PPHB
ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

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

T'was The Energy Report Before Christmas

We are reprinting an article by Phil Flynn, senior energy analyst at The PRICE Futures Group. Even though you are reading after Christmas, the analysis remains apropos for the New Year.

"T'was the energy report before Christmas and OPEC is ready to cut, as they feel it is time to ease the great oil glut. It is a historic agreement and the market does care because their focus is on price and not market share.

"The OPEC producers were in the same bed. The low price of oil they were beginning to dread. Even Non-OPEC Producers have agreed to a cap and the traders are betting that we could trade off the map.

"Yet, at the end of the day it's compliance that matters, if they cheat on production the traders might scatter. While OPEC made prices rise in a flash, if they fail to comply the prices might crash.

"Their goal to keep shale production in toe was somewhat successful as U.S. oil production has slowed. And even as rigs suddenly appear for shale to catch up it might take a couple of years. They started a price war so prices would fall like a brick and they think they won so they cut production real quick!

"Non-OPEC producers like Russia are game and will join OPEC Members that now I will name! Cut Iran! Cut Iraq! Cut Kuwait and Algeria! Cut, Venezuela! Cut UAE! Cut Qatar and Nigeria! Libya and Ecuador have their backs to a wall, but Saudi Arabia will cut enough for them all. So they will conspire on cuts like an evil cabal.

"I think they will hold to their quota. As there is need to comply because when Donald Trump is President U.S. energy will ride high. With less regulations we will add to supply. With stimulus spending and less red tape to get through. The U.S. producer will compete and their just due.

"And lower taxes will make growth go through the roof and for OPEC right now it is their moment of truth. Down with production so prices rebound Donald Trump may tax them and run them into the ground. With trade shenanigans, Trump will put down his foot. So the days of taking advantage is almost kaput.

"The U.S. economy is on its way back and with demand on the rise the frackers will frack. For energy producer's things will be merry as Rick Perry is the new Secretary. Donald Trump's appointments are in the energy know and instead of wasting money on bad regulations they can start making some dough.

"For the oil industry they are finally upbeat, they can produce oil instead of getting kicked in the teeth. President Barack Obama always gave them an ache in the belly. When he lifted sanction on Iran the deal seemed a bit smelly. He also banned drilling out in the Ocean shelfs and he did this to block Trump, in spite of himself. The loss of a legacy Obama is beginning to dread because the shale revolution he terribly misread.

"So, the U.S. people will get back to work, from the energy producers and the new shipping clerks. It has been awhile since the jobs rate was so low and as the economy expands the wages will grow.

"But still our soldiers are fighting in lands far away and remember to pray for them each passing day. It is for our Freedom they put up this incredible fight so to them and all a Merry Christmas and good night!"

America's Renewable Energy In A New Era – Offshore Wind

America's renewable energy industry opened a new chapter

Less than two weeks ago, America's renewable energy industry opened a new chapter with the official startup of the Block Island Wind Farm located 3.8 miles off the coast of Block Island in Rhode Island state waters. The wind farm was developed and is owned by Deepwater Wind LLC, which is an arm of the D. E Shaw Group, a global investment and technology firm with $38 billion of invested capital as of July 1, 2016. After receiving approval from Rhode Island's Coastal Resources Management Council (CRMC) to begin operations, the 30-megawatt, five-turbine project was switched on December 5th.

That effort was furthered by an executive order in 2006 of then-Governor Donald L. Carcieri (Rep.) that established a goal that 15% of "Rhode Island's electricity demand will be supplied by environmentally progressive wind power."

This historical event followed nearly 18 months of construction and testing, becoming the first offshore wind farm to operate in the United States. The timeline for the project was much longer than anticipated, having started its regulatory journey in April 2008 when Rhode Island issued a request for proposals to construct an offshore wind farm in furtherance of the state's efforts to promote renewable energy resources. In 2004, Rhode Island's legislature established a goal of meeting 15% of the state's electrical needs from renewable resources by 2020. That effort was furthered by an executive order in 2006 of then-Governor Donald L. Carcieri (Rep.) that established a goal that 15% of "Rhode Island's electricity demand will be supplied by environmentally progressive wind power." In recognition of the strong wind patterns offshore the United States, as mapped by the National Oceanic and Atmospheric Agency (NOAA), Rhode Island enlisted professors from the University of Rhode Island to undertake an assessment of the wind resources in state waters, which led to the creation of the Ocean Special Area Management Plan (Ocean SAMP) in 2008 under the supervision of the state's CRMC. One of the areas identified by the Ocean SAMP was offshore Block Island, the site of the Deepwater Wind project.

Exhibit 1. Block Island Is In A Strong Ocean Wind Area

Source: Old Harbor

The Ocean SAMP provided a road map for the development and facilitated an expedited approval process by a friendly government agency

The Ocean SAMP provided a road map for the development and facilitated an expedited approval process by a friendly government agency. CRMC had oversight of the permitting process and construction. It also possessed the authority to hire independent consultants to review the hardware manufacturing and wind turbine construction. CRMC was also involved in permitting the construction of an offshore electrical cable connecting Block Island to the mainland linking the previously isolated island from receiving electricity from the state's power grid rather than having to generate it all on the island. This isolation had contributed to very high power prices - in the neighborhood of $0.50 per kilowatt-hour (kWh) - from generators powered by diesel fuel. Diesel accounted for about half the cost of the power. The cable provides bi-directional movement

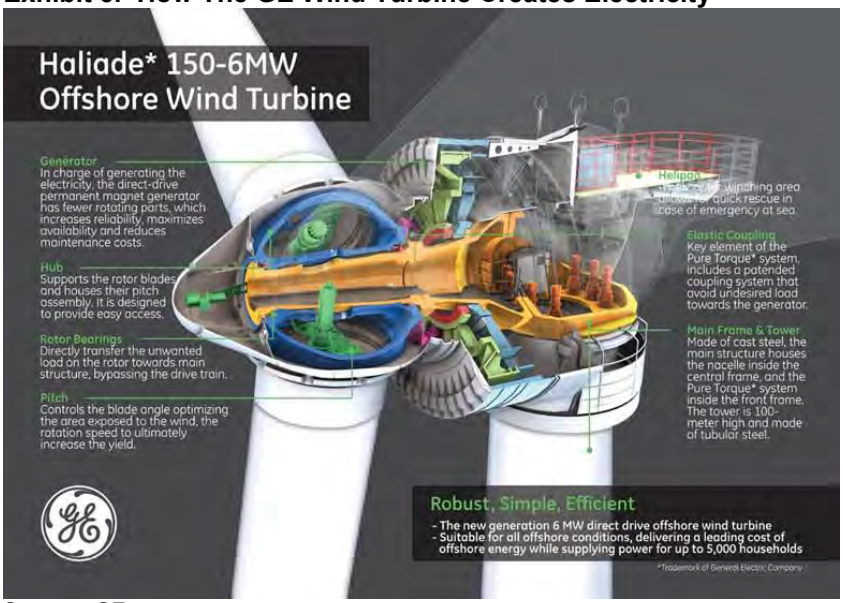
The state elected to have it cross a part of the state's Scarborough beach

of electricity so that any excess wind power can flow to the mainland, while when the wind isn't blowing, the grid can supply power to homes and businesses on the island. A slight problem the state had with the underwater power cable was that the residents of Narragansett didn't want it landing in their town. In response to the town's rejection, the state elected to have it cross a part of the state's Scarborough beach, which just happens to be located in Narragansett.

Exhibit 2. GE Wind Turbine Generator

Source: GE

Exhibit 3. How The GE Wind Turbine Creates Electricity



Source: GE

It appears that either the installer or the manufacturer left behind a 6-inch drill bit

The wind farm did experience a slight hitch with the start-up process as one of the turbines (number two) was damaged during the testing phase. After inspection, it appears that either the installer or the manufacturer left behind a 6-inch drill bit, which was found lodged in a gap between the generator and the direct-drive system. The picture in Exhibit 2 (previous page) shows a generator and the direct-drive unit without the blades. Exhibit 3 (previous page) shows a schematic of how the generator and direct-drive unit works.

It is interesting that the unit's warranty lasts for only 15 years, while the projected life of the unit for financial analysis purposes is estimated at 20 years

The damaged magnets in the generator will be replaced under the warranty from General Electric (GE-NYSE), the builder of the Haliade unit. Each magnet weighs about 60 pounds and they will be lifted manually up the 330-foot tall tower to the generator housing where they will replace the damaged ones. It is interesting that the unit's warranty lasts for only 15 years, while the projected life of the unit for financial analysis purposes is estimated at 20 years. Most of the wind turbines in operation are projected to become less efficient in their later lives, and that is why many of them are replaced after 15 years of service. Exhibits 4 and 5 (next page) put the generator unit's location and size in perspective with the overall wind turbine's scope.

Exhibit 4. How A GE Wind Turbine Is Structured

Source: GE

The key ingredient for the success of the project was the state's support for Deepwater Wind's expensive power-purchase agreement

The key ingredient for the success of the project was the state's support for Deepwater Wind's expensive power-purchase agreement (PPA) with Rhode Island's primary electricity provider, National Grid (NGG-NYSE). The initial agreement was rejected by the Rhode Island Public Utilities Commission (PUC) as uneconomic, a decision that was reversed following the state's legislature approving a new law restricting the ability of the PUC to consider a

Exhibit 5. An Example Of A Block Island Wind Turbine

Source: GE

The subsequent approval of the PPA led to legal challenges by industrial power consumers over the cost of electricity

cost/benefit analysis of the PPA and requiring it to approve the PPA if it merely found any economic benefit from a clean power project constructed in the state. The subsequent approval of the PPA led to legal challenges by industrial power consumers over the cost of electricity, which was spread among all recipients of power regardless of whether they provided their own power, which National Grid merely delivered.

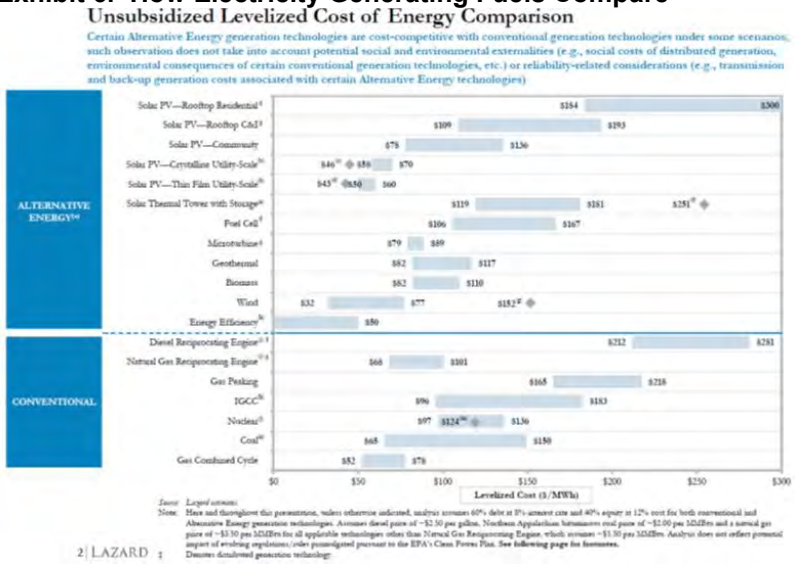
Levelized economic analysis assumes that all kilowatt-hours of power generated are equal in value

There was a simple reason why the state legislature didn't want the PUC to conduct any further cost/benefit analyses since the economics of offshore wind are not very attractive. A recent analysis of levelized costs of various power generating sources shows how expensive offshore wind is compared to nuclear, coal and natural gas power sources. Levelized economic analysis assumes that all kilowatt-hours of power generated are equal in value, regardless of when during a day the power is produced. This report, prepared by investment firm Lazard Ltd. (LAZ-NYSE), shows that the unsubsidized levelized cost of power from onshore wind turbines ranges between $32 and $77 per megawatt-hour (MWh). The median prices targeted for offshore wind is $152/MWh. These cost estimates do not include any costs for social and environmental externalities such as vibration, flicker, humming or the killing of bats and protected eagles.

In the case of wind, we would note that the primary cost improvement phase occurred in 2009 and 2010

One of the arguments made for the progress renewables are having in reducing their costs is reflected in Exhibit 6 (next page). It shows how much the unsubsidized levelized cost of wind and solar power have declined over the six-year period, 2009-2015. In the case of wind, we would note that the primary cost improvement phase occurred in 2009 and 2010, and since then the pace of cost improvement has been slower. Over the six-year period, the

Exhibit 6. How Electricity Generating Fuels Compare

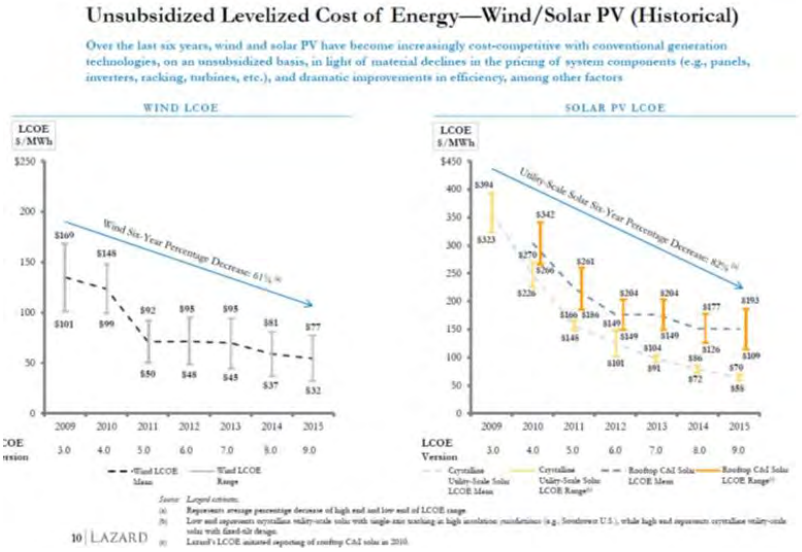


Source: Lazard

Between 2014 and 2015, the decline was 7.4%

average wind cost declined 61%, but since 2011, it has only declined by 33%, and between 2014 and 2015, the decline was 7.4%. In other words, the pace of decline in wind power costs have slowed over time raising questions about whether the cost decreases will continue in the future, and at what rate.

Exhibit 7. How The Cost Of Wind And Solar Have Fallen



Source: Lazard

With the start-up of the Block Island Wind Farm, Deepwater Wind can now begin collecting 24.4 cents/kWh for the electricity the turbines produce. That rate will increase by 3.5% annually for the

Currently, residential customers are paying 8.179 cents/kWh for their electricity, or one-third the price of Block Island power

20-year life of the PPA. This means that in 2036 consumers will be paying 47.9 cents/kWh. Currently, residential customers are paying 8.179 cents/kWh for their electricity, or one-third the price of Block Island power. At the time the PPA was negotiated, the ratio between the proposed Block Island power price and what Rhode Island electricity customers were paying was only about a two-to-one ratio, rather than today's three-to-one ratio.

It can now begin collecting on the federal tax incentives for renewable fuel production

Equally as important for Deepwater Wind is that it can now begin collecting on the federal tax incentives for renewable fuel production. There are two options: 1) receive a tax credit of $0.023/kWh of power generated, or 2) accept an immediate 30% credit of the cost to construct the wind farm. We have read that Deepwater Wind is planning on taking the second option, which based on a quick analysis would seem to be financially the best choice.

Deepwater Wind is eligible for an immediate tax credit of an estimated $90 million to $102.9 million

There seems to be some confusion as to exactly how much the Block Island Wind Farm cost to build. The number $300 million is frequently reported as the cost, which is close to the estimated $290 million in long-term financing Deepwater Wind secured in order to construct the project. In another place we have seen an estimate that the equipment, construction and installation totaled $225 million, with $118 million for design, legal and permitting, plus $108 million for the undersea cable. While Deepwater Wind was initially going to have to construct the cable, it eventually reached an agreement with National Grid for them to assume that cost. What we do not know is how much, if any, of the $108 million figure represents the cost of the cable to connect the five turbines together and bring the power initially to shore, and how much represents the cost to take the cable from Block Island to the mainland. If we assume that the entire $108 is the cost to National Grid, then the other two expenses total $343 million rather than $300 million. In either case, if all these costs are eligible for the 30% investment tax credit (ITC), then Deepwater Wind is eligible for an immediate tax credit of an estimated $90 million to $102.9 million.

We have seen an estimate that the wind farm will be selling 125,000,000/kWh of electricity per year, which implies a 47.6% efficiency rate

When we examine the benefits from the production tax credit for producing wind power, we must make some assumptions about the amount of power that will be generated. The math goes like this: a 1-Megawatt (MW) generator produces 1,000 kilowatts of power per hour (kWh), if it is producing continuously. There are 8,760 hours in a year, so that 1-MW generator produces 8,760,000/kWh a year. Since the turbines are rated for 6 MWs, then a single Block Island Wind Farm turbine generates 52,560,000/kWh a year if operating full time. The Block Island Wind Farm, having five turbines, would produce 262,800,000/kWh a year. We have seen an estimate that the wind farm will be selling 125,000,000/kWh of electricity per year, which implies a 47.6% efficiency rate. While that efficiency is above the top-end of estimates for offshore wind turbine performance, given that these turbines represent new technology, we will accept the higher performance estimate. With that efficiency and the

$0.244/kWh price for the power, the wind farm will generate $30.5 million a year in revenue. At $0.023/kWh, it will create $2.875 million a year in production tax credits (PTC). Those figures are for the first year as the PPA provides for a guaranteed 3.5% annual escalation in the price of electricity generated.

For analytical simplicity, we assumed the wind farm's output remains constant over the first 10 years of operation, which is the period during which it is eligible for the PTC. Under our assumptions, Deepwater Wind would generate $357.8 million in revenue and $28.75 million in PTCs, over the 10 years. Deepwater Wind has the option to collect either PTCs or take an immediate 30% ITC against other profits. As Deepwater Wind is a subsidiary of the D.E. Shaw Group, we believe the wind farm ITC has an immediate tax-shelter benefit for its owner. The projected PTC credits that would be earned under our assumptions represent less than one-third of the immediate ITC amount. Another advantage of selecting the ITC over the PTC is that it eliminates the risk that the power generated by the turbines falls below the 48% efficiency ratio, cutting down on eligible power credits.

Another advantage of selecting the ITC over the PTC is that it eliminates the risk that the power generated by the turbines falls below the 48% efficiency ratio, cutting down on eligible power credits

While the ITC option eliminates the uncertainty of performance, it is also consistent with the view of Warren Buffett, considered one of the outstanding investors of all-time. He has said, "[O]n wind energy, we get a tax credit if we build a lot of wind farms. That's the only reason to build them. They don't make sense without the tax credit." His view was supported by a study commissioned by the wind industry in 2015 showing that with the current subsidies, wind will produce eight gigawatts of power nationally, but without them, we will only have two gigawatts of power. More to the implications of the renewable subsidies is an analysis of the PTC, which has been in place since 1992, or for 24 years. In 2014, the PTC cost Americans $12 billion in tax subsidies, as wind power generation grew, versus an average cost over the period of about $5 billion a year. Today, wind accounts for about 5% of total electricity production in this country.

"[O]n wind energy, we get a tax credit if we build a lot of wind farms. That's the only reason to build them. They don't make sense without the tax credit."

For electricity customers in Rhode Island, the Block Island Wind Farm PPA is estimated to add between $1.07 and $1.35 per month to their power bills. Estimates presented to the Rhode Island PUC in 2015 show that local customers will pay an above-market price of $440 million for Deepwater Wind's output over the life of the PPA. That estimate has grown to more than $500 million due to escalated costs for the wind farm and its underwater power cable. When challenged by critics about the economics of Deepwater Wind, CEO Jeffrey Grybowski was quoted saying, "I think they miss what we're really trying to do here, which is to build a new clean energy industry in Rhode Island, something that's gained tremendous international attention. We're building clean energy for the next generation here. And I think there are always small-minded opponents who like to find conspiracies." I doubt most Rhode Islanders consider themselves

For electricity customers in Rhode Island, the Block Island Wind Farm PPA is estimated to add between $1.07 and $1.35 per month to their power bills

either “small-minded” or conspiracy-theorists. Moreover, I don’t believe they considered themselves leaders of a revolution creating a new industry. I think they were merely looking for cheap electricity – something they were promised initially, but aren’t getting now from Deepwater Wind.

Understanding The Challenges Of Oil Price Forecasting

The Wall Street consensus estimate in every year since 2000 called for a higher stock market the following year

A recent *New York Times* business column about Wall Street’s annual game of forecasting the level of the stock market in the next year reminded us of the old expression applied to many computer models – Garbage In, Garbage Out! That expression referenced the tendency for computer model builders to employ statistical relationships that were not sound, but on the surface looked solid. Therefore, many of the forecasts derived from these models were unreliable. The column pointed out that “[e]very December as the holidays approach, Wall Street gurus examine the stock market, and nearly all declare that stocks will rise in the forthcoming calendar year.” But as the record shows, since 2000, the Standard & Poor’s 500 stock index has declined in five calendar years and ended up virtually flat in a sixth year. However, the Wall Street consensus estimate in every year since 2000 called for a higher stock market the following year.

We are left with the conclusion that analyzing sheep entrails or merely flipping a coin might prove just as successful

The record of annual oil price forecasting seems to follow the same pattern. In Exhibit 8, we have the obligatory chart showing just how poorly oil price forecasters have done in predicting future prices. After looking at the chart, we are left with the conclusion that analyzing sheep entrails or merely flipping a coin might prove just as successful in predicting future oil prices as sophisticated models.

Exhibit 8. Evolution Of DOE Oil Price Forecasts

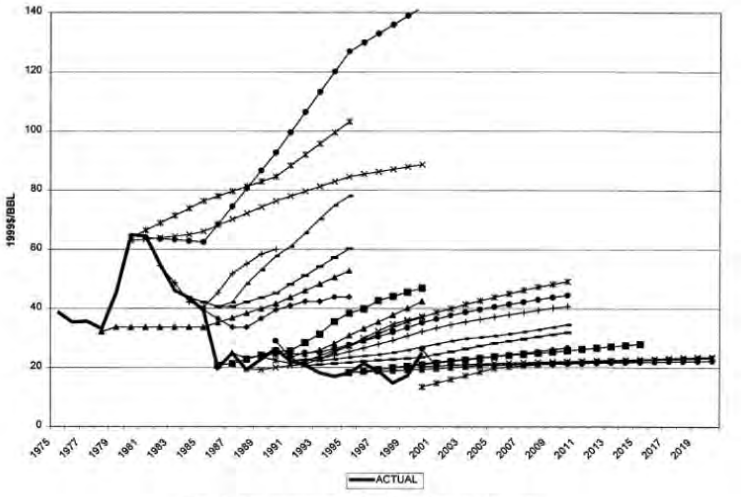


Fig. 1. The evolution of DOE oil price forecasts.

Source: Michael Lynch

The chart (Exhibit 8, prior page) we referenced comes from a paper by long-time energy consultant Michael Lynch that was published in the Quarterly Review of Economics and Finance in 2002. His article was essentially an update of a working paper he published in 1992 while at MIT's Center for International Studies.

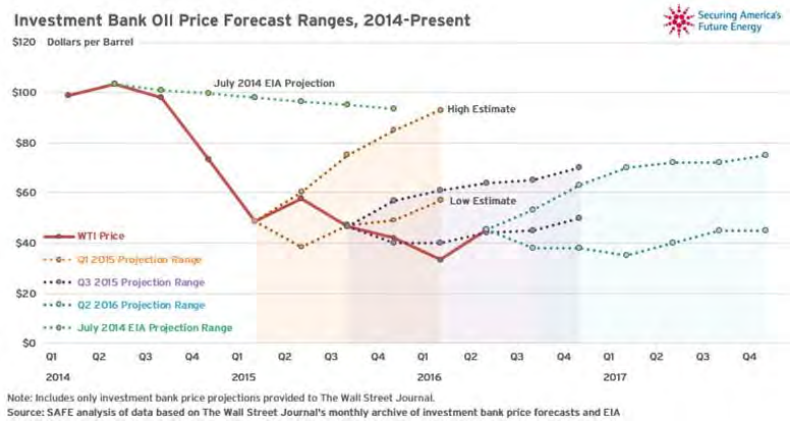
That forecast never contemplated the scenario of Saudi Arabia abandoning its traditional oil-price-support role; truly a Black Swan event

To provide a more contemporary view of the trials and tribulations of forecasting oil prices, Exhibit 9 shows what energy bankers have been thinking about the future of oil prices since 2014. As seen in the chart, at mid-year 2014, as oil prices were sliding, the U.S. Energy Information Administration's (EIA) view was that prices would continue to slowly decline until they reached $95 a barrel by year-end 2015. Of course, that forecast never contemplated the scenario of Saudi Arabia abandoning its traditional oil-price-support role; truly a Black Swan event.

The range of oil price forecasts went from wide to narrow and then back to wide – a sign of a lack of conviction

The next incorrect banker view came from the expectation for a V-shaped price recovery, starting during the first half of 2015, which would return oil prices to between $65 and $95 a barrel by early 2016. When prices failed to follow that forecast, the conventional view then shifted to year-end 2016 oil prices reaching between $50 and $70 a barrel. The bankers' mid-year 2016 oil price view then predicted either a lightly improved price of $45 a barrel or a greatly improved price of $75. Notice that the range of oil price forecasts went from wide to narrow and then back to wide – a sign of a lack of conviction.

Exhibit 9. Energy Bankers Fail To Forecast Oil Prices



Source: SAFE

Oil industry decision-makers need to understand that their forecasts can be "wildly wrong," and that "knowing why they might go wrong is crucial."

What does that lack of conviction say about future oil prices? The point of Mr. Lynch's research is not to argue that it is impossible to forecast oil prices, but rather that oil industry decision-makers need to understand that their forecasts can be "wildly wrong," and that "knowing why they might go wrong is crucial." This applies to bankers, too. Mr. Lynch went on to point out that "[t]he market has repeatedly moved in ways thought impossible, on both the high and low side, and too many oil companies have suffered because their

strategies reflected either a narrow vision of future prices or, quite simply, senior executives' wishes."

They often then discover that the trend they just jumped on was actually a peaking fad, and that they had overpaid for the privilege of participating, and as a result, suffered significant financial underperformance

As we know, 'wishing and hoping' may be a business strategy, but probably not a successful one. In fact, it is often a dangerous strategy. It can be compared to chasing the last industry fad, something risk-assessing-author Nassim Taleb warned about in his book The Black Swan: The Impact of the Highly Improbable when he wrote, "Missing a train is only painful if you run after it!" How many companies across all industry lines over the years have suffered from being late to embrace an evolving trend? They often then discover that the trend they just jumped on was actually a peaking fad, and that they had overpaid for the privilege of participating, and as a result, suffered significant financial underperformance. A recent example may be the American natural gas shale revolution whose production success ultimately decimated gas prices making further drilling and production efforts unprofitable, which destroyed a number of exploration and production companies who gambled late on this trend.

The success of the natural gas shale revolution also encouraged drillers to exploit oil shale (tight) plays

The success of the natural gas shale revolution also encouraged drillers to exploit oil shale (tight) plays, with what turned out to be equally as impactful results. Between 2006 and 2015, U.S. oil production doubled with tight oil contributing about 90% of that success. Unfortunately, the additional U.S. oil output wound up adding to the global oil supply glut that ultimately led to the collapse in oil prices for the past two years.

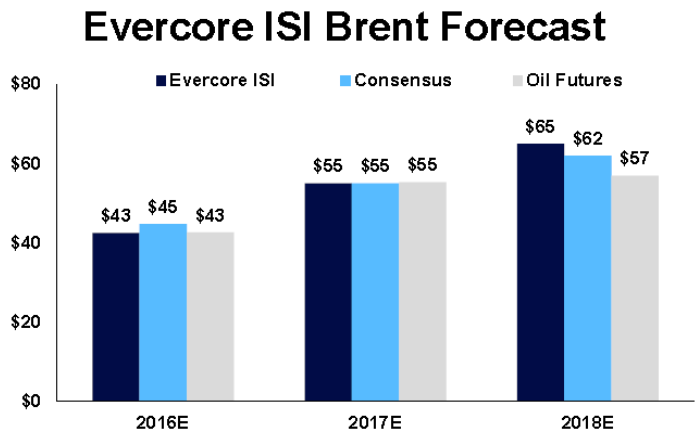
The combined output cut, to begin January 1, 2017, if adhered to, will accelerate the rebalancing of the global oil market

On November 30th, the energy and business world was stunned when the members of the Organization of Petroleum Exporting Countries (OPEC) were able to reach an agreement to cut their combined production by 1.2 million barrels a day. The more amazing development was that OPEC could convince a handful of non-OPEC oil producers follow suit. The combined output cut, to begin January 1, 2017, if adhered to, will accelerate the rebalancing of the global oil market, pulling it forward by possibly as much as half a year, or to the first half of 2017 rather than year-end. But what might that mean for oil prices?

His optimistic view of the crude oil market and therefore ebullient 2017 and 2018 earnings outlook for the major integrated oil companies he researches

A new report from oil analyst Doug Terreson of the investment banking firm Evercore ISI, discusses his optimistic view of the crude oil market and therefore ebullient 2017 and 2018 earnings outlook for the major integrated oil companies he researches. As all good oil producer analysts do in their reports, Mr. Terreson lays out his bullish case by focusing on the global supply and demand for oil and how the production cuts mean rising future oil prices that drive his companies' improved earnings outlooks. We were intrigued by a chart in the report that showed Mr. Terreson's oil price forecasts for 2016, 2017 and 2018, along with the consensus view of Wall Street oil analysts and what the forward oil futures prices suggest.

Exhibit 10. 2017 And 2018 Oil Prices Forecasts Are Close



Source: Bloomberg, Evercore ISI Energy Research
Source: Evercore ISI

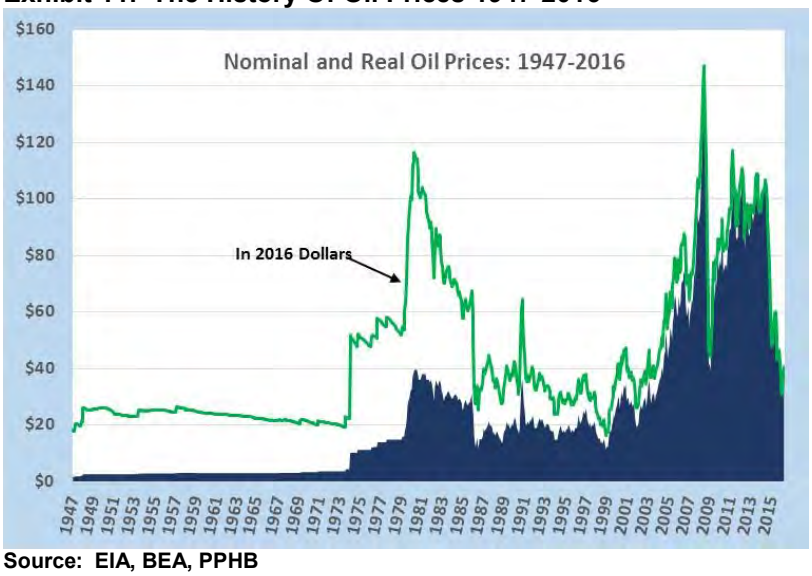
The certainty of locking-in their return now, especially after the past two years' experience, makes sleeping that much easier

While not totally surprising, all three forecasts for 2017 arrive at the exact same price - $55 a barrel. In 2018, Mr. Terreson is more bullish with an average oil price forecast of $65 a barrel, while the consensus calls for a $62 price and the futures market is predicting $57 a barrel. Some people suggest the reason the futures price for 2018 is lower is due to the hedging activities of oil producers who are happy to lock-in $57 a barrel for new, or even existing output that has a production cost in the low $40s a barrel, or possibly even lower. Yes, the extra $5-$8 a barrel that they are supposedly giving up by not waiting to sell their output until 2018, assuming Mr. Terreson and the rest of the oil analysts are correct in their projections, would lead to more cash flow and profits, but the certainty of locking-in their return now, especially after the past two years' experience, makes sleeping that much easier.

We were never sure what "lower" meant in terms of future oil prices, nor what "longer" meant in terms of time

One of the oil industry leaders who led the charge to right-size his company quickly after the 2014 year-end oil price collapse was Robert Dudley, the CEO of BP plc (BP-NYSE). Early in 2015, Mr. Dudley was quoted saying that his company and the entire industry needed to prepare for a "lower for longer" oil price environment. We always thought that was a catchy phrase – much like Madison Avenue advertising firms would have turned out. However, we were never sure what "lower" meant in terms of future oil prices, nor what "longer" meant in terms of time. Recently, BP has become much more active in positioning itself for growth with deals such as its investment in an onshore oil concession in Abu Dhabi, investments in world-class natural gas fields offshore the coasts of Mauritania and Senegal with Kosmos Energy Ltd. (KOS-NYSE), and an investment in ENI SpA's (E-NYSE) Zohr gas field off the coast of Egypt. These deals come after BP has drastically downsized largely due to the costs of its disastrous Macondo well blowout and oil spill.

Exhibit 11. The History Of Oil Prices 1947-2016

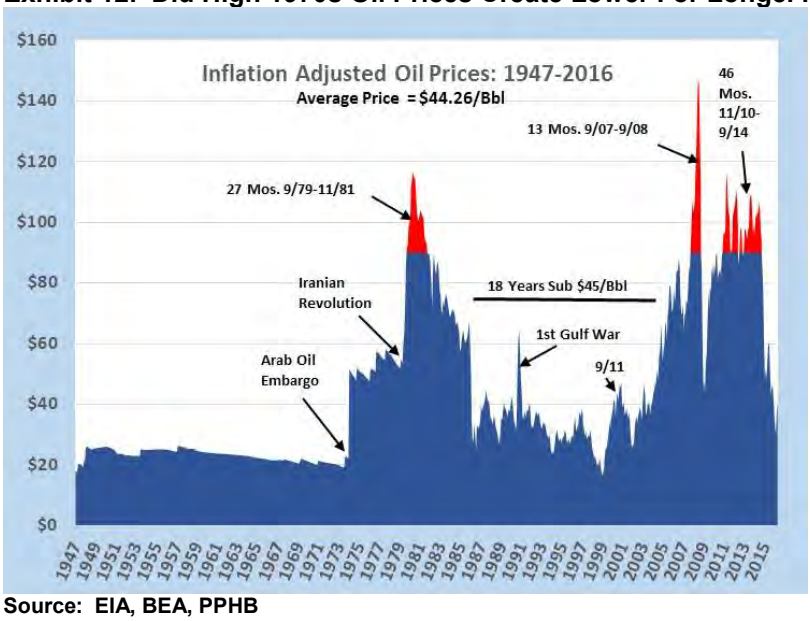


Source: EIA, BEA, PPHB

Oil prices in the 1970s, measured in 2016 dollars, were equally as elevated as those seen during the 2000s era of $100 a barrel prices

Mr. Dudley has recently said that the worst is over for the oil industry following two years of abnormally low oil prices. What exactly does that mean? Exhibit 11 shows monthly nominal U.S. oil prices and oil prices in 2016 inflation-adjusted dollars since 1947. What the chart does is highlight how oil prices in the 1970s, measured in 2016 dollars, were equally as elevated as those seen during the 2000s era of $100 a barrel prices.

Exhibit 12. Did High 1970s Oil Prices Create Lower For Longer?



Source: EIA, BEA, PPHB

In the 1970s, U.S. crude oil prices spent 27 months above that $90 a barrel threshold before collapsing

What is most telling about the modern history of inflation-adjusted oil prices is that if we assume any oil prices greater than $90 a barrel were excessive and contributed to future industry challenges, then looking at the experience in the 1970s compared to recent times is quite enlightening. In the 1970s, U.S. crude oil prices spent 27 months above that $90 a barrel threshold before collapsing during what eventually nearly destroyed OPEC during the mid-1980s.

The scary scenario is whether Mr. Dudley's "lower for longer" mantra reflects his vision of a future period similar to the post-1970s boom

In more recent times, oil prices were above $90 a barrel for 13 months from September 2007 to September 2008 before crashing to the low-$40s a barrel during the financial crisis and subsequent recession. Oil prices quickly recovered, however, and climbed back above $90 a barrel and remained there for 46 months before dropping below in 2014. The scary scenario is whether Mr. Dudley's "lower for longer" mantra reflects his vision of a future period similar to the post-1970s boom when oil prices traded for 18 years below $45 a barrel in 2016 inflation-adjusted terms.

The problem was that oil price volatility did not help lift oil prices anywhere near prior peak prices

As Exhibit 12 (prior page) shows, that 18-year span of "lower" was a lot "longer" than anyone expected. In fact, many people assumed nominal oil prices during that period were the "new normal" for the industry, even though there were several significant geopolitical and economic events that caused oil prices to briefly bounce above the $45 adjusted price. The 1st Gulf War, the 1998 Asian currency crisis and the 9/11 attacks, along with their associated economic recessions, are perfect examples of oil price-influencing events during the extended low-oil price period that had people convinced that oil prices were highly volatile. The problem was that oil price volatility did not help lift oil prices anywhere near prior peak prices, other than the brief spike immediately before the start of the 1st Gulf War.

Maybe we are destined to be condemned to live in a world where oil prices trade in the range of $45-$55 a barrel for decades

Given this history, we wonder whether many years in the future oil market researchers will look back on this era and remark how prescient Mr. Dudley was in his mantra of "lower for longer." Maybe we are destined to be condemned to live in a world where oil prices trade in the range of $45-$55 a barrel for decades, with only occasional and very brief excursions above or below that range as a result of geopolitical events. It is probably best that oil industry executives don't run to catch the last train of $70 to $80 a barrel oil price forecasts. Planning to live in a world of moderate oil prices will prove most rewarding, and certainly less stressful.

Electric Vehicles Get Environmental Boost But Fail CO2 Test

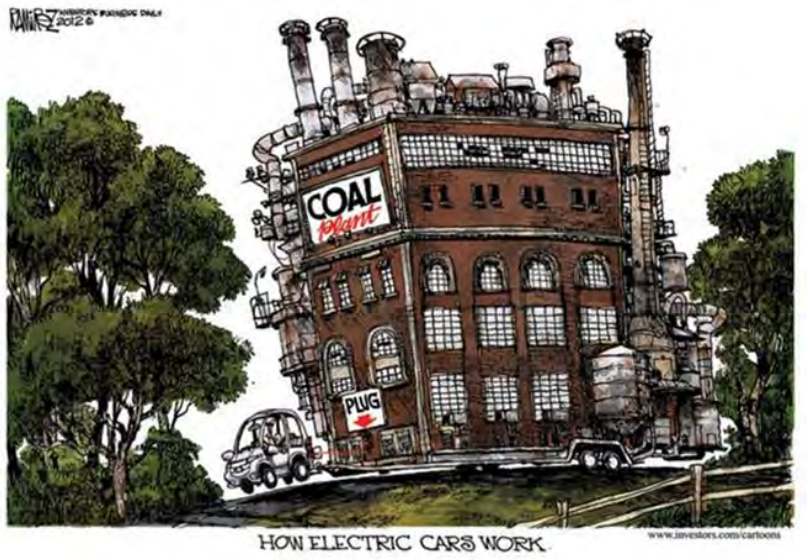
There is little doubt that EVs are playing a growing role in the future transportation system

We have written extensively about electric vehicles (EVs) in recent issues – probably more than we expected to write and maybe more than our readers expected to read. There is little doubt that EVs are playing a growing role in the future transportation system both in the United States and globally. We have received various responses from readers that EVs are not quite the environmentally-friendly

transportation option many people suggest, because they are powered by electricity and just how "green" that power is depends on where it is produced. We have never made that a major point of our discussions about EVs, but we have used that point when discussing the evolution of our energy supply beyond fossil fuels. We often use the cartoon below, suggesting that EVs are essentially extensions of power plants, and that's why it is important to understand what is fueling the generation of that electricity.

Suggesting that EVs are essentially extensions of power plants

Exhibit 13. EVs Seen As Extension Of Power Plants



Source: ***Investors Business Daily***

The argument has been made repeatedly that just how green an EV is depends on what fuels the power plant supplying the electricity. If it is a renewable fuel – wind, solar, biomass or hydro – then the EV is quite environmentally-friendly. On the other hand, if the electricity comes from a coal-fired or natural gas-powered plant, then the EV is much less environmentally-friendly. In fact, it may be downright dirty.

If the electricity comes from a coal-fired or natural gas-powered plant, then the EV is much less environmentally-friendly

With the election of Donald Trump as the nation's 45th president, there are signs environmental restrictions on fossil fuels will be loosened and more room will be made for fossil fuels. That will be a significant shift in the recent trends for environmental and energy regulation. Whether it significantly alters the current trajectory for the dirtiest of our fossil fuels – coal – remains to be seen. Clearly, short of an outright ban on renewable energy plants, the current backlog of new, cleaner power plants will not change, so our near-term energy mix will continue to shift toward more renewable fuels. The issue for the energy industry is whether the economic trends in place boosting renewable fuels are altered and slow down the pace of additions of new renewable fuel plants. That will partially depend on whether current renewable fuel mandates and subsidies are

Short of an outright ban on renewable energy plants, the current backlog of new, cleaner power plants will not change, so our near-term energy mix will continue to shift toward more renewable fuels

renewed once they reach their expiration dates, or even if they are outright cancelled early.

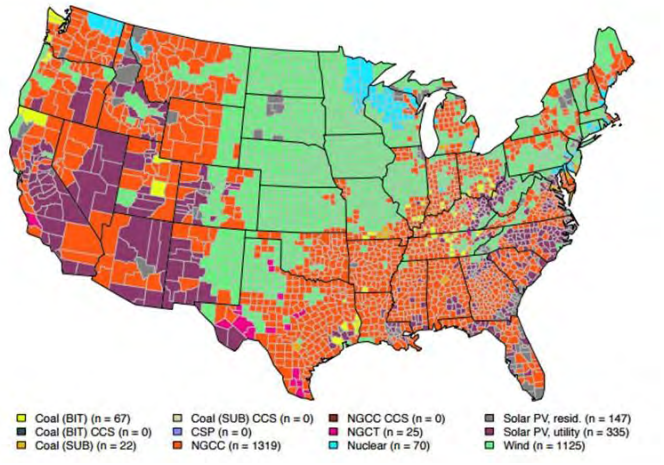
Standardized cost estimates provide a means to assess the impact on different fuel sources of various environmental policies

At the present time, businessmen, energy executives and consumers are struggling to understand the true economics of electricity. Analysts have strived to produce cost estimates for electricity produced by different fuels in such a way that they can be analyzed on the same basis. Standardized cost estimates provide a means to assess the impact on different fuel sources of various environmental policies. The process is called levelized cost of electricity. This tool enables direct comparison of electricity costs from power plants fueled by either fossil fuels or renewables. One drawback from this tool is that it assumes every kilowatt of power generated has the same value to consumers regardless of when during the day it is produced. It ignores the reality that during summer days in the southern regions of the United States, electricity to power air conditioners in the afternoon when temperature reach their highest levels is of greater value to consumers than during the middle of the night when temperatures drop.

These interactive web sites enable the user to compare and contrast the cost of electricity technologies by manipulating variables important to the determination of the cost of electricity

Levelized cost of electricity can be a powerful tool enabling consumers and utility executives to weigh the value of a wind turbine or a solar array against that of a nuclear powered or natural gas fired plant. The Energy Institute at the University of Texas, Austin, has created two online calculators that enable a user to examine electricity costs by fuel source, county-by-county, across the entire country. It also enables the comparison of power costs in a county by technology type. These interactive web sites enable the user to compare and contrast the cost of electricity technologies by manipulating variables important to the determination of the cost of electricity produced by a power plant utilizing specific fuels. The latest issue of *Popular Mechanics* magazine contains an article about these calculators.

Exhibit 14. What Electricity Technology Is Cheapest



Source: ***Popular Mechanics***

The large green swath through the central portion of the country represents areas where wind energy is the cheapest source of electricity

What one finds in looking at the map is the large swaths of the United States were certain electricity-generating sources dominate. For example, the large green swath through the central portion of the country represents areas where wind energy is the cheapest source of electricity. There are also areas in the Northeast where wind provides low-cost power, although that is not where wind power is heavily represented.

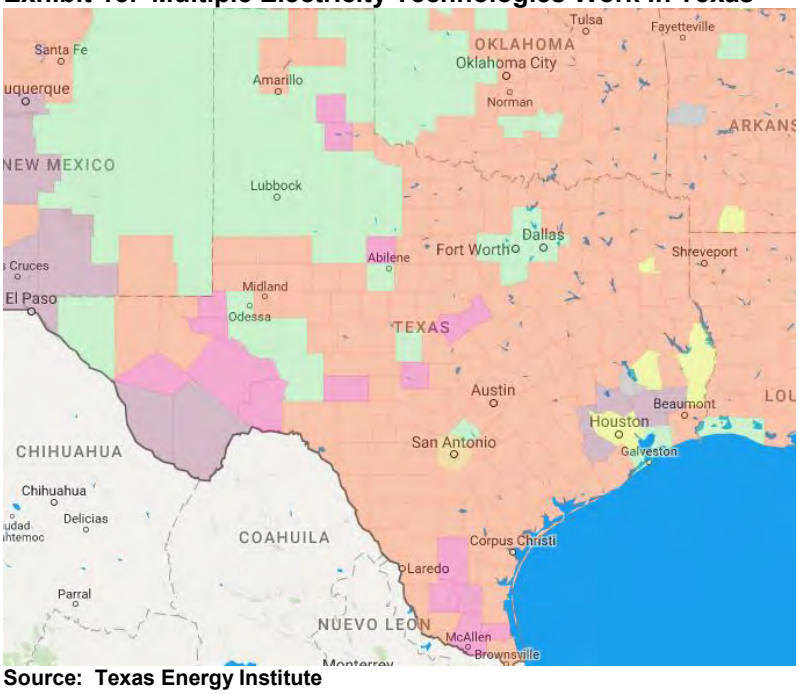
Those availability zones represent the Energy Institute's predictions of the ability to build a plant using a given technology

We were interested in understanding what these calculators showed for the cost of electricity and its favored technology across the State of Texas. Exhibit 15 shows a map extract focused on Texas. It shows that there are multiple electricity generating technologies that are favored in the state depending on the geographic location. The colors of the various counties represent the type of energy source that is the cheapest in terms of availability. Those availability zones represent the Energy Institute's predictions of the ability to build a plant using a given technology. It does not necessarily mean that it is the cheapest power source available in the county, which can only be examined using a second calculator the Institute operates.

Houston sits in a yellow area, meaning that bituminous coal from Wyoming would be the least-costly power source

We were surprised to see in the Texas map that Houston sits in a yellow area, meaning that bituminous coal from Wyoming would be the least-costly power source to build and such a plant could be built there if a power company wanted to. If you go to Dallas and Ft. Worth, wind (green) is the least-costly option that is also feasible to build. When one goes to El Paso on the western tip of the state, utility-scale photovoltaics (gray) is the least-costly option.

Exhibit 15. Multiple Electricity Technologies Work In Texas



Source: Texas Energy Institute

Electricity produced from a combined-cycle turbine powered by natural gas is actually the cheapest power at $101.03 a megawatt-hour

Examining a few counties in Texas to see how they stack up in terms of the cheapest source of energy produces interesting anomalies. Part of the difference is due to the nature of the power sources and their performance. For example, while Houston is in Harris County and stands out on the map for sitting in a sea of yellow representing coal, electricity produced from a combined-cycle turbine powered by natural gas is actually the cheapest power at $101.03 a megawatt-hour (MWh). The theoretical natural gas plant has a 47.0% capacity factor (how much time it is putting out electricity) and a capital cost (the investment necessary to build the plant) is $943.48 per kilowatt (kW) of capacity. Contrast those economics against a plant using Wyoming bituminous coal at $238.52/MWh with a 59.9% capacity performance, but it carries a $4,357.74/kW capital cost estimate, or four times the investment for the natural gas plant. Using subbituminous lignite coal didn't produce much of a difference given it had a cost of $241.65/MWh along with similar capacity and capital costs estimates as the bituminous coal plant.

After natural gas, the next cheapest source of electricity in Houston was nuclear at $144.29/MWh

After natural gas, the next cheapest source of electricity in Houston was nuclear at $144.29/MWh with an amazing 90.8% capacity, yet not surprisingly, an extremely high $7,725.79/kW capital cost estimate. Other electric power options include onshore wind at $164.48/MWh, yet a measly 18.9% capacity factor and a $1,749.15/kW capital cost figure. Following wind was utility-scale solar power at $184.26/MWh, with an 18.7% capacity factor and a $1,753.30/kW capital cost. The most expensive electricity option for Houstonians would be residential solar power at a cost of $344.10/MWh, yet only a 15.6% capacity factor along with a $3,275.90/kW capital cost estimate.

Dallas County, which is colored green for wind, actually finds natural gas to be the least-costly electricity option

Other locations in the state produce similar results. Dallas, sitting in Dallas County, which is colored green for wind, actually finds natural gas to be the least-costly electricity option at $101.85/MWh (46.1% and $962.92/kW) while wind power was $126.14/MWh (25.2% and $1,789.49/kW). Other fuel options were more expensive, such as utility-scale solar power at $179.20/KWh (23.3% and $1,793.57), lignite coal at $204.26/MWh (74.7% and $4,445.04), and residential solar at $335.95/MWh (16.3% and $3.351.15).

El Paso County, home to the City of El Paso, located in the westernmost tip of Texas, where the map in Exhibit 15 shows photovoltaic technology as the best option for new power plants, finds that combined cycle natural gas is the least costly source of electricity now

El Paso County, home to the City of El Paso, located in the westernmost tip of Texas, where the map in Exhibit 15 shows photovoltaic technology as the best option for new power plants, finds that combined cycle natural gas is the least costly source of electricity now at $104.51/MWh with 46.5% capacity rating and a capital cost of $1,015.01/kW. Utility-scale solar power is much more expensive at $141.82/MWh and capacity at 25.3% and $1,850.33/kW capital cost, and residential solar is nearly twice as expensive at $270.43/MWh (20.7% capacity and $3,457.30/kW). Some people believe that wind power should be a strong competitor for low-cost electricity in El Paso, but the Energy Institute calculator

puts its cost at $144.14/WMh with a 22.6% capacity rating and $1,844.13/kW capital cost.

There is no power source that is the clear winner in the State of Texas

The bottom line of this analysis is that there is no power source that is the clear winner in the State of Texas. This is interesting given that Texas has recently become the largest wind energy generator in the nation, yet in numerous locations natural gas remains the least-costly alternative for producing electricity. Therefore, Texans driving EVs should understand that just because Texas generates a substantial amount of wind electricity, in most cases fossil fuels are still the cheapest method of creating electricity and are more likely to be powering up their cars than green energy. Therefore, EVs are not quite as "green" as their owners would like everyone to believe.

Recent Arctic Blast A Reminder Of Perils Of Cold Weather

The study's conclusion was that extreme temperatures of either heat or cold were responsible for less than 1% of total mortality.

Last week, *New York Times* personal health columnist Jane Brody wrote about the perils, especially for older people, of the upcoming winter. Her column focused on a study published in *The Lancet* in July 2015 that analyzed more than 74 million deaths and calculated mortality attributable to heat and cold in a number of countries. Included in the study were Australia, Brazil, Canada, China, Italy, Japan, South Korea, Spain, Sweden, Taiwan, Thailand, Britain and the United States. The study's conclusion was that extreme temperatures of either heat or cold were responsible for less than 1% of total mortality. The authors of the study wrote that with regard to temperatures, "Heat stroke on hot days and hypothermia on cold days only account for small proportions of excess deaths."

7.3% of "temperature-attributable deaths" occurred on days when temperatures were below the optimum temperature, while only 0.4% of deaths were associated with higher than optimum temperatures

Less extreme temperatures, however, contributed to many more deaths, and temperatures were determined to have played a direct or indirect role in 7.7% of deaths overall. To determine the significance of temperatures related to deaths, an "optimum temperature" was calculated for each country. This is the temperature in a country that is associated with its lowest death rate. What the study's authors found was that 7.3% of "temperature-attributable deaths" occurred on days when temperatures were below the optimum temperature, while only 0.4% of deaths were associated with higher than optimum temperatures.

Most public health plans focus on heat waves, even though the death rate during cold periods exceeds that experienced during heat waves

As Ms. Brody pointed out, most public health plans focus on heat waves, even though the death rate during cold periods exceeds that experienced during heat waves. She also highlighted that minimal attention is paid to the life-threatening risks associated with everyday cold temperatures. So what deaths are we talking about? The overwhelming majority of cold-weather deaths are not associated with vehicular accidents, falls on icy walks or other snow-related activities. The deaths are associated with the more traditional leading killers – heart disease, stroke and respiratory disease – and with people aged 75 or older.

Milder winters would save more lives and have a greater impact on mortality than hotter summers.

One such study, conducted by two researchers at Queen Mary's School of Medicine and Dentistry at the University of London and published in 2004 in Southern Medical Journal, concluded that in nearly all countries outside of the tropics, "cold-related deaths are far more numerous than heat-related deaths." The researchers found this observation to be true for those countries as warm as Southern Europe or North Carolina. The key observation is that with respect to minimizing deaths everywhere but in the tropics, milder winters would save more lives and have a greater impact on mortality than hotter summers.

The British researchers found that about half the cold-related deaths result from blood clots that cause heart attacks and strokes

The British researchers found that about half the cold-related deaths result from blood clots that cause heart attacks and strokes. This is because exposure to cold causes blood to become more concentrated, which reduces blood flow to the skin as the body is attempting to reduce the loss of heat. What happens to the body is that this extra blood concentrates in the central parts of the body, and to counter the excess volume, salt and water move from the blood into the neighboring tissue leaving behind greater levels of red cells, white cells and platelets and fibrinogen that thicken the blood and make is more susceptible to clotting. Blood pressure also tends to rise with exposure to cold temperatures, and we know, blood pressure is closely associated with heart attacks and strokes.

It would seem that the evidence showing dramatically greater death rates from colder rather than warmer temperatures should have more of an impact on the climate change debate if researchers are truly committed to following sound science

Ms. Brody's column went on to detail and explain other personal health matters associated with living through cold winter weather – staying indoors that boost exposure to respiratory diseases, increased illnesses such as the flu, and more accidental deaths – that contribute to the increased death rates. Given all this data, it is somewhat surprising that within all the debate about the impact of global warming on humans, the idea that warming temperatures might actually reduce cold-related deaths is largely ignored. It would seem that the evidence showing dramatically greater death rates from colder rather than warmer temperatures should have more of an impact on the climate change debate if researchers are truly committed to following sound science. Could it be that since this data doesn't support the conclusions about the dangers of global warming is why it is ignored?

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