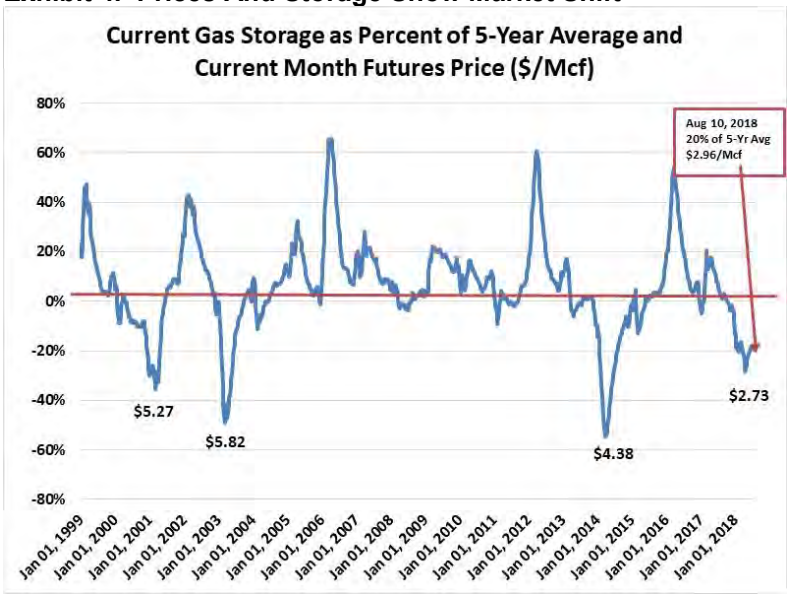
Our favorite natural gas market chart shows the weekly storage levels for the past several years, along with the weekly Henry Hub spot price. As shown in the oval located in the middle of the chart, spot gas prices are reacting to the flattening in weekly injections. That rise reflects prices moving from the $2.70-2.75 per thousand cubic feet (Mcf) level to $2.90-2.95/Mcf, judged necessary by the market to attract more supply. This is exactly how markets are supposed to work – price becomes the regulator, providing either an incentive or disincentive for producers to boost or shrink output.

As the tracking of 2018 spot gas prices reflects, once the winter cold snap ended, natural gas prices collapsed by over $3/Mcf from the start of the year, settling around $2.50/Mcf in February. From that point forward, gas prices rose steadily, reaching close to $3/Mcf in early June, before trading lower, and now rallying. Another chart we put together shows how significantly the natural gas market has changed in response to the success of the shale revolution.

These lower spot prices in recent years are associated with the rapid growth in gas production due to the shale revolution

As the chart on the next page shows, the 2018 storage low ranks as the fourth lowest since 1999. The monthly gas futures price coinciding with the storage lows show how the market has changed due to the shale revolution. We see that the 2014 storage low coincided with a futures price nearly a dollar to a dollar and a half below the prices experienced in 2001 and 2003. This year, the low was a dollar and a half below the 2014 figure, but over three dollars difference compared to the 2003 low. These lower spot prices in recent years are associated with the rapid growth in gas production due to the shale revolution, reducing the market's concern about inadequate supply needing to be attracted for storage with higher prices.

Exhibit 4. Prices And Storage Show Market Shift

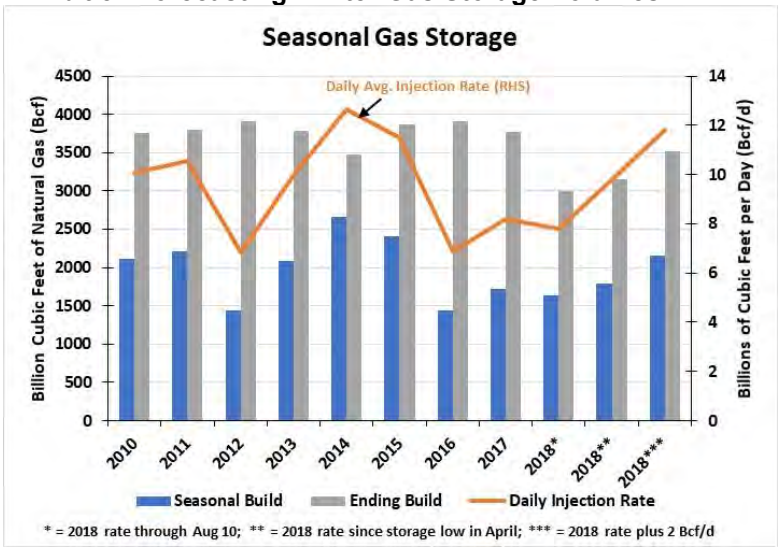


Source: EIA, PPHB

That three-week withdrawal period and lower volume starting point masks the strength of the gas reinjections

The gas injection season so far this year has been abnormal compared to most years. For three-quarters of April, the first month of the injection season, gas was still being withdrawn from storage in meaningful volumes. As a result, when we examine past injection seasons to see the total amount of gas injected, and, importantly, the daily injection rate, that three-week withdrawal period and lower volume starting point masks the strength of the gas reinjections.

Exhibit 5. Forecasting Winter Gas Storage Volumes



Source: EIA, PPHB

When we calculate the average daily injection rate since the start of the injection season (initial 2018 estimate), we barely reach the 3,000 Bcf level

When we examine the daily gas injection rate and the ending gas storage build, we see, in the first case, extensive volatility, and in the latter, a fairly consistent level. Can we get back to that relatively consistent ending build level? When we calculate the average daily injection rate since the start of the injection season (initial 2018 estimate), we barely reach the 3,000 Bcf level. If we measure the daily injection rate to August 10 from the April 20 storage low, and assume that injection rate can be applied to the entire injection season, we reach nearly 3,150 Bcf. Should the industry be able to boost the injection rate to an average of 2 Bcf/d more than used in our prior forecast, we would reach slightly over 3,500 Bcf of gas in storage. As the chart shows, only the most optimistic injection rate scenario returns us to the 2014 ending build volume. The other scenarios leave storage below winter starting levels since 2010.

Would sharply higher gas prices cause some LNG buyers to turn away from the U.S. for supply?

The risk of a significant storage build shortfall is sharply higher natural gas prices, or, if there be significant early cold weather, curtailed availability, too. Would sharply higher gas prices cause some LNG buyers to turn away from the U.S. for supply? Maybe we would need to curtail pipeline exports to Canada and Mexico. Will higher prices make natural gas uncompetitive in the electric generation fuel market, causing utilities to turn to cheaper coal, or forcing interruptible customers off the grid and needing to seek independent sources of power? Could we experience rolling power blackouts such as ruled several winters in the 1970s and 1980s? Which, if any, of these scenarios comes to pass will depend the future pace of weekly storage injections, something we will be watching closely.

California's Electricity Revolution And Renewables

Most people don't know that prospectors were examining oil seeps in California in the 1840s

We constantly remind readers that California has long had a reputation for leading the nation's social and economic waves. When people think about California's impact on social mores, most people think of surfing music, Hollywood movies, and television. Then throw in Silicon Valley's technology products as important factors shaping modern America. Most people don't know that prospectors were examining oil seeps in California in the 1840s, but most of the attempts to tap this resource proved uneconomic. In fact, a *Wikipedia* article points out these drillers spent $1 million in efforts to exploit oil seeps, while only harvesting oil worth $10,000. That return is reminiscent of what often happens in the venture capital industry, another business often associated with California.

As early as 1856, a prospector with pick and shovel began tapping the tar pits at La Brea Ranch, near Los Angeles

As early as 1856, a prospector with pick and shovel began tapping the tar pits at La Brea Ranch, near Los Angeles. This asphalt-like oil was induced to flow by having the tunnels tapping the tar run downhill. In the winter, the pipelines collecting the oil needed to be heated to get the tar to flow. In the 1870s, a handful of California towns used asphalt on their roads to help keep the dust down.

California prospectors were tapping tar oil a few years before Col. Edwin Drake drilled the first commercial oil well in Pennsylvania

It wasn't until 1865-1867, however, when the Philadelphia & California Petroleum Company drilled the first California "gusher" oil well in the Ojai region of Ventura County near the Sulfur Mountain oil seeps. This well was drilled with a steam-powered rig, opening up the California oil and gas industry. California prospectors were tapping tar oil a few years before Col. Edwin Drake drilled the first commercial oil well in Pennsylvania. Thus, California became the second oil producing state just a few years later.

From those early days, California's energy industry has grown and expanded as its sources of energy supply have diversified. It was the state's heavy dependence on fossil fuels to power its economy, and the carbon emissions emitted from their burning, that provided the catalyst for the state's population and political leaders to push for their elimination. Many residents in California are highly concerned about the impact of carbon emissions on climate change and the resulting environmental damage, and believe that the solution is for the state to develop a carbon-free economy.

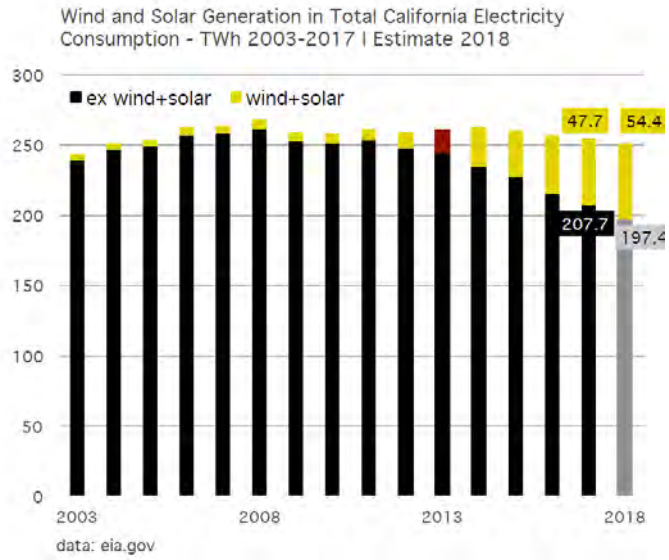
The ability to develop a zero-carbon energy market requires attacking the source of emissions in its two core market segments – transportation and electricity generation

The ability to develop a zero-carbon energy market requires attacking the source of emissions in its two core market segments – transportation and electricity generation. The former segment was attacked through implementation of aggressive vehicle fuel-efficiency standards, the development of mass transit systems and pushing for zero-emission vehicles via subsidies, principally powered by electricity. In the electricity sector, the state is working hard to incentivize the development of carbon-free electricity producing facilities – wind and solar – with utility mandates. Requirements to reduce carbon emissions from fossil fuel power plants are forcing utility companies to close them. At the same time, the low cost of natural gas and renewables are undercutting the economics of running nuclear plants, and, in some cases, even existing natural gas plants. These contrasting trends are altering the mix of energy supplies used in generating California's electricity.

"The collapse of fossil fuels in power grids is upon us, but it's a stealth revolution as wind and solar roar ahead in silence"

An energy journalist has been beating the drum that trends in California's energy market are a forerunner of the energy transition wave about to overwhelm the U.S. energy industry. He recently wrote about how solar and wind were already at the tipping point in California, and by implication would soon be reaching that same critical point nationwide. His article was titled "The Quiet Revolution." His article's tag line was "The collapse of fossil fuels in power grids is upon us, but it's a stealth revolution as wind and solar roar ahead in silence." Wind and solar may be quiet, but the California electricity market is slightly more complicated than the author suggests. It is also interesting that he never addresses the cost to consumers of this supply shift. But first, the chart he used in his report:

Exhibit 6. How Wind And Solar Are Growing In California



Source: ***TerraJoule.com***

We are not sure exactly what this data represents since the size of the market is about 45 gigawatt-hours (GWh) greater than in-state electricity generation, but also about 40 GWh smaller than the entire California electricity market system supply, which presumably equals power consumption. It is possible he has selected only parts of the power market, but we have constructed our charts from the specific energy source data reported annually by the Energy Information Administration (EIA). Importantly, the EIA generation data is exactly the same data reported by the California power regulator.

"While the word collapse may seem unjustifiably hyperbolic, it's an appropriate description of what's happening to the future growth prospects of coal, natural gas, and nuclear power in all power grids both locally, and globally"

The author wrote that wind and solar supplied nearly 30% of total electricity consumption in May 2018. His argument is that for the decade 2003-2013, the share of wind and solar power was between 1% and 2.5%. Starting in 2013, the share jumped to over 6%, and has steadily climbed since then, reaching nearly 30%. Based on his analysis, the future for fossil and nuclear power is dismal. He wrote, "While the word *collapse* may seem unjustifiably hyperbolic, it's an appropriate description of what's happening to the future *growth prospects* of coal, natural gas, and nuclear power in all power grids both locally, and globally."

Before we deal with our analysis of the local California power market, we will start by assessing it from a broader perspective. In 2017, the total California electricity generation market was just over 292,000 GWh, with in-state generation totaling slightly over 206,000 GWh. The difference is the amount of power imported from power generators outside of the state. According to the state electricity regulator, in 2017, approximately 40,000 GWh came from the Northwest and nearly 46,000 GWh from the Southwest.

Exhibit 7. California's Total Electric Supply By Fuel And Source

Total System Electric Generation

2017 Total System Electric Generation in Gigawatt Hours

Fuel Type	California In-State Generation (GWh)	Percent of California In-State Generation	Northwest Imports (GWh)	Southwest Imports (GWh)	California Energy Mix (GWh)	California Power Mix
Coal	302	0.15%	409	11,364	12,075	4.13%
Large Hydro	36,920	17.89%	4,531	1,536	42,987	14.72%
Natural Gas	89,564	43.40%	46	8,705	98,315	33.67%
Nuclear	17,925	8.69%	0	8,594	26,519	9.08%
Oil	33	0.02%	0	0	33	0.01%
Other (Petroleum Coke/Waste Heat)	409	0.20%	0	0	409	0.14%
Renewables	61,183	29.65%	12,502	10,999	84,684	29.00%
Biomass	5,827	2.82%	1,015	32	6,874	2.35%
Geothermal	11,745	5.69%	23	937	12,705	4.35%
Small Hydro	6,413	3.11%	1,449	5	7,867	2.70%
Solar	24,331	11.79%	0	5,465	29,796	10.20%
Wind	12,867	6.24%	10,015	4,560	27,442	9.40%
Unspecified Sources of Power	N/A	N/A	22,385	4,632	27,017	9.25%
Total	206,336	100.00%	39,873	45,830	292,039	100.00%

Source: CEC-1304 Power Plant Owners Reporting Form and SB 1305 Reporting Regulations
In-state generation is reported generation from units one megawatt and larger.

Source: California Energy Regulator

When all the additional supply is factored in, the share of power from renewables shrank by 0.65%

On the California regulator's web-site, there is a chart showing the fuel source of all the power generated in California and imported from the two regional suppliers. Based on 2017 data, total renewable power generated within California totaled 29.65% of the electricity produced. Of that amount, solar represented 11.79% and wind was 6.24%. What is interesting is to examine the fuel supply generating the imported electricity. When all the additional supply is factored in, the share of power from renewables shrank by 0.65%. Importantly, solar power's market share fell by 1.59%. On the other hand, wind's share rose by 3.16%.

The share of all power in California coming from coal rose from 0.15% based on in-state generation, to 4.13% with the imported power

Examining the mix of electricity and its generating fuel source from the imported power, we see important points. The share of all power in California coming from coal rose from 0.15% based on in-state generation, to 4.13% with the imported power. The primary culprit in the increase was power coming from the Southwest. That was also the supply with the greatest amount of solar power. Southwest power also has a substantial amount of natural gas-generated power, but because of all the other fuel shifts, its share of total California power shrank from 43.40% generated in-state to 33.67% of total power. The Southwest also brought in almost as much nuclear power as natural gas-generated electricity.

The amount of wind power imported from the Northwest was equal to about 80% of all the wind power generated within California

When we examine the Northwest power supply, we were not surprised to see it primarily coming from two sources – hydro and wind. California's hydro share, like that for natural gas, shrank due to overall fuel supply mix shifts. The amount of wind power imported from the Northwest was equal to about 80% of all the wind power generated within California.

Exhibit 8. Imported Power Is Important For California

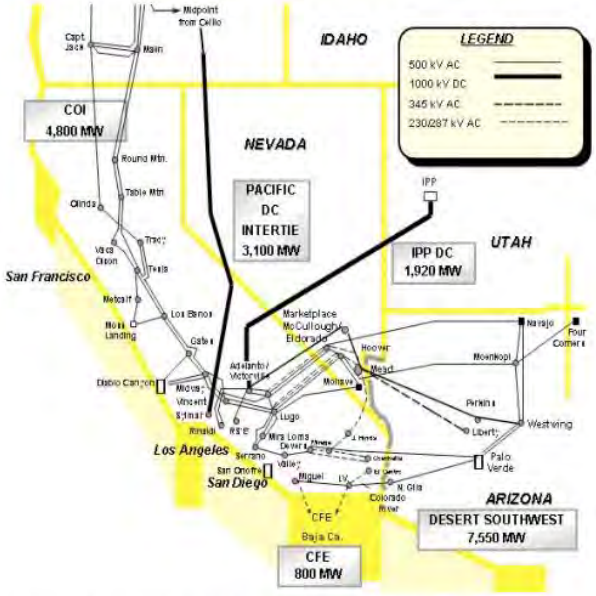


Figure 2 – California's 18,170 MW of EHV Transmission Interconnections
Source: ***info4disasters.org***

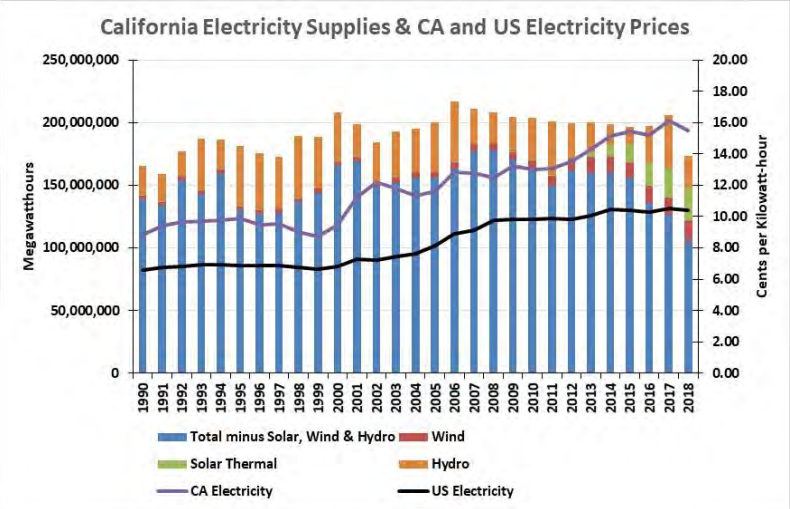
The mix of fuels, when adjusted for the power sources imported into the state, often shows something slightly different than the ideals being promoted

As much as environmentalists and energy analysts focus on just the power consumed in California, the mix of fuels, when adjusted for the power sources imported into the state, often shows something slightly different than the ideals being promoted. To assess California electricity market trends, and especially the cost of the push for renewables, we turned to the detailed year by year data by fuel source. Due to the lag in posting annual data, we turned to the monthly data posted, which is all preliminary for 2017 and 2018 through May, but which enables us to bring our analysis current. For 2018, we annualized the fuel supply data based on the first five months. Since we miss the summer, our data appears to understate the amount of electricity that will be consumed, although the trends remain in tack.

Exhibit 9 on the next page shows California's power generated within the state, as well as the annual overall cost of electricity in the state and for the United States. It also shows the amount coming from solar wind and hydro compared to all fossil fuels, nuclear and other renewables. Two visuals stuck out. First was the jump in power consumption between 1999 and 2000. That increase was accompanied by a sharp rise in the cost of electricity. This was the

period when Enron was engaged in gaming the state's power market, which ultimately led to economic problems and the downfall of the company. The important consideration is that the greater power used in 2000 and 2001, which was linked with the price rise, retreated briefly in 2002 before steadily rising for the next four years. During that time, electricity prices fell back slightly, but then began rising again.

Exhibit 9. California Power Sources And Prices



Source: EIA, PPHB

Hydro power has been greater than wind and solar through 2017

The second observation is that solar power became statistically significant in 2013, and its share of total power has grown since then, in step with the push by regulators. That push has forced utilities to build and purchase more solar power. On the other hand, wind power (red) has been significant since the 1990s, although its share began growing also in 2013. The most interesting data point is that hydro power has been greater than wind and solar through 2017. Even in our annualized calculation for 2018, hydro power still exceeds solar output (15% versus 14%).

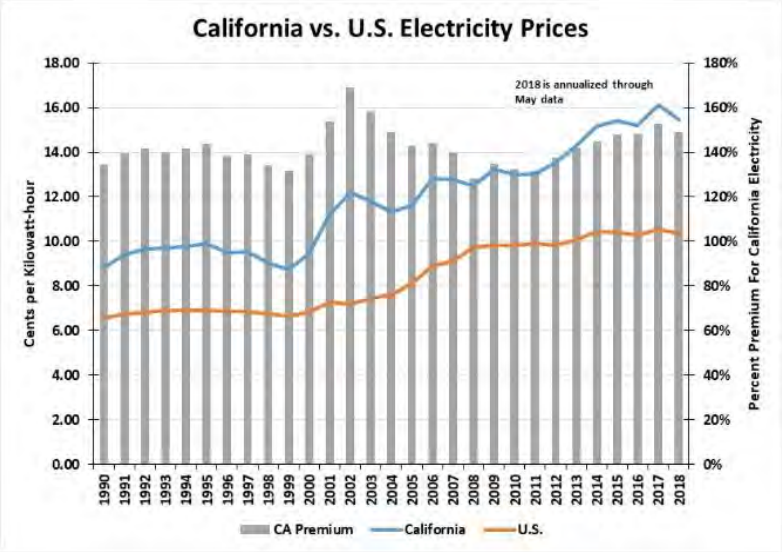
California's cost per kilowatt-hour for electricity has widened relative to the overall U.S. price

What is often missed in the back-patting exercise by environmentalists and politicians is the cost to consumers, which is reflected in the rise in the price of electricity. The purple line shows California's cost per kilowatt-hour for electricity has widened relative to the overall U.S. price, which includes California's contribution. To explore this issue, we generated a chart showing the two electricity price trends, as well as California's premium price.

Between 2008 and 2017, natural gas's share of electricity generation in California declined from 56.9% to 42.6%

Starting in 2008, the premium for California's electricity price (Exhibit 10, next page) has widened compared to the price of U.S. electricity. Between 2008 and 2017, natural gas's share of electricity generation in California declined from 56.9% to 42.6%. This decline came as solar and wind shares increased from 0% to 11% and 3% to 7%, respectively. It is also significant that the cost of natural gas, based

Exhibit 10. California Power Prices Soar As Renewables Grow



Source: EIA, PPHB

on the average of the futures contract price, fell from $8.90 per thousand cubic feet (Mcf) in 2008 to $3.02/Mcf in 2017.

As a result, Californians have been forced to subsidize the high cost of solar and wind, as the American shale revolution has reduced natural gas prices to a fraction of where they were priced in the first decade of this century

What becomes obvious is that the push for zero carbon emission fuels has led to a reduction in the use of the cleanest fossil fuel – natural gas – at the same time the natural gas price has fallen by two-thirds. As a result, Californians have been forced to subsidize the high cost of solar and wind, as the American shale revolution has reduced natural gas prices to a fraction of where they were priced in the first decade of this century. While the author of the article highlighting the "quiet revolution" of wind and solar power, the real quiet revolution is the cost being inflicted on power customers by clean energy policy actions. New England residents, paying some of the highest electricity prices in the nation, are now beginning to realize what their politicians' mandates to switch from fossil fuels to a 100% renewable energy will mean for their pocketbooks. Failure to address the cost of environmental fuel shifts being mandated is a dishonest exercise of political power.

Rhode Island Environmentalists On Both Sides Of The Fence

Holding to its independent history, Rhode Island was the first colony to rebel against British rule

Rhode Island had always marched to its own drummer. It was founded by Roger Williams, a religious outcast from the Puritan strictures of the Massachusetts Bay Colony. While not as dramatic as New Hampshire's "Live Free or Die" motto, Rhode Island's early motto was "Hope," which reflected the founder's view of religious and political freedom. Holding to its independent history, Rhode Island was the first colony to rebel against British rule by burning the British custom schooner HMS Gaspee, after it had run around in the waters near Providence in 1772, as a protest against the detested

customs duties levied by Britain on the colonies. That happened before Boston patriots dumped British tea in the harbor, the event often credited with starting the colonists' rebellion against harsh British governing. Nearly 20 years later, in 1790, Rhode Island was the last of the original 13 colonies to ratify the newly minted Constitution, joining the union thirteen months after it started.

Governor Gina M. Raimondo (D) decreed in the spring of 2017 that Rhode Island will have 1,000 megawatts (MW) of clean energy available by 2020, a tenfold increase from its starting point

Given the state's independent streak, it is not surprising that Rhode Island is home to this nation's first offshore wind farm. It had pushed for offshore wind energy as part of a drive to kick-start the nascent industry in hopes of becoming its East Coast operational headquarters. As part of the state's clean energy drive, Governor Gina M. Raimondo (D) decreed in the spring of 2017 that Rhode Island will have 1,000 megawatts (MW) of clean energy available by 2020, a tenfold increase from its starting point. As part of this aspirational goal, the governor also pledged a doubling in the number of green jobs in the state to 20,000 by 2020.

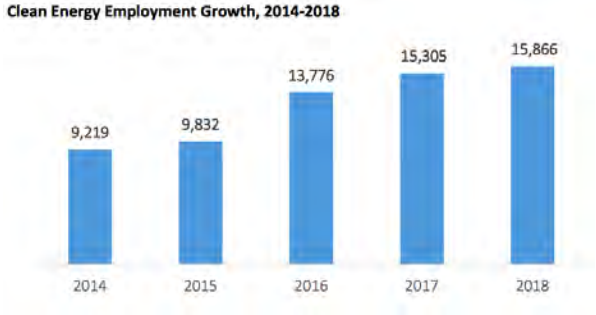
The problem lies within the data that shows a dramatic slowing of clean energy job growth in recent years

Rhode Island may have a problem reaching both of its goals, but in trying to succeed, it may undo the charm of the rural towns in the state, upsetting many residents. On the employment front, the Rhode Island Office of Energy Resources and the Executive Office of Commerce recently jointly released the 2018 edition of the Rhode Island Clean Energy Jobs Report. The report highlights the progress being made by the state in increasing the total number of clean energy jobs to nearly 15,900. The problem lies within the data that shows a dramatic slowing of clean energy job growth in recent years. After jumping by 40.1% in 2016, the employment growth rate slowed to 11.1% the following year and only 3.7% in 2018. This slowing rate of job creation suggests a high likelihood that the state's 20,000 clean energy job target will not be reached.

The report puts a favorable spin on the slowing rate by pointing out that clean energy jobs are growing faster than the overall Rhode Island economy. While a positive assessment, it is a stretch to highlight the growth without acknowledging the state's and federal government's help via subsidies and mandates. Economist Stephen Moore, writing in the Wall Street Journal, recalled a story told by famed economist Milton Friedman that highlights that point. Mr. Moore wrote:

> "At one of our dinners, Milton recalled traveling to an Asian country in the 1960s and visiting a worksite where a new canal was being built. He was shocked to see that, instead of modern tractors and earth movers, the workers had shovels. He asked why there were so few machines. The government bureaucrat explained: 'You don't understand. This is a jobs program.' To which Milton replied: 'Oh, I thought you were trying to build a canal. If it's jobs you want, then you should give these workers spoons, not shovels.'"

Exhibit 11. Rhode Island Green Job Growth

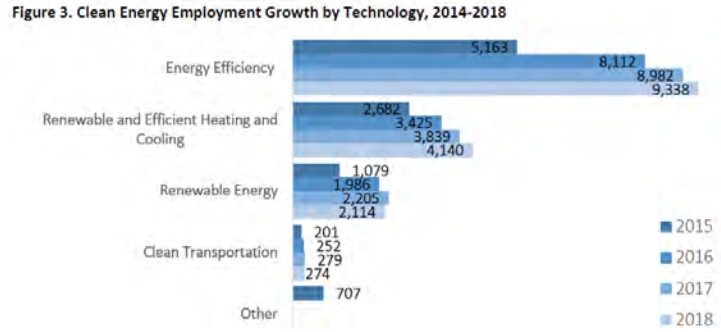


Source: RI Clean Energy Jobs Report

Past studies about green job creation have been rife with exaggerations of the number of positions created through loose interpretations of job classifications

While the 72% clean energy job growth recorded since 2014 is impressive, it is important to examine where and what types of jobs have been created. Past studies about green job creation have been rife with exaggerations of the number of positions created through loose interpretations of job classifications. This report divides the clean energy jobs into four categories: the largest category being Energy Efficiency, followed by Renewable Heating and Cooling, Renewable Energy Generation and finally Clean Transportation. The nature of the jobs included within these categories is less clear.

Exhibit 12. Real Clean Energy Jobs Are Falling



Source: RI Clean Energy Jobs Report

"In Rhode Island, energy efficiency workers are most engaged with advanced building materials and other energy-efficient products and services"

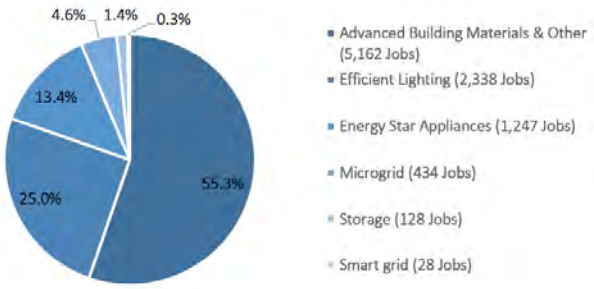
To gain a better understanding of the job classifications (still not very clear), we quote from the report. "In Rhode Island, energy efficiency workers are most engaged with advanced building materials and other energy-efficient products and services; this sub-sector accounts for 55 percent of total energy efficiency jobs, or roughly 5,160 workers. This is followed by efficient lighting (25 percent), and energy star appliances (13 percent). Grid modernization technologies account for just over 460 jobs."

What we can't tell is whether those working with advanced building materials are lumberyard workers or contractors putting up walls in homes and buildings. We don't believe Rhode Island has a significant appliance manufacturing business, so are the Energy Star

appliance workers those in the warehouses or sales people? This lack of clarity on the job descriptions raises questions of whether we have merely shifted workers from one category to another without actually creating any jobs overall.

Exhibit 13. Clean Energy Jobs' Largest Category

Figure 4. Energy Efficiency Employment by Sub-Technology, 2018



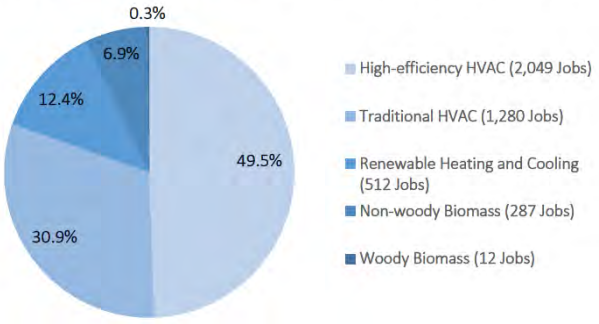
Source: RI Clean Energy Jobs Report

If you work with traditional HVAC technologies, how is this a clean energy job?

Looking at the second largest clean energy employment category, the jobs were classified in the following manner. "In the renewable heating and cooling sector, most employees spend their time working with both high-efficiency and traditional HVAC technologies, followed by renewable heating and cooling, and woody and non-woody biomass." If you work with traditional HVAC technologies, how is this a clean energy job?

Exhibit 14. Another Growing Clean Energy Group

Figure 5. Renewable and Efficient Heating and Cooling Employment by Sub-Technology, 2018



Source: RI Clean Energy Jobs Report

The renewable energy generation sector's decline was entirely due to a decline in solar jobs

What we learn from the report is that while the two largest employment categories experienced job growth, both the renewable energy generation and clean transportation sectors shrank, although the decline in the latter category was marginal. The renewable energy generation sector's decline was entirely due to a decline in solar jobs, as wind employment continued growing with the expansion of the offshore wind business.

Wind employment did not fall following the completion of Deepwater Wind's offshore wind farm off Block Island in 2016. That was due to

With the official awards, although contracts need to be finalized, there should be further wind employment increases as construction activity begins

the need to hire maintenance workers for the offshore turbines, as well as mariners required to move those workers to their job sites. The successful award to Deepwater Wind of the next Rhode Island offshore wind farm, a 400 MW turbine farm to be constructed off the end of Long Island, along with the potential for the company to win additional East Coast offshore wind farm contracts, also supported job growth, as more engineers and planners were needed to prepare proposals. With the official awards, although contracts need to be finalized, there should be further wind employment increases as construction activity begins.

Exhibit 15. Solar Jobs Down, Wind Jobs Up

Figure 6. Solar and Wind Employment Growth, 2016-2018

Source: RI Clean Energy Jobs Report

Solar employment fell 8.2% in Rhode Island in 2018, while it declined 4% nationally

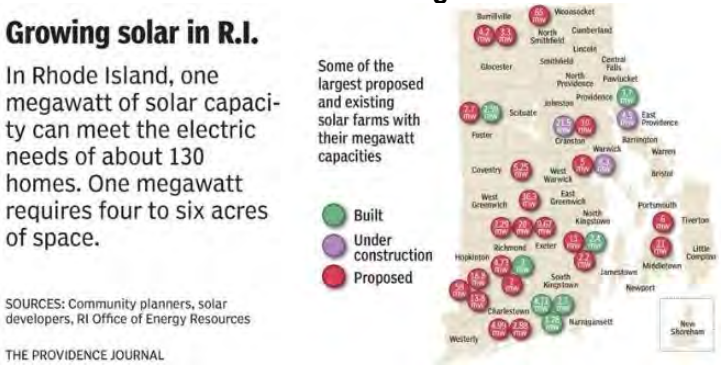
Solar employment fell 8.2% in Rhode Island in 2018, while it declined 4% nationally. President Donald J. Trump's decision to impose 25% tariffs on Chinese solar panels is creating concern within the solar industry about the impact on the cost of solar installations and sales. In our solar installation experience last year, Korean (LG) panels, manufactured in Germany, were considered a better option than Chinese panels. The other surprising point about the employment data is that our solar installer told us recently that 2018 is their best year ever, with installations running this summer at one a day. While they haven't hired any additional workers, they haven't laid off any. However, solar energy has become a touchpoint for environmentalists in the state.

Environmentalists pushing for clean energy are having to rationalize the replacement of environmentally-friendly trees with solar panels

The state's renewable energy incentives are stimulating a rush to construct industrial-scale solar farms. The problem is that many of these farms are being proposed in the most rural towns in the state. Many towns have yet to fully develop renewable energy zoning criteria, as a result, in several neighboring towns, solar farms are being proposed for farms and in forests. These planned solar farms require clear-cutting of acres of mature trees. Environmentalists pushing for clean energy are having to rationalize the replacement of environmentally-friendly trees with solar panels. Which is more beneficial – solar energy instead of natural gas-fired power, or trees that absorb and store carbon dioxide?

Hearings to approve solar farms are underway in a number of Rhode Island towns. In some cases, the hearings have had to be moved from town facilities to local schools to accommodate the

Exhibit 16. Where Solar Is Growing In Rhode Island



Source: ***The Providence Journal***

A problem confronting locals is their understanding that elected town officials often are not skilled in understanding the nuances of the technical issues associated with these industrial-scale solar farms

residential turnouts. Some of these hearings are on their third or fourth extension because the debates are so intense. As cited in the earlier history of Rhode Island, locals value their independence and are not easily swayed from their respective beliefs – be it trees or solar panels. A problem confronting locals is their understanding that elected town officials often are not skilled in understanding the nuances of the technical issues associated with these industrial-scale solar farms, in order to judge what may be the appropriate course of action. At the same time, these officials will continue to live in the towns where their decisions impact its future, and likely home values, which for many people is the bulk of their wealth.

They see the prospect of clear-cutting 60 to 100 acres of adjacent woods as completely changing the character of their neighborhoods, disturbing wildlife and the quiet they have been enjoying for years

Many of the people battling these industrial-scale solar farms are residents adjacent to the proposed sites. They see the prospect of clear-cutting 60 to 100 acres of adjacent woods as completely changing the character of their neighborhoods, disturbing wildlife and the quiet they have been enjoying for years. The prospect of such a radically different future is not appealing. What has some people upset is that the state legislature was supposed to pass a law setting a deadline for cities and towns to adopt ordinances regulating solar development. As a result, many towns and cities do not have approved procedures for dealing with these solar farm applications. The legislation had the support of the Raimondo administration, but it was caught up in a larger debate about open space and industrial-scale solar installations in the state in the latest General Assembly session.

Other environmental and clean-energy advocates were opposed due to the hit it would deliver to the renewable energy industry

Countering this bill was proposed legislation that would stop the conversion of large tracts of forestland for renewable energy by blocking state financial incentives that are the lifeblood for developers. Two significant environmental groups came out in support of this bill, but other environmental and clean-energy advocates were opposed due to the hit it would deliver to the renewable energy industry. As the stalemate developed, Gov. Raimondo stated: “Most of this is local and the last thing any locality wants is the governor telling them what to do. Cities and towns all have say over their land use.”

It decided to play games with incentives

So, what did the state do? It decided to play games with incentives. New incentives were announced by the Office of Energy Resources that include increasing funding for solar projects on former industrial sites, raising the cap in the state's renewable energy rooftop solar program, while also creating an incentive class in the same program for solar carports installed in parking lots. Guess what we've learned over the years: increase incentives/subsidies and you get more of what you are incentivizing. What this also means is that the state will be spending more money to drive investment in the direction of "favored" green energy. Welcome to the land of escalating electricity costs.

Autonomous Vehicles – Good, Bad or Who Cares?

The Insurance Institute for Highway Safety (IIHS) recently reported on tests it conducted on vehicles equipped with self-driving systems

The Insurance Institute for Highway Safety (IIHS) recently reported on tests it conducted on vehicles equipped with self-driving systems. As we know, autonomous technology is the critical ingredient in scenarios projecting a completely revamped mobility system in the low-carbon world of the future. It becomes a zero-carbon world if these autonomous vehicles are all powered by electricity.

We were amused to see the headlines and news coverage of the IIHS test results, some of which depends on how much of a cheerleader one is for autonomous driving technology. Unfortunately, this technology also brings in Tesla (TSLA-Nasdaq), which is the leading electric vehicle (EV) promoting it through the firm's Autopilot autonomous driving system.

When one goes to the IIHS web-site and clicks on the News button, up comes the following headline and story line:

"Tests uncover issues for advanced features"
"On-road and track tests of adaptive cruise control and active lane-keeping show performance can be inconsistent in typical driving situations."

Going to the actual article IIHS published, one finds the following headline:

"Evaluating autonomy: IIHS examines driver assistance features in road, track tests"

Those headlines are pretty straight forward about the test results.

The article that tipped us off to the release of the IIHS report was from *GreenCarReports.com*, which headlined its story as:

"IIHS: Self-driving systems aren't that, and aren't ready for prime time"

Other news sites had the following headlines on the testing.

"5 semi-autonomous cars took a road test and barely passed"
Mashable.com

"'We Aren't There Yet': IIHS Warns of Overreliance on Self-Driving Tech"
Cars.com

On the enthusiastic end of the coverage scale was the headline from the newsletter published by ARK Investment, a huge proponent of EVs, autonomous technology, and Tesla.

"Tesla's Autopilot Blows Competition Out of the Water"
ARK Investors

Each progressively higher level of automation relies more on the system and less on human control

SAE International, the organization of the Society of Automobile Engineers, has established a hierarchy of self-driving technology. There are five levels of driving – ranging from no automation Level 0 (needing a human driver in all situations), to full automation Level 5 (the vehicle does everything). Each progressively higher level of automation relies more on the system and less on human control. The IIHS was testing on-the-road and test track driving in order to develop a rating system for autonomous vehicle performance. In its test, IIHS was measuring adaptive cruise control (ACC) and active lane-keeping on curves and hills.

ACC maintains a set speed and following distance from the vehicle in front. The system is designed to slow for cars ahead, coming to a full stop if necessary, but it may not react to already-stopped vehicles. ACC doesn't react to traffic signals or other traffic controls. Active lane-keeping provides sustained steering input to keep the vehicle within its lane, but drivers must always hold the wheel.

Exhibit 17. SAE Autonomous Driving Rating System

Summary of Levels of Driving Automation for On-Road Vehicles

This table summarizes SAE International's levels of *driving automation* for on-road vehicles. Information Report J3016 provides full definitions for these levels and for the italicized terms used therein. The levels are descriptive rather than normative and technical rather than legal. Elements indicate minimum rather than maximum capabilities for each level. "System" refers to the driver assistance system, combination of driver assistance systems, or *automated driving system*, as appropriate.

The table also shows how SAE's levels definitively correspond to those developed by the Germany Federal Highway Research Institute (BASt) and approximately correspond to those described by the US National Highway Traffic Safety Administration (NHTSA) in its "Preliminary Statement of Policy Concerning Automated Vehicles" of May 30, 2013.

Level	Name	Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt definition	NHTSA definition
***Human driver* monitors the driving environment**								
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a	Driver only	0
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	System	Human driver	Human driver	Some driving modes	Partially automated	2
***Automated driving system* ("system") monitors the driving environment**								
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	System	Human driver	Some driving modes	Highly automated	3
4	High Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	System	Some driving modes	Fully automated	4
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	All driving modes		

Source: SAE International

"The early results underscore the fact that today's systems aren't robust substitutes for human drivers"

The conclusion from the IIHS testing was summed up in the following statement: "Evaluations of adaptive cruise control and active lane-keeping show variable performance in typical driving situations, such as approaching stopped vehicles and negotiating hills and curves. The early results underscore the fact that today's systems aren't robust substitutes for human drivers."

The question the testing was designed to address was whether these autonomous systems could perform as a human. The answer was: not always. As they wrote: "When they didn't perform as expected, the outcomes ranged from the irksome, such as too-cautious braking, to the dangerous, for example, veering toward the shoulder if sensors couldn't detect lane lines." We can accept the former as irksome, but we expect the latter might be not only dangerous but scary as well.

The two Tesla models performed better than the other three vehicles

The IIHS report went on to discuss the performance of autonomous system in each of the vehicle models driven in the on-the-road and test track situations. The summary of the performances was presented in one chart. Although the two Tesla models performed better than the other three vehicles, even they were not perfect. They did perform well enough for their promoters at ARK Investors to trumpet Tesla's "win."

Exhibit 18. How Autonomous Vehicles Performed In Tests

	Number of times vehicle went over line		touched line		system disengaged		stayed within lane	
	on curves	on hills	on curves	on hills	on curves	on hills	on curves	on hills
BMW 5 series	3	6	1	1	9	7	3	0
Mercedes-Benz E-Class	2	1	5	1	1	1	9	15
Tesla Model 3	0	0	0	1	0	0	18	17
Tesla Model S	1	12	0	1	0	0	17	5
Volvo S90	8	2	0	1	0	4	9	9

Source: IIHS

"If the systems seem too capable, then drivers may not give them the attention required to use them safely"

The commentary from David Zuby, IIHS chief research officer, summed up the results of the testing and the challenges facing autonomous driving systems. He said: "Designers are struggling with trade-offs inherent in automated assistance. If they limit functionality to keep drivers engaged, they risk a backlash that the systems are too rudimentary. If the systems seem too capable, then drivers may not give them the attention required to use them safely."

The lack of constant attention is pointed to as the cause of most of the crashes involving vehicles with Level 2 autonomous driving systems. If drivers perceive that their vehicle is doing the driving, the idea of having to hold the steering well all the time is not an attractive proposition.

A production autonomous vehicle that can go anywhere, anytime isn't available at your local car dealer and won't be for quite some time

Mr. Zuby went on to say, "We're not ready to say yet which company has the safest implementation of Level 2 driver assistance, but it's important to note that none of these vehicles is capable of driving safely on its own. A production autonomous vehicle that can go anywhere, anytime isn't available at your local car dealer and won't be for quite some time. We aren't there yet."

If a more cautious pace of development of these markets is the reality, then oil has a longer future than some recent forecasts are predicting

Based on Mr. Zuby's observations, one wonders what these test results mean for those scenarios forecasting rapid acceptance and high fleet penetration of autonomous vehicles, especially EVs, along with the development of new mobility systems. If a more cautious pace of development of these markets is the reality, then oil has a longer future than some recent forecasts are predicting. This points out the challenge in trying to forecast the performance of new technologies and predicting their uptake. Predicting the early demise of the oil industry may be premature.

Shale Gas Success Upends Historical Economic Evaluations

Little did he realize how much the natural gas industry would be upended

When George Mitchell and his team at Mitchell Energy & Development Corp. successfully tapped the shale formation underlying the Barnett Basin in North Central Texas, little did he realize how much the natural gas industry would be upended. As producers began understanding how Mitchell Energy had successfully married horizontal drilling with massive hydraulic fracturing to drill prolific gas wells in shale formations, they began testing the technology elsewhere in the oil patch. In fact, wildcatting producers became enamored with the possibility of re-establishing a vibrant petroleum business in the Ohio, West Virginia and Pennsylvania region of the nation.

Early shale well successes stimulated vigorous anti-fracking movements

Despite the region's early history of hydrocarbon success, the days of meaningful oil and gas production were in the past. The region was more known as the center of the coal industry. As such, it became a hotbed of environmental activism against the mining and burning of coal. Early shale well successes stimulated vigorous anti-fracking movements, led by engineering professors from leading eastern universities. Pennsylvania was even the location of the 2012 anti-fracking movie "Promised Land," with its many technical inaccuracies and distortions.

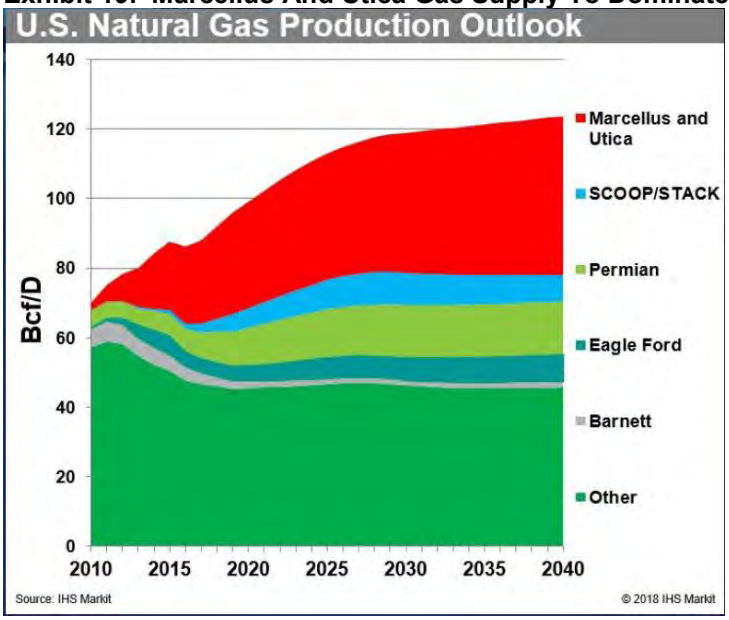
At times these challenges included wellhead prices barely above zero and fierce battles to sell the stuff!

The shale traveling roadshow moved progressively from Pennsylvania through West Virginia and into Ohio, especially after New York Governor Andrew Cuomo (D) successfully mounted an anti-shale, anti-natural gas and anti-oil campaign, blocking both the exploration and development of shale resources and their use. Prospects of attractive petroleum resources in the Utica formation below the gas-rich Marcellus formation in the region attracted producers from all over. Their success, however, created challenges few envisioned. At times these challenges included wellhead prices barely above zero and fierce battles to sell the stuff!

That meant producers had to work hard to push their output into the Eastern Canadian market

With Northeast and Mid-Atlantic politicians fighting the use of fossil fuels, as well as battling the application of fracking to exploit hydrocarbon resources, tapping that large American gas market became nearly impossible. That meant producers had to work hard to push their output into the Eastern Canadian market, as well as cheering on the construction of pipelines to haul their production to the hydrocarbon processing center of the world located in the Gulf Coast region.

Exhibit 19. Marcellus And Utica Gas Supply To Dominate



Source: ShaleCrescentUSA

Building pipelines has become ground zero for the anti-fossil fuel movement

The growth of Marcellus and Utica natural gas has been dramatic, and according to IHS Markit, it will become the largest supply source of any of the major gas plays in the United States for years to come. Given this outlook, access to markets has become the critical ingredient for producer success in this region. Building pipelines has become ground zero for the anti-fossil fuel movement. Opponents have realized that fighting pipeline approvals may be the easiest and most disruptive tool in battling the petroleum industry.

Shale Crescent USA is up and running and marketing the economic advantage the Ohio-West Virginia-Pennsylvania region provides

To address the region's challenge, a new group has formed to promote the attractive economics of petrochemical plants located in this region. Shale Crescent USA is up and running and marketing the economic advantage the Ohio-West Virginia-Pennsylvania region provides any company contemplating building a new petrochemical plant in the United States. We were recently privileged to see a presentation of the results of a study conducted by IHS Markit for the group. The punch line of the study is:

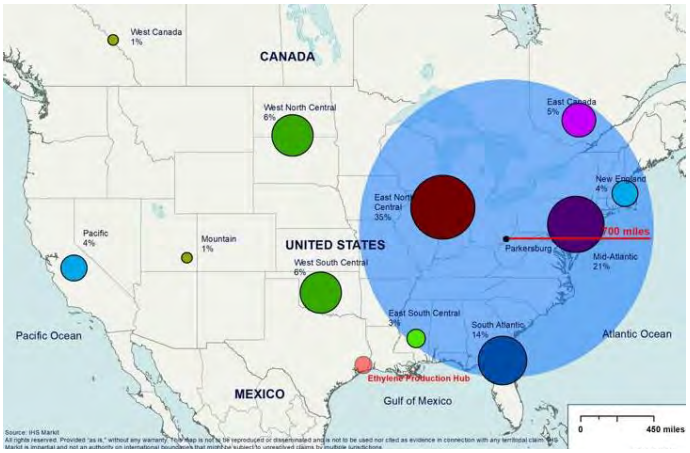
> "Without considering the time value of money, the pre-tax cash flow of the Shale Crescent USA project from 2020 to

2040 amounts to $11.5 Billion, compared to $7.9 Billion for a similar Gulf Coast project, a pre-tax cash flow advantage of $3.6 Billion for a nearly $3 Billion investment in an ethylene/polyethylene plant."

70% of this demand is within a 700-mile radius, or the equivalent of one day's drive

How does this happen? It is due to the Marcellus and Utica supplanting the Gulf Coast as the largest producer of natural gas, and it has now become the low-cost gas and ethane supplier in the nation. But, the Shale Crescent USA region has another critical advantage – it is in the heart of the market for U.S. and Canadian polyethylene demand. As the map shows, 70% of this demand is within a 700-mile radius, or the equivalent of one day's drive. There is also rail and water transportation available. The map's circles reflect relative market potential. The study predicts that demand in this region will be almost six million tons of liner low-density polyethylene (LLDPE) in 2023, equal to about 14% of global demand then. That compares to Northeast Asia is the world's LLDPE demand leader with a 40% market share.

Exhibit 20. Shale Crescent In Heart Of Market Demand



Source: ShaleCrescentUSA

Shell Oil is building a petrochemical complex in Ohio consisting of an ethylene cracker with a polyethylene derivatives unit

A subsidiary of Royal Dutch Shell Ltd. (RDS.A-NYSE) is building a petrochemical complex in Ohio consisting of an ethylene cracker with a polyethylene derivatives unit, capable of producing 1.6 million tons per year. Construction will create 6,000 construction jobs. When the plant begins commercial production in the early 2020s, it will employ 600 workers. Because the plant is located on the water, it will also stimulate barge transportation, including barge construction and the necessary workers.

Exhibit 21. Shell's Ohio Petrochemical Complex

Source: Shell Oil

Shell's rationale for siting the plant here is to capitalize on the cheap and abundant Marcellus and Utica natural gas and ethylene

Shell's rationale for siting the plant here is to capitalize on the cheap and abundant Marcellus and Utica natural gas and ethylene. In addition, its proximity to customers, either by road, rail or water, minimizes product delivery costs. These cost advantages were a key ingredient for the improved economics compared to a similar Gulf Coast plant, as cited in the IHS Markit study. In a highly competitive, global commodity business, minimizing costs helps improve margins and return on investment – how you make money.

Exhibit 22. How Shale Crescent Plant Will Save Money

Source: ShaleCrescentUSA

Chemical company managements need to explore how the shale revolution is changing the economics for locating petrochemical plants

Much as Mitchell Energy had to change its mindset about how the natural gas industry would operate in the future following its Barnett Shale success, the petrochemical industry needs to re-examine its traditional business assumptions. Chemical company managements need to explore how the shale revolution is changing the economics for locating petrochemical plants along the Gulf Coast in favor of putting them in the Shale Crescent region. It's easy to say I want to be part of the crowd, but that decision may sacrifice profits. This is another example of a disruptive force at work in the energy world.

Saudi Oil Minister Rewriting History – Too Young To Know?

We were very intrigued to read an item in the August 10, 2018, newsletter published by the *National Post* newspaper of Canada. The item was reported during the kerfuffle that recently erupted between Saudi Arabia and Canada. The dispute involved two Canadian government tweets calling on Saudi Arabia to release detained women's rights activists. One of the female activists jailed was Samar Badawi, sister of writer Raif Badawi who was arrested in Saudi Arabia in 2012 and later sentenced to 1,000 lashes and 10 years in prison for insulting Islam while blogging. Mr. Badawi's wife and three children became Canadian citizens earlier this year.

The dispute involved two Canadian government tweets calling on Saudi Arabia to release detained women's rights activists

Taking umbrage at the tweets, Saudi Arabia retaliated by expelling the Canadian ambassador, ordering 15,000 Saudi students, including about 800 medical trainees, to halt their studies in Canada, and ordering its state airline to suspend operations in Canada. Saudi Arabia also canceled new trade with Canada and barred Canadian wheat imports. Reportedly, the Saudi central bank and state pension funds instructed their overseas asset managers to sell their Canadian equities, bonds and cash holdings. Although trade between the two countries only amounts to about $3 billion a year, Canada does get 10% of its imported crude oil from Saudi Arabia. It was fear of having to seek replacement oil supplies, not too difficult given U.S. oil exports, that prompted the *National Post* item. It said:

Although trade between the two countries only amounts to about $3 billion a year, Canada does get 10% of its imported crude oil from Saudi Arabia

> "Saudi Arabia says its quarrel with Canada will not stop oil shipments. Its energy minister, Khalid al-Falih, calmed feathers yesterday by saying that oil sales are not affected by politics as there is a 'firm and longstanding policy that is not influenced by political circumstances.' The ruffling began suddenly on Monday when Saudi Arabia's assertive 32-year-old Crown Prince Mohammed bin Salman took offence at Canada's offence at the kingdom's treatment of political activists."

The comment about the "longstanding policy that is not influenced by political circumstances" made us curious. We remember King Faisal of Saudi Arabia leading a group of Middle East oil exporters in an embargo of oil exports to Western countries, including the United States, that supported Israel in the 1973 Yom Kippur War with Egypt. King Faisal was motivated to support the embargo after President Richard M. Nixon sent $2.2 billion in military aid to Israel.

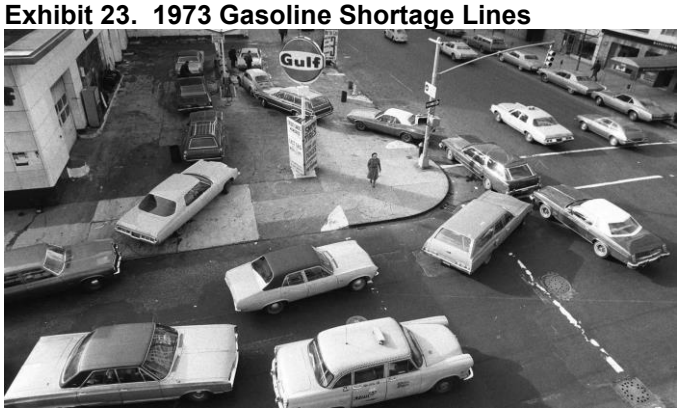
King Faisal was motivated to support the embargo after President Richard M. Nixon sent $2.2 billion in military aid to Israel

Beginning in October 1973, the members of the Organization of Arab Oil Petroleum Exporting Countries (OAPEC) including Egypt and Syria instituted a cut of 5% a month in output destined for Canada, Japan, the Netherlands, the UK and U.S., and later expanded to include Portugal, Rhodesia [now Zimbabwe] and South Africa. The embargo was to end when Israel withdrew from Palestine and Jerusalem.

It did, however, lift global oil prices from $3 to $12 a barrel – producing the first global oil shock

The embargo lasted from October 1973 to March 1974. Israel did not leave Palestine and Jerusalem (return to the 1949 borders), but the embargo did end. It was U.S. pressure on Israel to negotiate with Syria over the Golan Heights that brought the embargo to an end. The embargo had little impact on geopolitics as it failed to change relationships between the targeted Western countries and Israel. It did, however, lift global oil prices from $3 to $12 a barrel – producing the first global oil shock. The scene of cars lined up at gasoline stations became commonplace in the United States, but those lines and shortages were more likely caused by the Nixon administration's wage and price controls, which were always backward looking. Therefore, any area growing was always short of fuel, while areas in decline swam in gasoline.

Exhibit 23. 1973 Gasoline Shortage Lines



Source: *npr*, Marty Lederhandler/*AP*

Clearly, Saudi Arabia's Khalid al-Falih's statement must be referencing a policy that went into effect after the 1973-1974 oil embargo, or maybe he didn't know the earlier history. The policy may have started in concert with the fall of 1974 agreement negotiated between Secretary of State Henry Kissinger and the Saudi Royal Family to price oil in U.S. dollars in return for a U.S. guarantee of protection of the kingdom from attack by Israel as well as supplying the kingdom with U.S. military hardware.

Since Khalid al-Falih was born in 1960 and was only 13 at the time of the embargo and oil pricing deals, he may not have been familiar with the history

Since Khalid al-Falih was born in 1960 and was only 13 at the time of the embargo and oil pricing deals, he may not have been familiar with the history of the weaponizing of oil. He graduated in 1982 from Texas A&M University with a mechanical engineering degree, but we doubt he was schooled in the fine points of oil industry and U.S.-Saudi Arabia political history.

Arab oil exporting countries had twice before 1973 attempted to use oil as a weapon to achieve political purposes. The first time was in 1956 during the Suez Crisis when the UK, France and Israel invaded Egypt. During that battle, the Syrians bombed both the Trans-Arabian Pipeline and the Iraq-Baniyas pipeline, disrupting oil supplies to Western Europe. The second time was in 1967 when

Given that history, Saudi Arabia was leery of using oil as a weapon to influence policy

war broke out between Egypt and Israel. The embargo lasted only a few months and was considered to be ineffective. Given that history, Saudi Arabia was leery of using oil as a weapon to influence policy. We will forgive Khalid al-Falih attempting to rewrite the history of Saudi Arabia's oil policy, but since it was only used reluctantly in 1973, a long time ago, he probably wasn't aware of the fine details. The lack of success in using the policy probably explains why it isn't used.

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