PPHB
ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

May 29, 2018

Allen Brooks
Managing Director

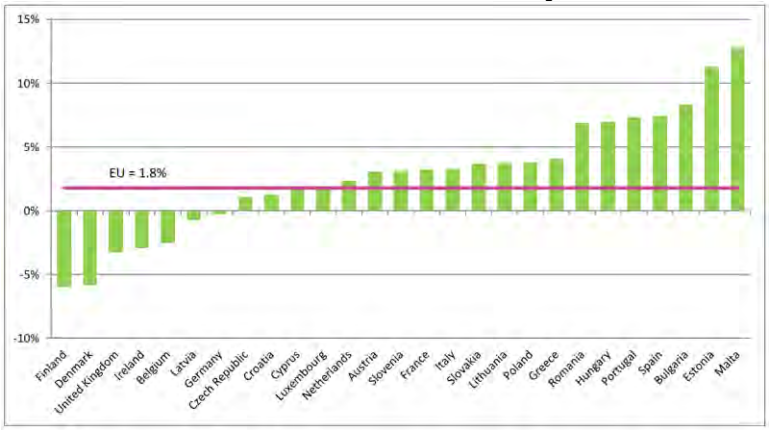
Note: *Musings from the Oil Patch reflects an eclectic collection of stories and analyses dealing with issues and developments within the energy industry that I feel have potentially significant implications for executives operating and planning for the future. The newsletter is published every two weeks,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

A Europe Surprise: It Is Losing The Carbon Emissions Battle

The organization's members' carbon emissions increased last year by 1.8% over those of 2016

Eurostat, the statistical agency of the European Union, reported that the organization's members' carbon emissions increased last year by 1.8% over those of 2016. The performance of the individual countries was mixed. Among the five countries accounting for 10% or more of total EU emissions, three were up significantly, one was essentially flat, and one was down materially. Germany, which accounts for 23% of total emissions, saw a minor decline of 0.2%. On the other hand, the United Kingdom, with 11.2% of total emissions, posted a 3.2% decline. Poland and France, each representing 10% of EU emissions, saw their emissions rise by 3.8% and 3.2%, respectively. Italy with its 10.7% share of EU emissions, experienced a 3.2% year-over-year increase.

Exhibit 1. EU Carbon Emission Rose Nearly 2% In 2017



Source: Eurostat

Spain and the Netherlands, the other two countries with meaningful shares of total EU emissions at 7.7% and 5.0%, respectively, also

exceeded the organization's average increase. Spain's emissions grew by 7.4% over 2016, while the Netherlands increased by 2.3%. The overall performance of the EU, and that of leading emissions emitters raises questions about the ability of the continent to meet its long-term climate change goals, and whether that would impact the terms of the Paris Agreement.

The stumbling block seems to be the demand, as agreed in the Paris Agreement, for developed economies to pay $100 billion a year to developing economies to help them transition to clean energy

The recent UN environmental meeting in Bonn, Germany, charged with drafting text for the operational manual for implementing the Paris Agreement that is to be approved at the COP24 meeting in December, ended in failure, forcing the scheduling of a second session this summer. The stumbling block seems to be the demand, as agreed in the Paris Agreement, for developed economies to pay $100 billion a year to developing economies to help them transition to clean energy. Since many of the developed countries are broke, there is a question of where this money will come from. The U.S., under President Barack Obama, committed to give $3 billion in funds, but only $1 billion was paid before President Donald Trump pulled the country out of the deal.

UN officials confirmed in 2017 that $100 billion would be needed, but it would have to rise to $400 billion a year by 2020 if the reduction in carbon emissions is to be achieved. The spat in Bonn highlights what many people, who opposed the Paris Agreement, believed underlay the climate change push, which was that it was really about redistributing global wealth.

Germany has shut down its nuclear power plants and is adopting renewables, which has caused residential power prices to soar and energy poverty rates among its residents to climb

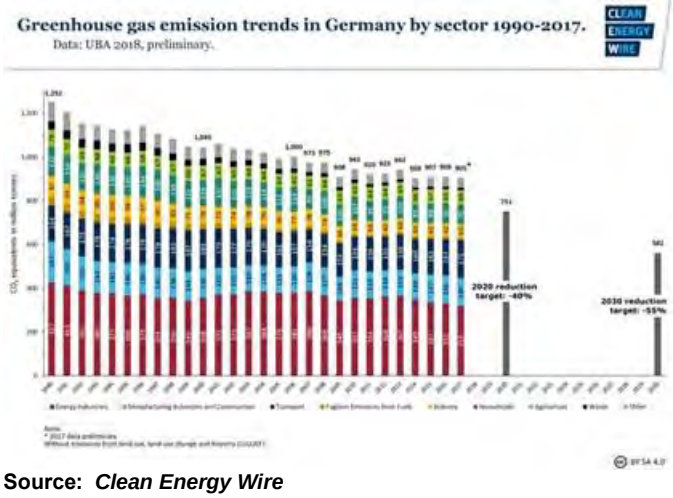
The conflicts inherent in the climate change movement increasingly are becoming evident. For example, Germany has shut down its nuclear power plants and is adopting renewables, which has caused residential power prices to soar and energy poverty rates among its residents to climb. The government's effort to create a commission to deal with the planned shutdown of all the country's coal-fired power plants is running into problems. The commission's establishment has been postponed for a second time and will now be addressed at the next cabinet meeting scheduled for May 30th. The government assures that the delay will not prevent completion of the report by year-end.

Exiting coal-generated power is mandatory for Germany to reach its goal of becoming largely carbon emission neutral by 2050

The coal exit commission, otherwise known as the Special Commission on Growth, Structural Economic Change and Employment, is supposed to bring together policymakers, industry, labor unions, and possibly environmental non-governmental organizations (NGOs) to establish a roadmap and a firm date for ending coal-fired electricity generation. Exiting coal-generated power is mandatory for Germany to reach its goal of becoming largely carbon emission neutral by 2050.

The commission's strategy paper acknowledges the long-term carbon emissions reduction goal and confirms the 2030 target of a 55% reduction. However, the paper also says that climate action

Exhibit 2. Germany's Carbon Emissions Failing Target Cut



Source: ***Clean Energy Wire***

must be "harmonized" with economic development and social considerations. According to media reports, there was intense fighting over the commission's structure, with both anti-coal mining area residents and coal mining states demanding a voice. At the same time, environmental NGOs are insisting that a rapid ending of coal use is possible without risking energy supply. Also, the economy and environmental ministries wrestled with the commission's leadership.

Defenders of coal have estimated that exit of all lignite production will require over €6 billion ($7 billion) in compensation payments and can only happen "in the long run"

The commission leadership struggle is a microcosm of the battle between the coal interests and mining-state governments worried about the employment impacts in their regions, versus the environmentalists who are calling for immediate shutdowns of coal power plants with a total capacity of at least seven gigawatts by 2020, or the equivalent of one-third of Germany's total lignite capacity. As it is, due to the lack of progress in reducing its carbon emissions, Germany will miss its 2020 target by a wide margin. Defenders of coal have estimated that exit of all lignite production will require over €6 billion ($7 billion) in compensation payments and can only happen "in the long run."

At the present time, Germany has only about 30,000 coal workers, a fraction of the number employed in the nation's wind industry. However, these coal workers are concentrated in three German states, making the transition away from coal that much more difficult.

Exhibit 3. Few Coal Workers, But Concentrated

Source: ***Clean Energy Wire***

After years of steady declines, new passenger cars registered in 2017, on average, emitted 0.4 grams of CO2 per kilometer more than in 2016

Another issue bedeviling Europe and its carbon emissions goal is the revelation that there was no improvement in average carbon dioxide emissions among new cars sold in 2017. Data from the European Environmental Agency (EEA) showed that after years of steady declines, new passenger cars registered in 2017, on average, emitted 0.4 grams of CO_2 per kilometer more than in 2016, rising to 118.5 g CO_2/km. Since monitoring began in 2010, emissions have decreased by 22 g CO_2/km driven. This figure highlights the challenge the European auto industry faces in reaching the EU's target for carbon emissions of 95 g CO_2/km in 2021, a 20% reduction from 2017 levels.

Gasoline-powered car average fuel efficiency remained constant for the past two years, while diesel car fuel efficiency increased by 1.1 g CO2/km between 2016 and 2017

Several other market trends were noted in the auto data, further showing shifts underway as a result of the diesel emissions cheating scandal and the push for electric vehicles (EV). For the first year since monitoring began, gasoline-powered cars represented the largest market share, at almost 53%, versus diesel-powered cars, at 45%. Registrations of diesel cars fell in every EU member country with the exception of Italy and Denmark. Additionally, the difference between average fuel efficiency of gasoline-powered cars (121.6 g CO_2/km) versus diesel-powered ones (117.9 g CO_2/km) has narrowed. That is because gasoline-powered car average fuel efficiency remained constant for the past two years, while diesel car fuel efficiency increased by 1.1 g CO_2/km between 2016 and 2017.

It is also noteworthy that EV sales in 2017 grew by 42%, with battery-electric vehicles (BEV) rising by 51%, as plug-in electric vehicle (PHEV) sales increased by 35%. France led Germany as the top two countries in BEV sales. The problem is that despite these record sales numbers, the share of EVs among total auto

sales in 2017 was only 1.5%. This comes as the EU auto industry experienced a 3% increase in total sales for 2017, rising to 15.1 million vehicles, the highest number since 2007.

Kicking the ball down the road and focusing on the new goals makes it easier to avoid explaining why earlier targets were missed

The carbon emissions challenges being faced by the EU spotlight a problem for the climate change movement. Getting to a decarbonized world, in order to stop global temperatures from rising and creating a climate disaster, will necessitate significant costs and economic disruptions. In addition, it will necessitate the commercialization of technology for capturing and storing carbon. We fully expect to see European governments announcing revised carbon reduction targets, as their inability to reach their 2020 targets becomes clear. Kicking the ball down the road and focusing on the new goals makes it easier to avoid explaining why earlier targets were missed. Next year will likely usher in an era of environmental mea culpas from Europe.

Transitioning From Texas To Rhode Island For The Summer

This trip, however, lasted seven days, and involved a family event and some touring on the way north

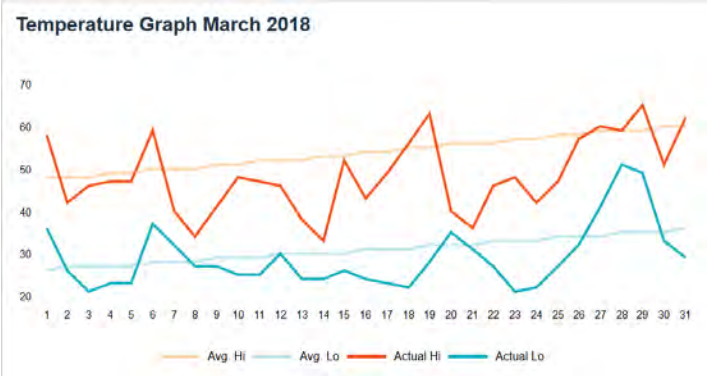
Transitioning from our home in Houston to our summer home in Rhode Island is always a challenge. The challenge is primarily the 1,900-mile drive, and the fact we are usually striving to minimize the time on the road to either three days and two nights, or two days and one night. Our decision depends on when we are ready to leave, which is often dictated by my business schedule and traffic conditions, such as weather, traffic, road construction, and major accident slowdowns. This trip, however, lasted seven days, and involved a family event and some touring on the way north.

One of the primary experiences our transition provides is climate change – no not that climate change. This one involves the fact that we were leaving warm Houston and going to the cooler temperatures of New England. This year, the disparity was a real shock. We left 80^{o}-90^{o} temperatures in Houston, although for the previous three days I had been in Calgary, but we stayed in that temperature range for the first four days, before experiencing cooler weather and rain. During the first several days at our summer home, it has been long pants, long sleeve shirts and coats, as temperatures were in the 40^{o}s to low-60^{o}s, and more rain.

This weather pattern has meant we are getting another full pollen season – great for our sinuses!

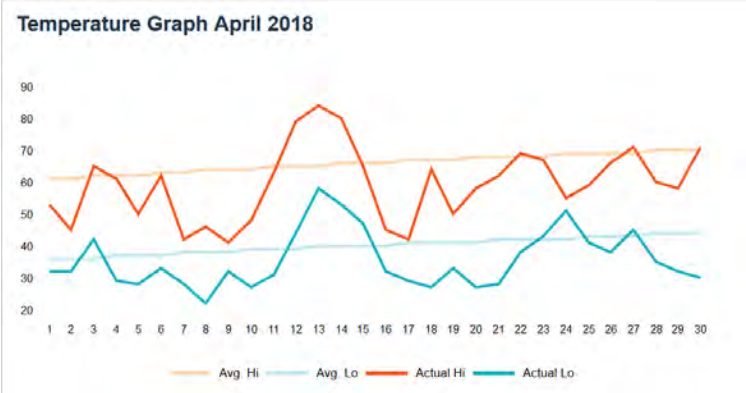
New England has experienced a cool spring as evidenced by Exhibits 4 and 5 (next page). The first half of May was warmer than average (Exhibit 6, next page), but the forecast called for below-average temperatures heading into Memorial Day weekend, and that is what has happened. This weather pattern has meant we are getting another full pollen season – great for our sinuses!

Exhibit 4. A Cool March For New England



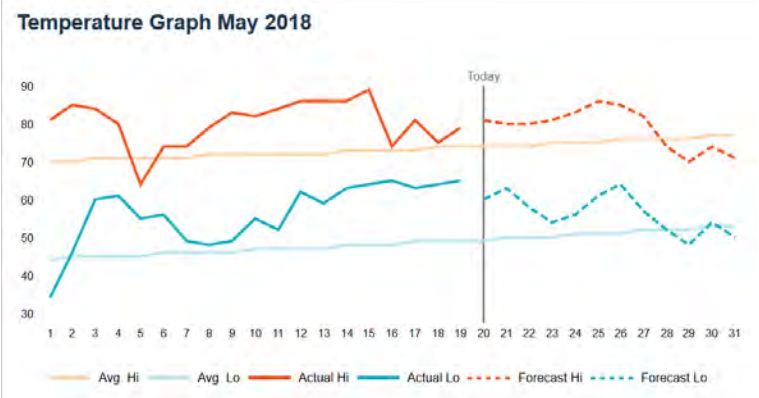
Source: Accuweather.com

Exhibit 5. April Wasn't Much Warmer In New England



Source: Accuweather.com

Exhibit 6. Warm Weather Arrives In New England



Source: Accuweather.com

We expect our cars to be covered in green pollen in a matter of days

We did notice that after our first two days in Rhode Island, the warm early May days has resulted in the trees leafing out and the flowering trees beginning to bloom. We expect our cars to be covered in green pollen in a matter of days.

We also noticed that only the robins were in residence, as it has been too cool for the rest of the birds migrating north to arrive. We have one bird's nest under our deck that has been the birthplace for baby threshes for the past few years. No activity yet.

Her grandparents told her it was her decision, especially since neither of us had attended any of our college graduations

The first leg of our trip took us to Fort Worth where our daughter and her family live. Our visit coincided with our oldest granddaughter's graduation from TCU. Unfortunately, we were not able to get up there for the honor ceremony, but we were there for her celebratory brunch the following day. She then decided to ditch her graduation, as a last name beginning with 'P' meant a couple of hours of sitting, something she decided she didn't care to do. Her grandparents told her it was her decision, especially since neither of us had attended any of our college graduations.

Another issue caused by heavy truck traffic was highway trash of rubber treads from recapped truck tires that split apart

On Monday morning, we headed off on our journey north. An early departure helped avoid the Dallas morning rush-hour traffic. We then rolled on through eastern Texas and into Arkansas with its rolling pasture land housing horses, cattle and hay farms. After passing Dallas, truck traffic grew, presenting the challenge of managing our speed as trucks trying to pass slower ones caused extended traffic backups. This became a recurring issue as the truck traffic remained heavy on the east-west highways of I-30 and I-40. Another issue caused by heavy truck traffic was highway trash of rubber treads from recapped truck tires that split apart. Our front end became a casualty of one such recap as we had no place to go either right or left, so hoped we could straddle the rubber blob. The damage fortunately was not severe, as only part of the wind deflector under the bumper was dislodged, which our local auto body shop reattached in about 15 minutes.

We learned that tourism is the second largest industry in Nashville, with health care first

We spent our first night in Nashville where we rendezvoused for dinner with our granddaughter and her boyfriend who were heading to Cleveland to make arrangements for attending law school this fall. The next morning, we toured Nashville, including visits to the Ryman Auditorium – the home of the Grand Ole Opry from 1943 to 1974 – and the Country Music Hall of Fame and Museum. We couldn't get over the massive amount of new office and condo construction underway in downtown Nashville. We learned that tourism is the second largest industry in Nashville, with health care first.

As evening approached, we noticed truck stops and rest stops were overflowing

After lunch, we headed off to visit the TVA's Raccoon Mountain Pumped Storage Plant, located near Chattanooga, Tennessee. (There is more on this unique facility elsewhere.) From there, we headed north. As evening approached, we noticed truck stops and rest stops were overflowing. The large number of trucks parked at such stops in the early afternoon made us wonder whether the trucks were stuck awaiting completion of their mandatory rest periods, or if they had driven all night and the drivers were sleeping. We observed similar situations at truck stops and rest areas in Virginia. What was interesting, as we drove late that night, was the

large number of trucks still on the road. The evening truck traffic was greater than we experienced in recent trips, suggesting that maybe drivers were adjusting their routines to compensate for the lack of parking spaces at night. As trucks lined up along highway exits and entrances from rest areas, special truck stops and freeway exit and entry ramps, drivers may be deciding to drive through the night and sleep during the day when the parking areas are empty.

During the first two hours of the next day, trucks accounted for nearly three-quarters of all the road traffic

Once again, truck traffic was heavy. In fact, we estimated it at about 45% of all traffic traveling south. During the first two hours of the next day, trucks accounted for nearly three-quarters of all the road traffic, suggesting either more trucks on the road, or drivers adjusting their driving schedules. Maybe it meant fewer passenger cars were traveling at that time. Is this a sign of higher economic activity? We are guessing so.

Our peak price was $3.09 a gallon on the Connecticut Turnpike

Gasoline prices tracked progressively higher as we moved north. Only this time there was a more noticeable upward move once we crossed into Virginia. From pump prices in the $2.45-$2.66 a gallon range in Texas and Arkansas, we hit $2.75 in Tennessee, but $2.99 in West Virginia. Prices for regular gasoline were regularly above $3 a gallon from that point forward. Our peak price was $3.09 a gallon on the Connecticut Turnpike. Interestingly, gasoline prices fluctuated by 6-cents a gallon – higher in southern Connecticut, and then again near Rhode Island. Fortunately, we purchased our fuel in the middle of the state, at the cheapest price.

We did learn one thing about Connecticut drivers – they follow directions very well. As we entered I-95 in the state, there was an electronic highway sign stating that traffic would be slow between Exits 3 and 27. At one point, another sign said that Route 7 was seven miles ahead and would take 30 minutes. Later, another sign told us it would take 25 minutes to travel seven miles to Route 8. The time estimates proved accurate.

We concluded that when the drivers saw the word: DELAY, they assumed it was an instruction of how they were to drive

As we approached Exit 27, there was another highway sign warning drivers that the exit would be closed starting in three days. During the entire span of slow traffic, there were no accidents, signs of construction or lane closures. We concluded that when the drivers saw the word: DELAY, they assumed it was an instruction of how they were to drive.

The slow traffic followed our time in New Jersey where we were about the slowest car on the road, as we were only traveling about 12-miles above the posted speed limit. We were not surprised when a white Jeep SUV pulled up behind us, clearly hoping we would move over to let him pass. As we cast our eyes around looking for the right opportunity to move over, we glanced in the rearview mirror and noticed a white sign with green letters sitting in the Jeep's windshield window. As we signaled we were moving over to let the Jeep pass, we noticed the sign being removed. The sign said:

"Move Over." We guess this driver, a NJ resident, was used to "slow" cars, so the sign was his form of communications.

That was the fewest number of police we have observed in recent years while making this nearly 2,000-mile drive

Among notable observations were: Out of five days of driving, we saw only one policeman during each of the first four days, but five on the final day. Those five were all associated with ticketing vehicles for traffic offenses. That was the fewest number of police we have observed in recent years while making this nearly 2,000-mile drive. Secondly, road construction has returned to areas where it existed several years ago. We now know that after recent years with no highway construction, we will be facing delays and challenges during the next few years until these projects are completed.

We saw two Amazon Prime trailer trucks in the north, but it was the FedEx trucks that predominated the truck traffic. Unfortunately, we experienced more than our share of highway delays due to FedEx trucks experiencing the toughest time passing slower trucks. That led us to think about the challenges of dealing with autonomous trucks on highways, projected to be the first commercial application of autonomous driving. We are already confronting lines of 18-wheelers stretching nearly a mile long, so what will happen when autonomous trucks are programmed not to speed? We envision highways lined with a wall of 18-wheelers. How will they be programmed to allow a car to move into their lane in order to exit the highway, or even to enter? It is much easier for trucks to de-group on highways with multiple lanes, but many of the roads we travel are two-lane highways. Not only will maneuvering on highways become a greater challenge, so will traveling times, as highway driving speeds will be dictated by the slowest vehicle on the road.

Everywhere we went, there were Help Wanted signs posted

As usual, we saw and experienced a number of conditions during our trip north. No restaurants were full, but the truck stops were. Hotels were not full, but the check-in process has become more automated, leading to bored staffs. Despite the Hampton Inn in Tullahoma, Tennessee undergoing renovations, we were not inconvenienced. Everywhere we went, there were Help Wanted signs posted. Everything we observed suggested an economy doing well and not showing signs of slowdown.

New England – What's Wrong With This Picture?

While the region has areas of high population density, the region is losing population

New England is home to a lot of history of the United States. The six states forming the region have long and distinguished histories and have provided many of the key leaders instrumental in the creation of the nation and its growth. While the region has areas of high population density, the region is losing population. Four of the six states experienced noticeable outmigration. One state had a balanced migration record, while the sixth experienced net immigration. In 2017, there were 14.8 million New England residents, equal to two-thirds of the population of Texas, but only 4.5% of the nation's population.

Of the five regions experiencing increases, two rose by slightly under 2%, one was flat, the non-contiguous states experienced a 5.7% increase, and New England saw its power price rise by over 11%

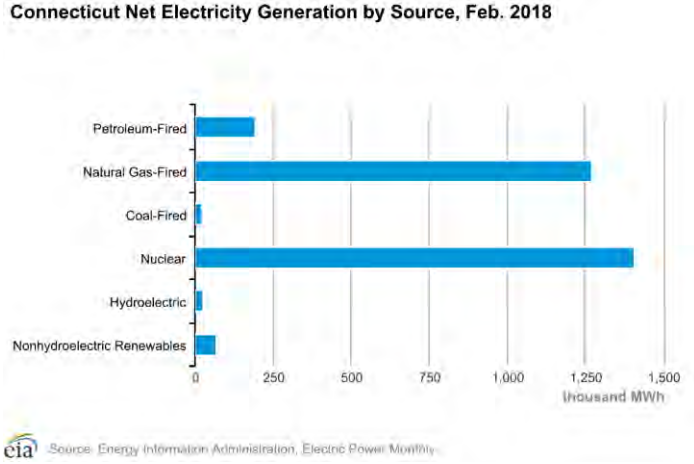
What New England does have is the highest electricity costs in the nation. According to the Energy Information Administration (EIA), the cost of New England residential electricity in February was 20.94-cents per kilowatt-hour (kWh), up from 18.81-cents/kWh the year before. Only the non-contiguous states of Alaska and Hawaii have higher electricity prices, averaging 26.30-cents/kWh. New England's residential power cost is nearly 166% of the national average. It is noteworthy what happened to electricity costs between February 2017 and 2018. Nationally, residential electricity prices declined 1.3% over that time. Meanwhile, half of the 10 geographical regions designated by the EIA for measuring electricity prices also experienced declines. Of the five regions experiencing increases, two rose by slightly under 2%, one was flat, the non-contiguous states experienced a 5.7% increase, and New England saw its power price rise by over 11%.

Between February 2018 and February 2017, national electricity prices rose 1.2%, while New England's price climbed by 12.8%

Examining total regional and national electricity costs, we find New England's price last February was 18.18-cents/kWh. That was almost 75% higher than the national average electricity price of 10.43-cents/kWh. Once again, between February 2018 and February 2017, national electricity prices rose 1.2%, while New England's price climbed by 12.8%.

What we know about power costs is that New England has among the most aggressive clean energy mandates for its power companies, but these are promised to lower residential electricity bills. Connecticut just passed legislation boosting its mandate from 28% in 2020 to 40% in 2030. The legislation also outlawed net-metering for solar power, which many environmentalists suggest will make attaining the clean energy goal more difficult.

Exhibit 7. Renewable Power Hardly Registers In CT

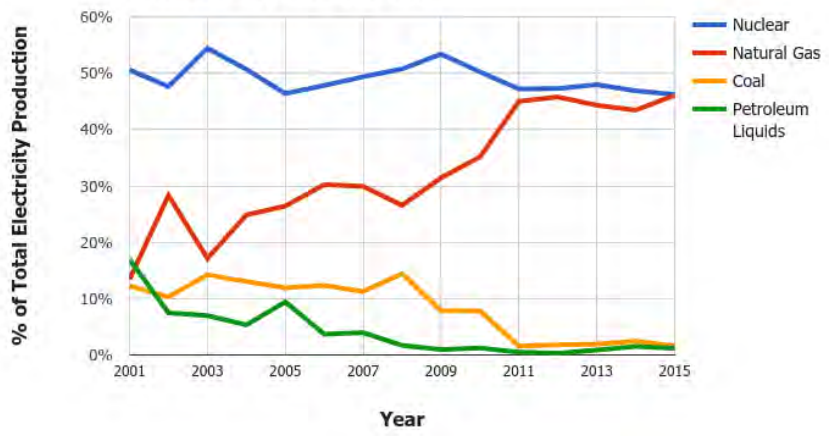


Source: EIA

The EIA's data for Connecticut for 2018 shows renewables and hydroelectric power hardly register as sources of supply. We would

not be surprised that the change in Connecticut's Renewable Portfolio Standard was made to kick the football down the road and avoid the state having to admit it failed to even come close to its 2020 emissions target.

Exhibit 8. Natural Gas Stars In CT Power Market

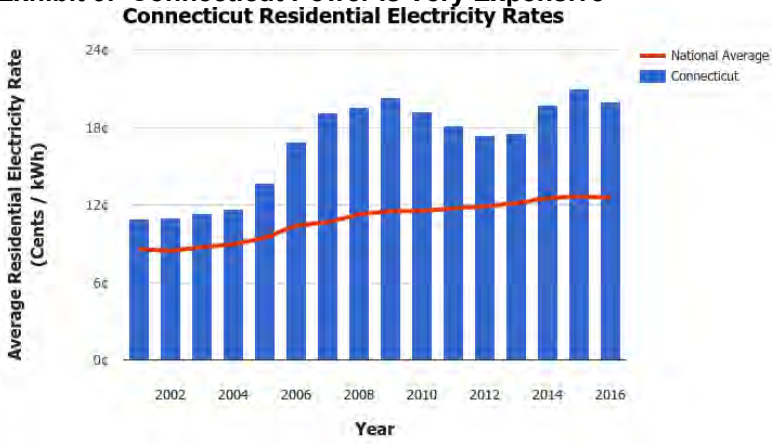


Source: Arcadia Power

Natural gas use has soared, as nuclear power has declined slightly

While it is interesting to see the 2018 fuel mix for Connecticut's electricity industry, Exhibit 8 shows how the fuel mix has shifted in recent years. What was striking was the amount of coal and oil used to generate power in Connecticut as recently as 2001. Both of those fuels are now nearly at zero. At the same time, natural gas use has soared, as nuclear power has declined slightly. The next impact of this fuel shift has been a steady rise in Connecticut's residential power rates. As Arcadia Power, from whose web site these charts came, pointed out, in December 2016, Connecticut residential power cost 19.02-cents/kWh, which was 6.81-cents above the average U.S. residential electricity price of 12.21-cents/kWh.

Exhibit 9. Connecticut Power Is Very Expensive



Source: Arcadia Power

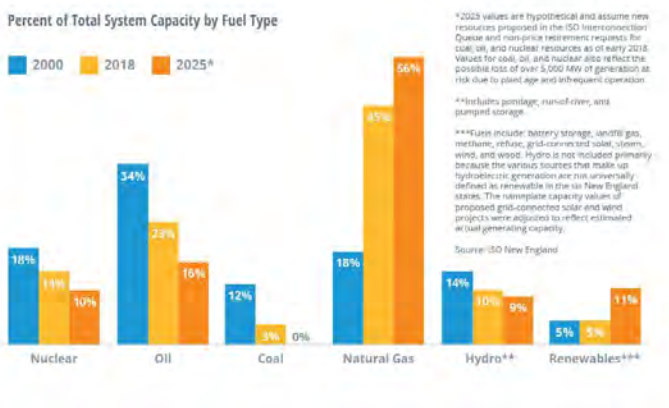
To balance his latest budget, the governor claimed funds being held in three green energy funds designed to help homeowners

A side note about Connecticut and its clean power effort. The state's financial picture is dismal as high-income earners are exiting the state due to its confiscatory income taxes. To balance his latest budget, the governor claimed funds being held in three green energy funds designed to help homeowners with improving their energy efficiency and pay their power bills, while also providing other financial assistance. After the financial raid, the administration returned $10 million of the $155 million taken to help with winterizing homes.

Natural gas is the only fuel source increasing its share

Broadening the perspective from Connecticut to New England, we see how the fuel mix for the region's power grid has changed between 2000 and 2018, and a projection of what it will look like in 2025. As Exhibit 10 shows, natural gas is the only fuel source increasing its share. We were surprised that the contribution from renewable fuels was unchanged over the past 18-year period. While the renewables contribution is projected to more than double over the next seven years, it will come at a cost.

Exhibit 10. Natural Gas Dominates Energy Market Growth

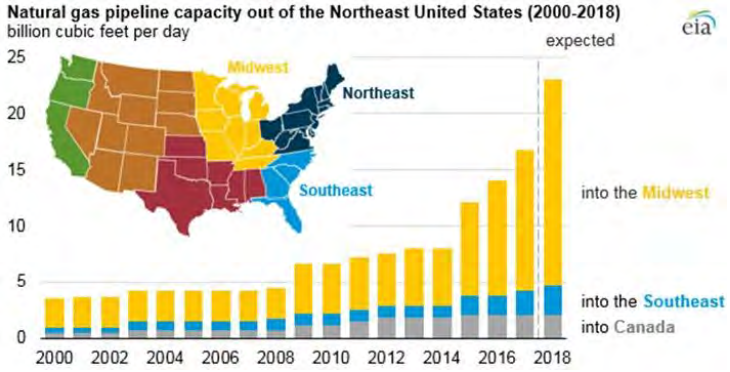


Source: ISO New England

This increase is directly attributable to the shale revolution's success in the Marcellus and Utica formations

The question we posed in the headline for this article was: What's wrong with this picture? It references the chart in Exhibit 11 (next page) from a recent posting by the EIA. It shows natural gas volumes being shipped out of the Northeast region over 2000-2018 growing. There has been significant shipment growth during 2015-2017, with a dramatic increase forecast for 2018. This increase is directly attributable to the shale revolution's success in the Marcellus and Utica formations.

Exhibit 11. Northeast Nat Gas Flows Out Of Region

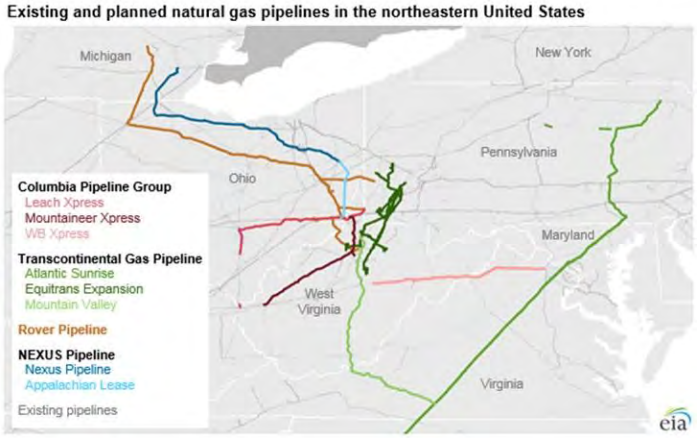


Source: EIA

Rather than having to rely on expensive oil or liquefied natural gas to help power companies keep the lights on in the region during the winter, more natural gas could have helped lower power bills

The EIA also showed a map containing the newly-constructed export pipelines. While the increased export capacity is lifting wellhead prices for natural gas producers in the region, one wonders what would have happened had those gas volumes gone north into New England. Rather than having to rely on expensive oil or liquefied natural gas to help power companies keep the lights on in the region during the winter, more natural gas could have helped lower power bills.

Exhibit 12. New Pipelines Helping Nat Gas Prices

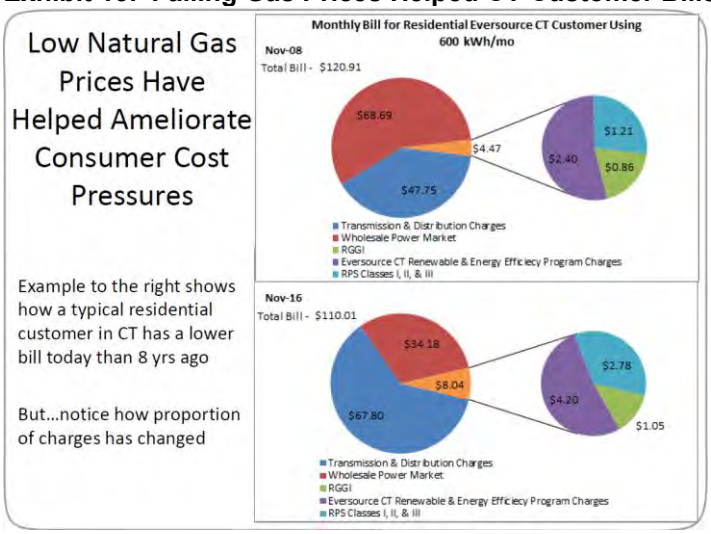


Source: EIA

The cost of the transmission and distribution system rose by nearly 50%

In a presentation at a New England Independent System Operator (ISO) seminar, James Bride, president of Energy Tariff Experts, LLC, showed a slide highlighting how a Connecticut residential customer's monthly power bill changed over the eight years of 2008 to 2016. Their bill fell, but importantly, the decline in natural gas prices during that time contributed to a sharply lower wholesale power price. At the same time, the cost of the transmission and distribution system rose by nearly 50%. There was also a near doubling of the costs associated with renewable fuels and clean energy programs.

Exhibit 13. Falling Gas Prices Helped CT Customer Bills



Source: Energy Tariff Experts, LLC

This redirection of the natural flow of energy away from traditional markets is a reason why the entire U.S. energy industry is being upended

The energy picture for New England, and what has happened to electricity consumers in the region, has been exacerbated by the anti-fossil fuel agenda of activists. Had that agenda been more balanced in reducing carbon emissions while helping control high electricity costs, natural gas pipeline capacity into the region would have been expanded. Had that happened, rising natural gas supplies from wells in Ohio, Pennsylvania and West Virginia would be benefitting New England residents. This redirection of the natural flow of energy away from traditional markets is a reason why the entire U.S. energy industry is being upended. That dislocation is adding to the cost of energy, to the detriment of U.S. citizens.

Visiting Raccoon Mountain Pumped-Storage Power Plant

The power plant is located about eight miles off I-24, up a long, and winding TVA road

On trips from Texas to Rhode Island, we normally go through Chattanooga, Tennessee on I-59/I-24/I-75. On our recent trip, since we were visiting the Jack Daniel Distillery in Lynchburg, Tennessee, southeast of Nashville and off I-24, we elected to continue on the interstate to Chattanooga. We had read about the Tennessee Valley Authority's pumped storage power plant at Raccoon Mountain just west of Chattanooga, so we decided to visit. The power plant is located about eight miles off I-24, up a long, and winding TVA road. At the top of the mountain are the hydroelectric and pumped-storage power plants. There is a visitor center at the pumped-storage plant, which is manned by retired TVA employees. Not surprisingly, there aren't many visitors. In fact, we were the only one that day.

In front of the visitor center is one of the original pump valves, which was replace several years ago when the plant underwent a maintenance upgrade. The upgrade shut down the plant for 18 months, which forced TVA to draw surplus from its other plants.

Exhibit 14. Massive Valve To Lift Water For Power Storage

Source: Allen Brooks

TVA has set up several very educational exhibits to explain the workings of the pumped-storage plant, as well as how it fits into the TVA system.

Exhibit 15. Raccoon Mountain P-S Visitor Center

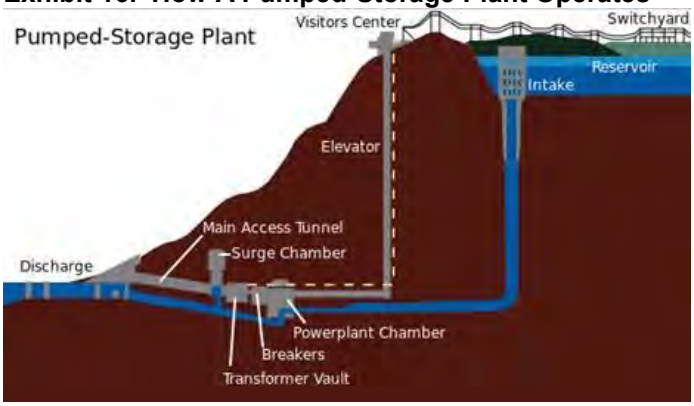
Source: Allen Brooks

Prior to 9/11, the tour allowed people to descend to the generators to see the inner workings of the plant

There were three retired employees manning the visitor center that afternoon, and we talked with all of them about the area, etc. Mr. Ken Coppage, a 30-year veteran of TVA and one of its construction managers, gave us a tour of the exhibit. Prior to 9/11, the tour allowed people to descend to the generators to see the inner workings of the plant. Now, you have to rely on the pictures in the exhibit. As can be seen from Exhibit 16 (next page), the visitor center was built with an elevator to the powerplant chamber where

the electricity is produced as the reservoir water is released. After generating power, the water flows into the Nickajack River. At night, water from the river is pumped up to the reservoir for storage until it is needed again for generating power.

Exhibit 16. How A Pumped-Storage Plant Operates



Source: TVA

The Raccoon Mountain Pumped-Storage Power Plant is the 11th largest in the world with a capacity of 1,652 MW

The pumped-storage plant is the only one within the TVA system. A *Wikipedia* list of the world's pumped storage power plants with 1,000 megawatts (MW) shows that the Raccoon Mountain Pumped-Storage Power Plant is the 11th largest in the world with a capacity of 1,652 MW. That power enables the plant to provide critical electricity during the hot afternoons in the Tennessee area. The plant, which normally cycles water during the day and at night, actually can provide electricity for up to 26 consecutive hours before having to reverse its water flow.

Exhibit 17. Raccoon Mountain P-S Plant Water Intake/Outlet

Source: Allen Brooks

From the visitor center's observation deck, one can look down on the Nickajack River and the facility that protects the water intake/discharge point. The commercial photo shows the facility's layout, which our photo only shows its location.

Exhibit 18. Raccoon Mountain Water Intake/Outlet Facility

Source: TVA

According to *Wikipedia*, there are 66 pumped-storage power plants worldwide with 1,000 MW or greater capacity. The United States has 10 of those super plants, including the world's largest – Bath County Pumped Storage Station at 3,003 MW of capacity.

Exhibit 19. U.S. Pumped-Storage Power Plants

World Rank	Name	Construction/ In-service date	Cost	Nameplate Power (MW)
1	Bath County Pumped Storage Station	1977-1985	$1.6 b	3,003
5	Ludington Pumped Storage Power Plant	1969-1973	$350 mm	1,872
11	Raccoon Mountain Pumped-Storage Plant	1970-1978	$310 mm	1,652
14	Castaic Power Plant	1970-1978		1,247
31	Helms Pumped Storage Plant	1977-1984		1,212
43	Bienheim-Gilboa Hydroelectric Power Station	-1973		1,100
46	Rocky Mountain Hydroelectric Plant	1977-1995	$1 b	1,095
47	Northfield Mountain	1964-1972		1,080
48	Muddy Run Pumped Storage Facility	1964-1968	$73 mm	1,072
49	Bad Creek Hydroelectric Station	-1991		1,065

Source: Wikipedia, PPHB

We have to assume there will not likely be any new pumped storage plants, as they suffer from the same pushback as hydroelectric plants and the dams associated with them

In researching pumped storage plants in the United States and worldwide, we were struck by the fact that only one plant was put into operation in the 1990s, and none since. In fact, almost all the plants began planning or construction in the 1960s and 1970s. We have to assume there will not likely be any new pumped storage plants, as they suffer from the same pushback as hydroelectric plants and the dams associated with them. We know that in the Pacific Northwest, dams are being dismantled in favor of spawning fish. Hydroelectric and nuclear power are two major non-carbon

These power sources should be part of an overall national portfolio of energy sources

emitting sources of electricity, but they are not favored by environmentalists for different reasons – environmental damage and safety. These power sources should be part of an overall national portfolio of energy sources, as they provide clean, dispatchable power in contrast to the intermittent power supplies from wind and solar facilities. If you are ever in the Chattanooga area, we suggest taking the time to visit the Raccoon Mountain Pumped-Storage Plant.

California As Don Quixote Chasing Carbon Emissions

One wonders what the state's current political, social and economic agenda will create for its future

California is a land of contrasts. It has the nation's largest population, estimated at 39.5 million as of July 1, 2017, according to the Census Bureau. At the same time, it has a housing crisis that has contributed to the state's large homeless population, forced workers to live greater distances from places of employment, and is driving people and businesses out of the state. The state's legislature, and its political leadership leans extremely left, which contributes to high taxes, accommodative social and legal attitudes, and an aggressive environmental agenda. After reading an article by a Californian who claims responsibility for helping to create the housing crisis, one wonders what the state's current political, social and economic agenda will create for its future.

A *Bloomberg* opinion writer, Virginia Postrel, has written several recent articles about the state of California's housing market. One article was titled: "How I Caused California's Housing Crisis." The gist of the article was that the vast influx of citizens in the 1980s and 1990s was caused by a transient event that caused a reaction by existing residents that was translated into laws restricting new home construction, and ultimately causing the current housing crisis 30 years later. Mrs. Postrel quoted a 1986 comment from a San Fernando Valley activist to the *Los Angeles Times*. The activist said, "What I am seeing now – the trees coming down, the hills bulldozed and the cheap apartment houses and stores going up, with no regard for the surrounding neighborhood – breaks my heart."

The ballot message conveyed to local officials was that they should approve new housing projects with great trepidation

That fall, in reaction to the construction boom, anti-growth initiatives were on ballots across the state. Most succeeded. This was like closing the door after you have arrived to prevent anyone from following you in to the desirable place you had just chosen. The ballot message conveyed to local officials was that they should approve new housing projects with great trepidation. The problem was that the migration into California continued, driven in response to the defense buildup sponsored by President Ronald Reagan. It directly benefited the aerospace companies located in Southern California. It also helped propel the growth of the technology companies in Silicon Valley, which were embarking on the personal computer wave.

California's population grew by 26% in the 1980s, with most of the growth from migration as opposed to local births

At the same time California was booming, Texas was suffering from its oil and real estate busts, and the Rust Belt states from the dismantling of the nation's basic manufacturing businesses. California became a magnet for job creation and migration. California's population grew by 26% in the 1980s, with most of the growth from migration as opposed to local births. But then the bottom fell out in California. The Cold War ended and military expenditures slumped, directly impacting aerospace jobs, and the manufacturers supporting them.

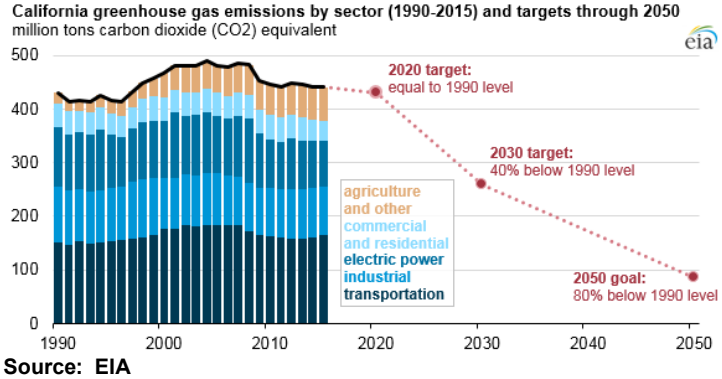
The impact of this whipsawing of economic fortunes, is best observed through the growth figures for Los Angeles County. In the 1980s, the county grew by 1.4 million people, up from the 445,000 increase experienced in the previous decade. In the 1960s, L.A. had grown by one million people. However, as the economic contraction began, the population grew by only 656,000 in the 1990s and 299,000 in the 2000s. The population growth in those recent decades was largely from domestic births and not immigration.

The lack of new building is the primary reason for high housing costs and the current housing crisis

The changed attitudes toward new housing construction failed to change even after the recessionary impact on housing had passed. The lack of new building is the primary reason for high housing costs and the current housing crisis. Recently, the state started allowing homeowners to build "granny flats" on their property. These are single units, or converted garages, etc., allowing homeowners to add rental units to the property that hopefully are available to people at below market rates, helping to ease the housing crisis. The program is gaining momentum, but it will require some time to seriously dent the current housing shortage.

This policy move on housing has not received as much attention as the latest move requiring all new single or multi-family, under three stories high, construction after 2019 to include solar panels. This policy is being implemented to help the state achieve its ambitious carbon emission reduction goals. The question is whether this policy will achieve the desired outcome, and at what direct and ancillary costs.

Exhibit 20. California Struggles With CO_2 Emissions Goal



Source: EIA

Recent emissions are higher than 1990, which represents the 2020 target

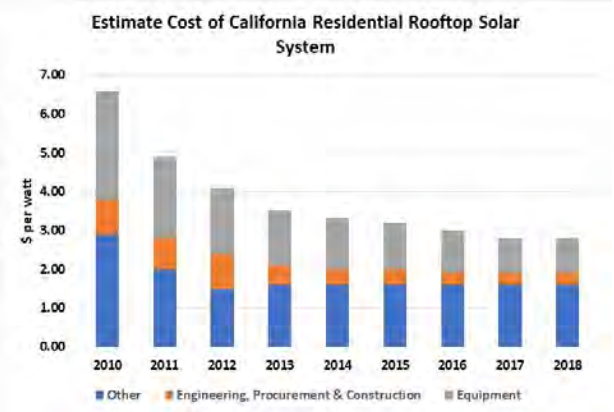
The chart in Exhibit 20 (prior page) shows the history of California's carbon dioxide emissions from 1990 to 2015. Recent emissions are higher than 1990, which represents the 2020 target. A decade later, California wants its carbon emissions to be 40% below the 1990 level, which further falls to 80% below the 1990 level some 20 years later. The solar panel mandate is targeting emissions from the commercial and residential sector (the light blue segment of the bars), which happens to be the smallest component of total emissions, and since it is targeting residential, there is even a smaller potential impact.

The state's Energy Commission, who voted in the new mandate, estimates it will only add $9,500 to the cost of a new house. They also estimate that the savings in electricity costs over the 30 years of the home's assumed mortgage will be twice the solar system's cost. With the median California home price at $500,000, the estimated additional cost is not significant. However, one has to wonder about the present value of the solar system's electricity cost savings. There is also the issue of solar system life, as none that we are aware of has lasted 30 years.

Other estimates suggest the mandate will add $8,000 to $20,000 to the cost of new homes

Other estimates suggest the mandate will add $8,000 to $20,000 to the cost of new homes. On the other hand, proponents of the new mandate suggest those costs will not be as high, since the housing construction industry will manage installations. They see permitting being incorporated into the entire house permitting process. Therefore, the time for paperwork preparation, traveling to government offices seeking permits, and the waiting for them to be issued will be eliminated, thereby lowering the cost. This is part of the soft costs involved in solar system installations, and the target for cost savings in turning solar system installations over to homebuilders.

Exhibit 21. Mandate Viewed As Cutting Soft Costs



Source: ***Bloomberg*****, PPHB**

An article outlining how the cost savings will emerge, suggested that additional cost savings will come from national homebuilders buying

Proponents also believe the time for installations can be reduced by using new installation systems and eventually solar roof tiles

solar panels directly from manufacturers, eliminating the many markups involved in one-off solar system installations. Proponents also believe the time for installations can be reduced by using new installation systems and eventually solar roof tiles such as those being developed by Tesla (TSLA-Nasdaq) and The Dow Chemical Company (DOW-NYSE), which is licensed exclusively to RGS Energy (RGSE-Nasdaq). Solar panel systems are envisioned to need fewer hours of electricians' time, another cost savings.

Based on the analysis, it is estimated that a new home solar installation will cost only $3,381.66, or $1.12 per watt, versus a retrofit system at a total cost of $8.743.50, or $2.90 per watt

Based on the analysis, it is estimated that a new home solar installation will cost only $3,381.66, or $1.12 per watt, versus a retrofit system at a total cost of $8.743.50, or $2.90 per watt. In the comment section following the article, there were numerous comments from solar and home construction professionals questioning numbers used in the analysis. When the author responded, he acknowledged the validity of the criticisms, and implied that some of the estimates are based on assumptions about how the market and solar products will evolve between now and 2020 when the mandate becomes effective. The cost of the labor component was also criticized by people identified as home builders for being unrealistic. The author responded that he was relying on a government report on the estimated cost for the various types of labor. That reminded us of medical reimbursements, which are always a fraction of what we are charged.

The addition of more solar power is expected, at least by one analyst, to boost the volume of electrons arriving at mid-day, adding to the glut of renewable energy that now exists

Another consideration by analysts speculating about the impact of the mandate is what it will mean for power prices. The addition of more solar power is expected, at least by one analyst, to boost the volume of electrons arriving at mid-day, adding to the glut of renewable energy that now exists. We are not sure that will actually happen. The mandate applies to new home construction and small apartment buildings. This represent incremental future electricity demand unless the new units replace existing ones. There is also a question of how large the solar units are. Will they be able to fully power a home, or only a large portion? Could they be so large that they actually always send power to the grid? To the extent that the new units are not lived in during the afternoon, they could be providing more power to the grid at that time compared to the needs of the home. That could create greater problems for the utility companies in managing the grid and handling the growing intermittency of their power supply. For solar providers, it could mean that power prices during those glut periods drop, harming the economics of their projects.

Given the problems Los Angeles County is having with its highway congestion (something we wrote about in the last *Musings*), carbon emissions are rising, adding to the challenge the state faces in meeting its emissions reduction goal. The costs being imposed on California residents are quickly becoming onerous. We will wait to see whether those estimates of how little the solar panel mandate will cost actually comes to pass.

Will East Coast States Stumble With Offshore Wind Power?

The East Coast states of Massachusetts, Rhode Island, New York, New Jersey, Maryland and Virginia, are striving to become the first to build a large-scale offshore wind farm. The five-turbine wind farm off Rhode Island's Block Island was created to be a demonstration project and set the offshore wind industry in motion. It achieved both objectives, and in doing so, helped its developer, D.E. Shaw, a financial money management firm, gain a leg up in competing for other offshore projects.

The East Coast offshore wind power rush has attracted some of the biggest European offshore wind farm developers. They are hoping to add a growth leg to their businesses as Europe's offshore market becomes saturated.

The problem for offshore wind is that it is still extremely expensive power, only surviving with the grace of government mandates and/or subsidies

The problem for offshore wind is that it is still extremely expensive power, only surviving with the grace of government mandates and/or subsidies. The Block Island project required rewriting the Rhode Island Public Utility law to mandate the purchase of clean energy produced within the state and outlaw conducting any cost/benefit economic analysis by the Public Utility Commission. This rewriting was necessary after the PUC rejected the initial power-purchase agreement as too costly for rate payers. That cost burden remains. For Block Island residents, however, the economics of expensive offshore wind was helped by the extremely high cost of electricity on the island, which came from diesel powered generators. It had never been considered economical to install a 10-mile power cable to connect the island with the mainland power grid.

The surprising repair effort is needed after only five years of service, well short of their estimated 25-year life without a major overhaul and will cost $100 million

Recent news from Europe about offshore wind farms is not a positive omen for the economics of the proposed new East Coast turbine farms. In February, Danish wind operator Ørsted indicated that it needed to repair more than 600 wind turbines due to early blade failure. The blades will be removed from the turbines, brought to shore for repair and then re-installed. The surprising repair effort is needed after only five years of service, well short of their estimated 25-year life without a major overhaul and will cost $100 million. That announcement was followed in March with news that the 175-turbine London Array, the world's largest offshore wind system, would also need major repairs after only five years of use. Few offshore systems have made it to the end of their estimated 25-year lives without a major overhaul.

The European offshore wind farms do not experience the same weather conditions and storms as those that will be located along the East Coast. Storms offshore Europe rarely match the normal, but powerful, nor'easters that routinely strike the area. One hit Rhode Island last March, causing no damage to the Block Island wind farm, although the storm only generated 75-mile-per-hour winds. Specifications call for the wind turbines to withstand gusts up

to 156 miles per hour, but that may not be good enough to withstand some Atlantic hurricanes. The East Coast wind farms are going ahead, but still face economic hurdles.

Contact PPHB:
1900 St. James Place, Suite 125
Houston, Texas 77056
Main Tel: (713) 621-8100
Main Fax: (713) 621-8166
www.pphb.com

PPHB is an independent investment banking firm providing financial advisory services, including merger and acquisition and capital raising assistance, exclusively to clients in the energy service industry.