ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

June 12, 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

Emissions Goal Failure May Force Direction Re-examination

Efforts to reorient the workings of the global economy to a zero-carbon emissions world may not be as feasible as earlier believed

Energy demand growth in 2017 may mark a tipping point in rethinking how the world attains its goal of reducing carbon emissions. Efforts to reorient the workings of the global economy to a zero-carbon emissions world may not be as feasible as earlier believed due to technology, social, political and economic issues. These conflicts, and the lack of progress in resolving them, were highlighted by Royal Dutch Shell (RDS.A-NYSE) in its recent planning scenario, Sky, about which we have commented in previous *Musings*.

A key question is whether this high demand growth represents a new norm for global energy growth

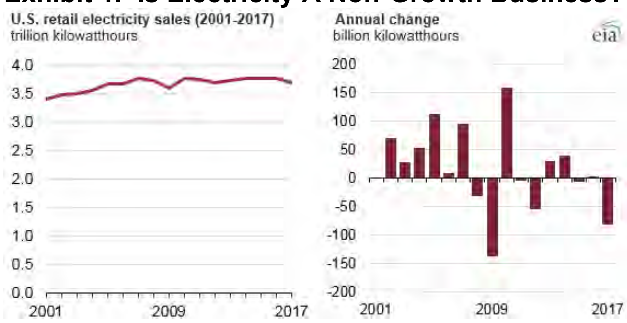
According to the International Energy Agency (IEA), global energy demand rose by 2.1% last year to 14,050 million tons of oil-equivalent. That growth was more than twice the increase experienced in 2016, and was driven by strong synchronized global economic growth, helped by lower energy and other commodity prices. Energy demand grew by 0.9% in 2016, the same percentage increase it averaged during 2010-2015. A key question is whether this high demand growth represents a new norm for global energy growth, or if it will return to the average growth rate of 2010-2016? If we are on a new growth plane, the world will need every form of energy generation available in order to meet that growth, but it will likely come at the expense of global carbon emissions. Is it possible to reconcile these conflicting outcomes?

"The significant growth in global energy-related carbon dioxide emissions in 2017 tells us that current efforts to combat climate change are far from sufficient," said Fatih Birol, the IEA's executive director. He went on to say: "For example, there has been a dramatic slowdown in the rate of improvement in global energy efficiency as policy makers have put less focus in this area." As a result of these trends, global energy-related carbon dioxide emissions increased by 1.4% in 2017 to 32.5 gigatons, a record high. This rise followed three years of flat carbon emissions, pointing to the challenge posed by a meaningfully higher energy demand growth rate.

In 2017, sales of electricity experienced its largest decline since the Great Recession of 2009

Dr. Birol's point about the lack of governmental focus on improving energy efficiency in recent years was brought home when we looked at several recent energy data sources. The Energy Information Administration (EIA) just released an analysis of U.S. electricity consumption. In 2017, sales of electricity experienced its largest decline since the Great Recession of 2009. Exhibit 1 shows that after the rebound in electricity consumption in 2010, there have been more years of negative growth than increases, although the U.S. economy continued to grow.

Exhibit 1. Is Electricity A Non-Growth Business?

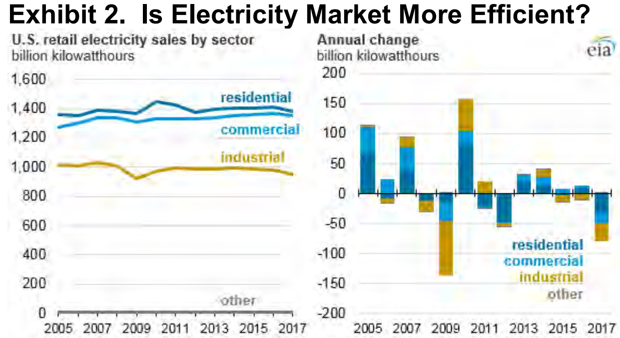


Source: EIA

Is the U.S. economy becoming more energy efficient?

A second chart (Exhibit 2) of electricity sales showed that last year all three economic sectors – residential, commercial and industrial - experienced declines. If we go back to the 2010 rebound year, we find that residential and industrial electricity sales are lower, while commercial is about flat. A seven-year span is sufficient to suggest a trend, as opposed to demand being subject to weather or economic activity. That is significant when we reflect on the knowledge that in 2017 the U.S. economy experienced its strongest growth since the Great Recession. Is the U.S. economy becoming more energy efficient?

Exhibit 2. Is Electricity Market More Efficient?

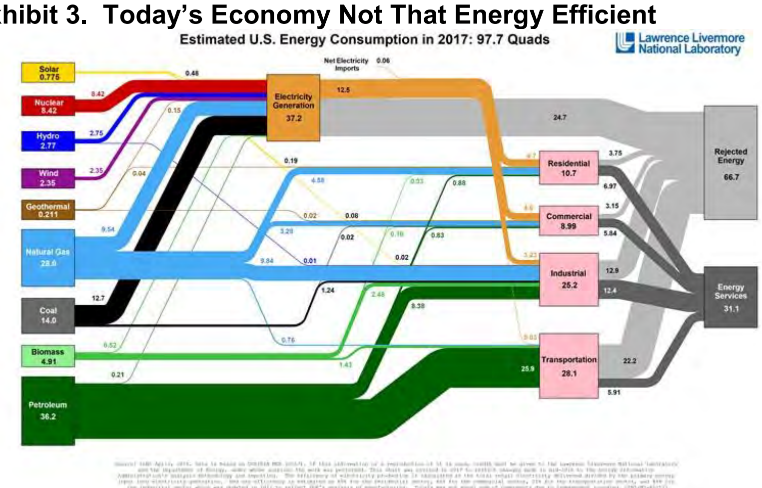


Source: EIA

Of the 97.7 quadrillion British thermal units (Quads) of energy generated in the U.S. last year, essentially two-thirds was "rejected"

That is an interesting question when we consider data for energy use complied and displayed in flow charts from Lawrence Livermore National Laboratory (LLNL) for 2017. It shows that of the 97.7 quadrillion British thermal units (Quads) of energy generated in the U.S. last year, essentially two-thirds was "rejected." According to LLNL, energy efficiency "...is the division between 'useful' and 'rejected' energy based on estimates of conversion efficiencies in the various end-use sectors. 'Rejected energy' consists primarily of heat losses. Conversion and plant losses at electric utility generation stations that burn fossil fuels are a matter of record, but inputs to total transmitted electricity such as nuclear and geothermal power, are associated with estimated efficiencies of the conversion process to electricity. These estimates vary from 90% in the case of hydroelectric power to 18% for geothermal energy." These conversion efficiency differences play a key role in the analysis.

Exhibit 3. Today's Economy Not That Energy Efficient



Source: LLNL

The conversion performance of these two sectors is materially different – nearly 34% for electricity, but only 21% for transportation

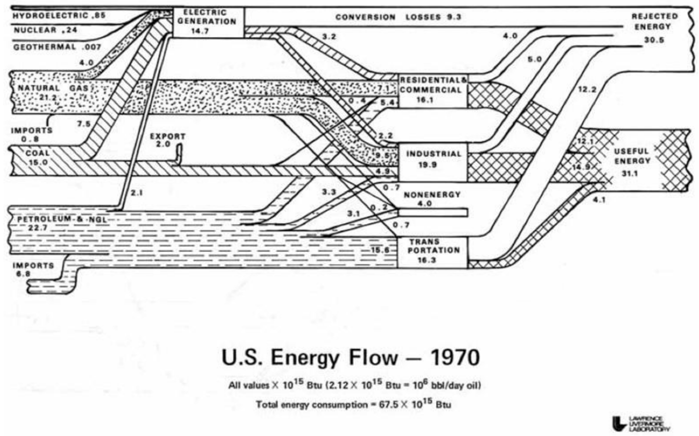
The two major energy sectors of the economy are electricity and transportation, each with different fuel inputs. The conversion performance of these two sectors is materially different – nearly 34% for electricity, but only 21% for transportation. On the surface, these different energy conversion rates didn't seem surprising, as we know internal combustion engines are not that efficient, which is an argument for electric vehicles since their motors are more efficient. But, further research left us wondering about the LLNL data.

Our first surprise was discovering the LLNL chart for 1970. Then, electricity generation had a nearly 37% efficiency rating, while transportation's rating was slightly over 25%. When we consider the electricity sector, there has been a major shift in the slate of fuels powering generation plants over the years. In 1970, the three leading fuel sources were coal (51.0% of total electricity), natural gas (27.2%) and oil (14.3%). Together, they accounted for 92.5% of the electricity generated.

PPHB

In contrast, in 2017, the three most important fuels were coal (34.1%), natural gas (25.6%) and nuclear (22.6%). Collectively, these three fuels represented 82.3%. When we looked at the 2017 contribution from the three leading 1970 fuels, they only accounted for 60.2%, more than a third less than in that earlier year.

Exhibit 4. Surprisingly Highly Efficient 1970 US Energy



Source: LLNL

Hydropower is the most efficient at 95%

While each power plant has its own energy efficiency, in general they are similar, with the exception of renewable fuels. Hydropower is the most efficient at 95%, but that rating is based on the power head (the tip of the dam) being extremely close to the power plant so little energy is lost while moving through copper wires. There is a limit, however, to the power output from hydro plants as once the entire head is covered, the plant is maxed out.

The two most prominent renewable fuels – wind and solar – have the lowest efficiencies, with the former in the 30% range and the latter around 20%

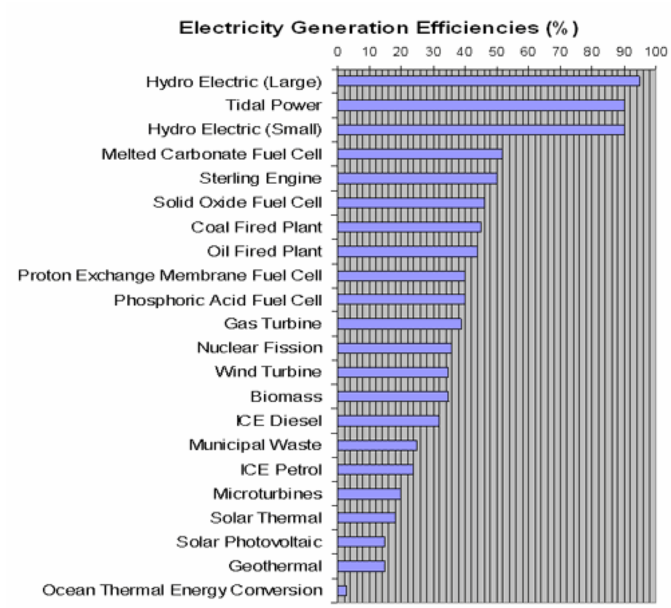
Following hydro are coal, natural gas and oil power plants with energy conversion rates of 48% to 38%. Coal has the highest conversion factor and natural gas the lowest. Natural gas plant efficiency can be boosted by designing them as combined-cycle plants, meaning they use the waste heat from burning the natural gas as additional fuel for heating boilers making power. The two most prominent renewable fuels – wind and solar – have the lowest efficiencies, with the former in the 30% range and the latter around 20%. Importantly, wind and solar efficiencies should also be discounted for their intermittency, with some engineering experts suggesting solar plant overall efficiency is more like 12%. Wind may have an efficiency rating in the 30%, with offshore wind possibly as much as 40%, but when the wind isn't blowing, or blowing too much, the conversion will be zero.

As the fuel slate for electricity has changed between 1970 and 2017, it is not surprising that the overall efficiency (rejected energy) rating has declined. As our energy industry continues to shift toward more renewable fuels with lower efficiency ratings, the nation's utility industry will need to over-invest in generating capacity, or possibly

Picking a rooftop solar system in Arizona probably doesn't mean much for the economics of an installation in Maine or Michigan

battery storage, to meet energy needs. So, while the renewables industry trumpets the falling costs for wind and solar power, in almost every analysis, the data is cherry-picked to emphasize the low cost in the most optimal location, and without considering backup power supplies or battery storage. In other words, picking a rooftop solar system in Arizona probably doesn't mean much for the economics of an installation in Maine or Michigan. The same goes for thermal solar plants, which are based on a price in the U.S. Southwest, but no plant has performed as advertised. It is also strange that many of the latest wind power cost figures are assuming efficiency ratings of upwards of 55%, when the EIA reports peak utilizations in the low 40%, and actual utilization based on BP plc (BP-NYSE) data is in the low 30%.

Exhibit 5. Renewable Fuels Much Less Efficient



Source: Eurelectric

Turning to the transportation sector, the most surprising trend was that the percentage of useful energy has declined from 1970's 25.2% rate to only 21.0% in 2017

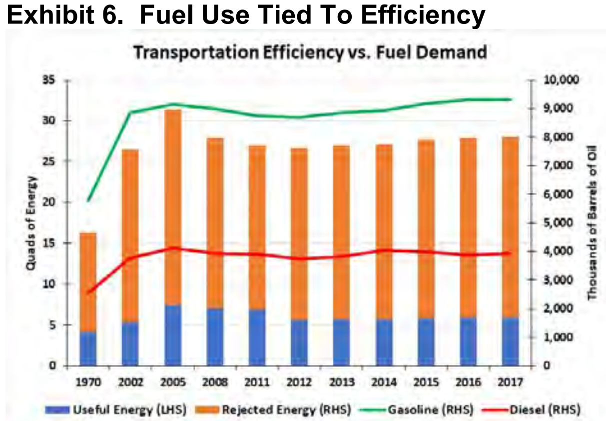
Turning to the transportation sector, the most surprising trend was that the percentage of useful energy has declined from 1970's 25.2% rate to only 21.0% in 2017. Initially, when we tracked down the data and did the calculations we were shocked. Remember that automobiles in the 1960s and early 1970s had very different mile-per-gallon performance statistics than today. In that earlier time, when *Consumer Reports* would review various car models, it would list fuel performance with a range for city driving and a single figure for highway driving. The typical car in 1970 might have an in-city performance of 7-18 miles per gallon (mpg), with highway driving averaging 19 mpg. Those mileage rankings traditionally came from the Mobil Economy Run, an annual event from 1936, except during World War II, until 1968, in which cars drove cross-country on regular roads and in normal weather and traffic conditions. After 1968, fuel performance ratings came from the magazine's testing.

Today, we have elaborate mechanical testing by government agencies in order to comply with current fuel efficiency laws.

It had to do with changes in assumptions about vehicle and appliance efficiency

When we tracked the performance of the transportation sector since 1970, we found some interesting trends, such as the one showing how overall, the percentage of useful energy declined. We found that the data for 2012 showed a significant deterioration of the useful energy performance. While total transportation energy declined between 2011 and 2012 by 0.3 Quads, from 27.0 to 26.7, useful energy fell from 6.76 to 5.60 Quads. Rejected energy increased from 20.3 to 21.1 Quads. Total U.S. rejected energy increased from 55.6 to 58.1 Quads. Why the sudden change? It had to do with changes in assumptions about vehicle and appliance efficiency.

Exhibit 6. Fuel Use Tied To Efficiency

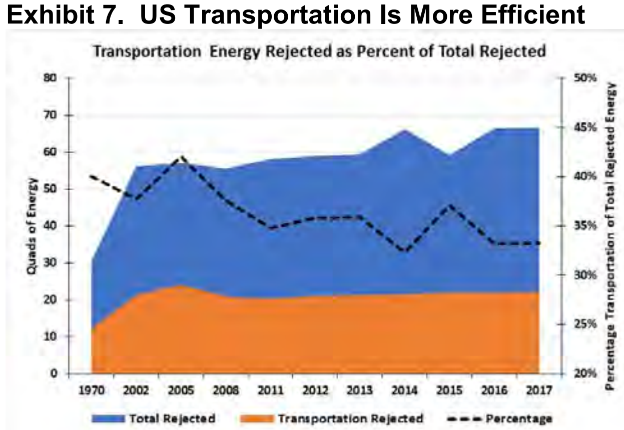


Source: LLNL, EIA, PPHB

While transportation's rejection of energy rose between 1970 and 2017, as a percentage, it has been trending lower

While transportation's rejection of energy rose between 1970 and 2017, as a percentage, it has been trending lower. As the largest share of energy, the improvements in the fuel-efficiency of vehicles, planes and trains have had an impact on the sector's performance. We also know fuel-efficiency assumption changes can alter results.

Exhibit 7. US Transportation Is More Efficient



Source: LLNL, PPHB

The assumption changes were driven, according to A.J. Simon, a senior researcher at LLNL who leads the energy flow studies, by recent (2011) studies about the end-use efficiency of vehicles and appliances. These studies are very detailed by device and fuel. To understand how the useful and rejected energy estimates are arrived at, we have presented the automobile commentary below.

> "Automobiles -> Energy Services"
> "Energy use by Automobiles for combined city and highway driving has been estimated using the following percentages: 70 - 72% to engine losses, 3% to standby or idling, 5 - 6% to accessories, 8 - 10% to aerodynamic drag, 5 - 6% to rolling resistance, 5 - 6% to drivetrain losses, and 4 - 5% to braking (Fuel Economy, 2011). Defining useful energy to include the energy necessary to overcome aerodynamic drag, rolling resistance, braking, and half of the energy used by accessories, using the average percentages of the provided ranges, 22% of the total energy is attributed to Energy Services. Therefore, the flow from Automobiles to Energy Services is calculated as 2,100 trBTUs."

Motorcycles have a 15% efficiency, but surprisingly, medium- and heavy-duty trucks are 38% efficient

The 22% efficiency rate was also used for light-duty trucks, which are subject to the government's CAFE standard. Motorcycles have a 15% efficiency, but surprisingly, medium- and heavy-duty trucks are 38% efficient. These figures struck us as strange, until we researched the energy efficiency of these vehicles. Engineers studying the mechanical performance of vehicles suggest that automobiles are 25% energy-efficient, while heavy-duty trucks are 38%.

Is this the result of an economy that has become more service oriented, or dependent on more power from electricity?

Studying these results caused us to question the trillions of dollars invested in improving the energy efficiency of the U.S. economy. Based on the LLNL data, the U.S. economy in 1970 was more efficient (rejected less than half of all energy consumed) than today's. Is this the result of an economy that has become more service oriented, or dependent on more power from electricity? Maybe, the analysis is skewed by the conversion of all energy calculations to electricity, which we know is less efficient, especially as we shift away from fossil fuel and nuclear power plants, which are more efficient than renewables.

If you think about it, if we could cut our rejected energy back to 1970's performance – 48% - we could cut our energy use by 15%, and presumably reduce our carbon emissions significantly

We are also led to the conclusion that there is so much more that can be done with our economic structure, for example, improving the efficiency of internal combustion engines. Maybe instant-on appliances and electronic devices are too energy and carbon emissions wasteful versus their convenience. If you think about it, if we could cut our rejected energy back to 1970's performance – 48% - we could cut our energy use by 15%, and presumably reduce our carbon emissions significantly. Furthermore, if we moved from coal to natural gas and nuclear power for electricity generation, we could improve efficiency. Those fuels are much cleaner than coal, although not as clean as renewables, but the economic benefits of a power grid with nearly 100% of dispatchable energy are huge. Maybe we are thinking about how to clean up the environment in the wrong way.

Why Saving Coal Plants Is An Inspector Clouseau Moment

The effort has been labeled 'crony capitalism,' as it appears President Trump is willing to upend existing competitive power markets by forcing utility companies to purchase more expensive power and raise consumer bills

President Donald J. Trump has directed Energy Secretary Rick Perry to try to fashion a plan to bail out uneconomic fossil fuel power plants, which has as its poster child bankrupt FirstEnergy Corp. (FE-NYSE) with its fleet of coal and nuclear plants. The effort has been labeled 'crony capitalism,' as it appears President Trump is willing to upend existing competitive power markets by forcing utility companies to purchase more expensive power and raise consumer bills. A draft Energy Department plan is being prepared for discussion by the National Security Council, with the aim of seeking a two-year moratorium on closing uneconomic fossil fuel-powered plants while the federal government seeks to identify those plants nationwide critical for ensuring reliable power in case of an attack or natural disaster.

Plan opponents focus on the bumbling and destructive performance of Inspector Clouseau, while President Trump would point to Clouseau's successful outcomes

Many people are abhorred at the thought of the federal government propping up uneconomic and, for many environmentalists, the dirtiest plants in operation. Those opposed to the effort would call it an Inspector Clouseau moment. For those not old enough to remember the Blake Edwards' Pink Panther movies of the 1960s, Inspector Jacques Clouseau, portrayed by Peter Sellers, was an inept and incompetent police detective in the French Sûreté. The movies featured his investigations that quickly turned to chaos. His absent-mindedness almost always led to the destruction of property, before Clouseau solved the case and finds the correct culprits, entirely by accident. Plan opponents focus on the bumbling and destructive performance of Inspector Clouseau, while President Trump would point to Clouseau's successful outcomes.

The power from these plants would have to be purchased by the grid operator and its utility clients

The report, seen and reported on by various media outlets, concludes that a forecast of retirement of coal and nuclear power plants creates emergency circumstances that rise to the level of national security. That status triggers possible actions by the Department of Energy under sections of the Federal Power Act (FPA) and the Defense Production Act (DPA). The principle action envisioned is that the power from these plants would have to be purchased by the grid operator and its utility clients, with the federal government creating a power reserve that might also have to be purchased.

One of the regional grid operators who opposes the plan, PJM Interconnection LLC, the operator of power markets in 13 states across the mid-Atlantic and Midwest, issued a statement saying: "There is no need for any such drastic action." However, in June

2017, the DOE issued an emergency order under the FPA for Dominion Energy, Inc.'s (D-NYSE) Yorktown power plants when PJM determined their closure for noncompliance with Mercury Air Toxics Standards would threaten the grid's reliability.

There are many issues involved in the possible plan, and key among them is the economics of power plants confronting low-cost natural gas and mandated renewable fuels

There are many issues involved in the possible plan, and key among them is the economics of power plants confronting low-cost natural gas and mandated renewable fuels. Our purpose is not to analyze this issue, but rather to highlight these problems for the independent grid operator for New England (ISO-NE). Not only is FirstEnergy experiencing a problem with uneconomic power prices, but so too is Exelon (EXC-NYSE) for its Mystic units 8 and 9 in the ISO-NE system. The dynamic was explained in a recent letter to ISO-NE. The letter stated:

> "We understand that both ISO-NE's January 2018 fuel security report as well as its April 3 memorandum, identified Mystic units 8 and 9 as critical to maintaining reliable electric supply in New England and avoiding potential rolling blackouts beyond May 2022. Unfortunately, operations of Mystic 8 and 9 beyond May 2022 are not economic because of flaws in the existing market design, and, while we appreciate the ISO's recognition of these flaws and its goal to propose changes through the stakeholder process, that process is both too late and too uncertain to alter our retirement decision."

In introducing ISO-NE's 2017 Regional Electricity Outlook report issued a few months ago, CEO Gordon van Welie explained the core problem that renewables, lack of additional natural gas infrastructure, and power pricing flaws are creating for the future of the region's electricity supply. Mr. van Welie wrote:

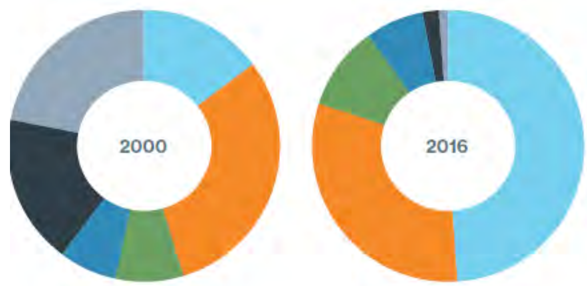
> "This leads to a thorny market-design challenge: given that state policymakers are taking action to reduce emissions, how does the wholesale marketplace account for state-sponsored resources without compromising reliability and investment through the markets?"

The region's lost gas supply is replaced by reactivated coal and oil plants, and the use of expensive, imported LNG

At issue for New England is that it has become highly reliant on natural gas for its power generation. In 16 years, natural gas has grown from 15% to nearly half the power generation market. At the same time, coal's and oil's shares declined from 18% and 22%, to only 2% and 1%, respectively. Unfortunately, the lack of pipeline capacity and the inability of electric utilities to sign long-term supply contracts means the region's gas supplies are limited during winter cold snaps, as home heating needs become a priority. As a result, the region's lost gas supply is replaced by reactivated coal and oil plants, and the use of expensive, imported liquefied natural gas (LNG). This means that customer electricity bills rise due to this use of higher-cost fuels and emissions increase.

Exhibit 8. How NE Power Fuel Mix Has Shifted

Annual Fuel Mix



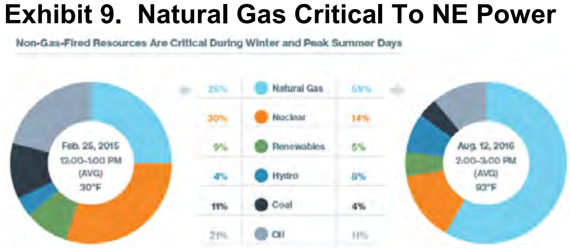
	2000	2016
Natural Gas	15%	49%
Nuclear	31%	31%
Renewables	8%	10%
Hydro	7%	7%
Coal	18%	2%
Oil	22%	1%

Source: ISO-NE

The renewables contribution falls almost by half between peak winter and peak summer days, which is largely due to the lack of wind power

The impact of the gas shortage situation is highlighted by the New England fuel supply mix on peak winter and summer days. Note that during the winter as gas supply falls, nuclear, coal and oil supplies grow. In contrast, on peak summer days, natural gas is the largest supply component, followed by nuclear and oil. We would also point out that the renewables contribution falls almost by half between peak winter and peak summer days, which is largely due to the lack of wind power. Hydropower, on the other hand, doubles between winter and summer peak days.

Exhibit 9. Natural Gas Critical To NE Power



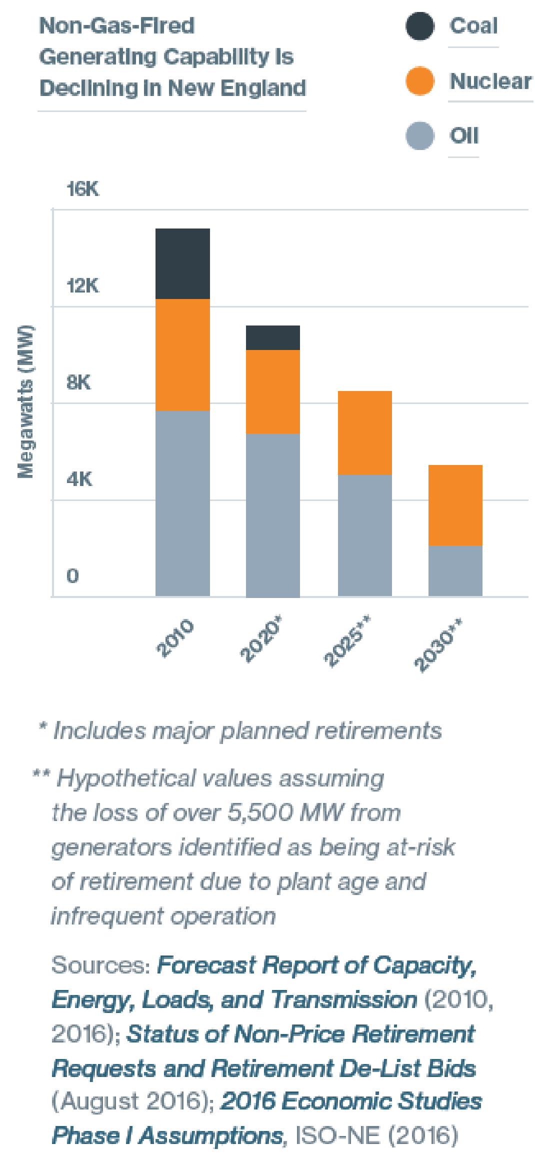
Source: ISO-NE

The problem for ISO-NE is that the amount of power coming from non-natural gas power plants is in decline. Between 2012 and 2020, the equivalent of 15% of the system's capacity, represented by coal,

These plants, along with older natural gas plants, are becoming a topic of concern about the power grid's future reliability

oil and nuclear plants, is scheduled to be retired. Additionally, nearly 20% of capacity represented by coal and oil plants is at risk of retirement, and uncertainty surrounds nuclear plants equal to an additional 12% of capacity. These plants, along with older natural gas plants, are becoming a topic of concern about the power grid's future reliability.

Exhibit 10. NE Falling Fossil Fuel Power Capacity



Source: ISO-NE

A January 2018 ISO-NE report focused on future grid performance under a range of scenarios dealing with energy supplies and equipment performance. The 23 possible scenarios studied included the following:

1. A reference case that ISO-NE characterized as incorporating likely levels for each variable if the "power system continues to evolve on its current path;"
2. Eight scenarios that increase or decrease the level of one of the five key variables from the reference case to assess its relative impact. The key variables are: renewables, LNG injection volumes, dual-fuel plant replenishment, power imports, and plant retirements;
3. Two boundary cases that illustrate what would happen if either all favorable or all unfavorable levels of variables are realized simultaneously, but since ISO-NE believes these are unlikely to occur, they don't reflect the outer boundaries;
4. Four combination scenarios that combine the five key variables at varying levels to represent potential future portfolios; and
5. Eight outage scenarios that assume winter-long loss of four energy facilities.

Considerations included the ease or difficulty of delivering LNG, renewable buildouts, transmission line construction, increased LNG deliveries, and plant and/or compressor outages. The scenarios also assume no new pipelines would be built, and some older power plants would close.

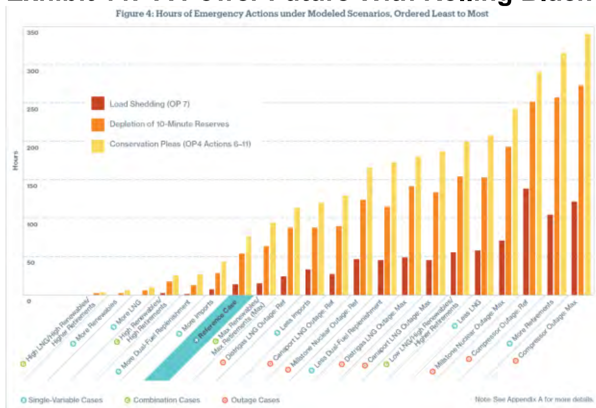
19 of the 23 possible scenarios led to rolling power blackouts for the region

The study's conclusion found that 19 of the 23 possible scenarios led to rolling power blackouts for the region. Rolling blackouts are when a utility shuts down power to one segment of its system to ensure reliability for the remainder. The longest blackouts projected resulted from an extended outage at a nuclear plant or a long-lasting failure of a natural gas pipeline compressor.

The one "no-problem" scenario (no load shedding or emergency procedures needed) results from everything going right

The one "no-problem" scenario (no load shedding or emergency procedures needed) results from everything going right. That means there is no major pipeline or power plant outage. That scenario further assumes a large renewables buildout and substantially increased LNG deliveries, even in the face of challenging winter weather. It also assumes a minimum number of coal, oil and nuclear power plant retirements.

Exhibit 11. A Power Future With Rolling Blackouts



Source: ISO-NE

An analysis of ISO-NE's report was conducted by Power Advisory LLC, an energy consulting firm. It wrote in its report that:

> "We believe that these scenarios overstate the fuel security risks faced by New England. The scenarios are overly pessimistic; fail to consider the ability of ISO-NE markets to respond to such conditions; understate changes to the region's generation mix that are likely to better allow New England avoid these system conditions; and fail to consider actions that the region and ISO-NE could take to respond to winter-long outages of critical elements of New England's energy infrastructure."

Power Advisory also pointed out that ISO-NE neglected to factor in growth in renewable and clean energy projects being discussed at the time of the report's issuance, and which could increase 2024 energy supply by 10%

The point was that ISO-NE failed to consider price in its study about how the power market would respond to market supply tightness. It also didn't consider whether conservation efforts could curtail the projected 2% per year growth in natural gas use in the region. But, cheap natural gas is likely to sustain the growth, and if additional pipeline capacity is built, power companies might have more cheap gas available to ease blackouts and hold down prices. Power Advisory also pointed out that ISO-NE neglected to factor in growth in renewable and clean energy projects being discussed at the time of the report's issuance, and which could increase 2024 energy supply by 10%. There was also 1,000 megawatts of imported energy not considered. While Power Advisory noted in a footnote that its assessment might be too harsh, it is important to remember that utilities are supposed to be conservative in their planning, and the risk to ISO-NE from power-market judgement mistakes is much greater than wrong opinions from an energy consulting firm.

While a bankrupt Ohio coal and nuclear power plant operator has highlighted the impact low natural gas prices and state-mandated renewables use is having on the economics of traditional fossil fuel power plants, addressing this issue will prove critical for ensuring future electricity reliability. As Mr. van Welie of ISO-NE put it, "…the

Politicians in the region believe clean energy can be achieved without any risk or cost for consumers, and virtually overnight

region is decades away from installing enough renewable resources and grid-scale energy storage to allow for complete independence from fossil fuels." That observation would seem to fly in the face of politicians in the region who believe clean energy can be achieved without any risk or cost for consumers, and virtually overnight. He elaborated on the problem facing grid operators, or at least the one running New England's system.

> "For the foreseeable future, the region will require resources such as natural-gas-fired units that can do what wind and solar resources cannot: make large contributions to meeting regional electricity demand; run in any type of weather and at any time of day; quickly change output levels; and provide essential grid-stability services. On frigid winter days in particular, the region has no alternative but to depend on fossil fuels and the remaining nuclear power stations, while also working to improve fuel accessibility for natural-gas-fired generators."

They are promoting wind and solar projects, providing subsidies and mandating that their power output be purchased before all other energy supplies

This outlook is challenged by states pushing clean energy agendas. They are promoting wind and solar projects, providing subsidies and mandating that their power output be purchased before all other energy supplies. As a result, the region is forcing uneconomic change on the power market. Mr. van Welie stated:

> "The states view long-term contracts as the most expeditious way to promote the development of clean-energy resources and the transmission investments needed to deliver that energy. Because clean-energy resources typically have higher development costs and New England's wholesale markets do not price carbon, these resources are currently not competitive in the wholesale marketplace without some form of subsidy. "

The growth of renewable fuels, with presumably lower costs, will force down overall power prices and undercut the economics of the existing fossil fuel power plants

Mr. van Welie further pointed out that the growth of renewable fuels, with presumably lower costs, will force down overall power prices and undercut the economics of the existing fossil fuel power plants the system needs in order to ensure the grid's reliability. Until renewables can demonstrate competitive operational and economic performance, their use will cause issues for grid operators.

What we know is that while some grid operators don't perceive any system risk from the growth of renewables, at least one major system is concerned about the green agendas of its region's politicians to the consternation of the environmental movement. Think of the angst people experience when the lights don't come on when the light switch is turned on. That may become a more frequent experience in New England. So, are we really watching Inspector Clouseau-created chaos with this proposed power emergency plan, or are we merely on course to solve the clean power system mystery?

The Battle For East Coast Wind Industry Supremacy Begins

After shrinking EMI, Mr. Gordon surveyed the renewable energy market and identified offshore wind as the most promising opportunity

Neighboring New England states – Massachusetts and Rhode Island – began battling back in 2000 over which one would become the East Coast offshore wind industry hub. That was the year James Gordon, and a few of his remaining associates at Energy Management, Inc., settled on offshore wind as their next target. EMI started in the late 1970s designing and installing energy efficient power systems for industrial plants in New England. When oil prices collapsed in the mid-1980s and conservation became less important, EMI morphed into building "merchant power plants" that were the outgrowth of energy decontrol. In 1999 and 2000, respectively, EMI sold two plants to El Paso and its remaining three to Calpine. After shrinking EMI, Mr. Gordon surveyed the renewable energy market and identified offshore wind as the most promising opportunity. After studying 17 offshore sites, the group picked Horseshoe Shoal, in Nantucket Sound, for a 130-turbine wind farm, named Cape Wind.

As Cape Wind was being conceived, in neighboring Rhode Island, re-elected Governor Donald Carcieri (R) established an energy advisory position with the aim of creating an offshore wind industry in which the state would become the hub for construction activities. By focusing on state waters, Gov. Carcieri was able to convince the legislature to enact legislation enabling Deepwater Wind, a company headed by his former chief of staff, to secure a contract for a 5-turbine demonstration project, Block Island Offshore Wind.

As the two projects moved forward – one under federal regulations and the other under state laws – the debate was whether the center of the offshore wind industry would be in New Bedford, Massachusetts, or Quonset Pt., Rhode Island. The race was between the former center of the whaling industry and a World War II training and war-effort mobilization site.

Although Cape Wind's death knell was sounded, it wasn't until 2017 that it officially died

In 2015, Cape Wind's problems in securing approvals prompted the two utilities who had agreed to buy the power to cancel their power-purchase agreements (PPA), effectively undercutting the financing for the $2.6 billion project. Although Cape Wind's death knell was sounded, it wasn't until 2017 that it officially died. In Rhode Island, however, 2017 marked the official start up for the Block Island wind turbines and residents' freedom from diesel-generated electricity.

Both states have moved ahead with plans for developing more offshore wind. Last month, Massachusetts and Rhode Island announced agreements to develop 1,200 megawatts (MW) of offshore power in two projects located in the same federal offshore permit area south of Martha's Vineyard. The projects are still subject to execution of PPA and construction contracts, as well as securing necessary government approvals. Those should not prove challenging as the states are pushing the projects. Reading media coverage of these awards has proven entertaining.

Exhibit 12. East Coast Wind Power Race Is On!

Source: Providence Journal

When Massachusetts announced the award of the right to build 800 MW to Vineyard Wind, a joint venture of Avangrid Renewables, a subsidiary of Spanish utility Iberdrola, and Copenhagen Infrastructure Partners, a renewable energy investment firm, Rhode Island decided to pick one of the losers in that auction to build the state's second offshore wind project. The state chose Deepwater Wind to build a 400 MW wind farm named Revolution Wind.

"We see this not just as a project but as the beginning of an industry"

Lars Thaaning Pedersen, chief executive of Vineyard Wind, told *The New York Times* that "We see this not just as a project but as the beginning of an industry." On the other hand, Deepwater Wind's CEO Jeff Grybowski, when commenting on the significance of the first large-scale offshore wind procurement, said, "It means that offshore wind is no longer a growing industry, it really is an industry that's maturing." We suspect executives competing for future offshore wind projects in Connecticut, New York, New Jersey and Maryland are hoping the industry is just beginning rather than maturing, as the latter characteristic suggests being closer to the end than the beginning.

We were also amused to read the *Associated Press* reporter's comments about the Massachusetts award. He wrote that the award "is the result of a 2016 bill [Gov. Charlie] Baker signed authorizing the largest procurement of renewable energy generation in Massachusetts' history." This stood in contrast to the explanation from a *Providence Journal* reporter who wrote about the 2016 law "requiring that state's electric companies to purchase 1,600 megawatts of offshore wind power over a decade." The difference between "authorizing" and "requiring" or, as we prefer, "mandating" is significant. The Massachusetts law mandating the purchase of offshore wind, is similar to the rewriting of the Rhode Island Public Utility Law that prevented the state's Public Utility Commission from performing a cost/benefit analysis of the Block Island project, after the initial PPA was found to be uneconomic for ratepayers, while also requiring the utility to purchase clean power generated within the state. The new law facilitated the Block Island project.

The Block Island Wind Farm PPA price started at 24.4-cents per kilowatt-hour (kWh), with a 3.5% annual escalation

For ratepayers in the two states, the critical issue is what will be the cost of the electricity? For the respective state politicians, it is about which one will emerge as the de facto center of the offshore wind industry. This is critical as other projects in the region will be coming. With respect to the first question, the Block Island Wind Farm PPA price started at 24.4-cents per kilowatt-hour (kWh), with a 3.5% annual escalation. That price was agreed upon in 2011 when the power cost for Block Island Power Company customers was 47-cents/kWh, although statewide it was only 14.8-cents and declining. Why such a wide discrepancy? Block Island was not connected to the mainland, thus it relied on diesel engines to generate its electricity, so power costs were tied tightly to global crude oil prices. Onshore, power bills were much more dependent on the price of natural gas, which is the primary fuel for generating electricity.

Currently, the difference between the 2017 pre-wind farm power cost and post-wind farm electricity price is almost non-existent

In its efforts to secure public support, Deepwater Wind trumpeted that the offshore wind project would save customers 40% of their electricity bills. They emphasized that when the wind farm was operating in 2014-2015, wind power would cost 30.7-cents/kWh, down 35.4% from the 2011 price. They also highlighted that based on 2012 island power prices of 54-cents, the reduction in electricity costs would be 42%. The reality has proven something else, however. Most of the projected savings occurred because crude oil prices collapsed in the interim. Currently, the difference between the 2017 pre-wind farm power cost and post-wind farm electricity price is almost non-existent. That spread shifts in favor of wind power if one considers what today's diesel-generated power might have cost.

The analysis presented to the PUC showed that ratepayers would pay approximately $440 million in above-market prices over the 20 years of the agreement

At the time the National Grid (NNG-NYSE) PPA was signed, the analysis presented to the PUC showed that ratepayers would pay approximately $440 million in above-market prices over the 20 years of the agreement. Opponents of the project argued that the burden would actually be closer to $500 million due to cost overruns and the inclusion of the electric power cable National Grid would install to haul surplus power to the mainland. The cable was to cost $75 million, but that was raised to an estimated $107 million cost when construction of the wind farm began. The final cost of the cable and installation was $125 million. Another cost over-run was for the substation needed on Block Island. The original cost was targeted at $350,000, but the final bill was closer to $2.5 million. Since that cost was to be largely absorbed by Block Island customers, there has been a move to get National Grid to socialize the additional cost to all mainland ratepayers. That will add to the $1.07 per month mainland ratepayers pay to subsidize the above-market power cost.

PPAs still need to be negotiated, but prices are supposed to be "low"

The National Grid-Deepwater Wind PPA demonstrates the risk of projecting future energy prices based on current market trends. That makes people nervous about the power costs of the Revolution and Vineyard Wind projects. PPAs still need to be negotiated, but prices are supposed to be "low." At least that is what Carol Grant, commissioner of the Office of Energy Resources in Rhode Island told the *Providence Journal.* "From our evaluation, they will actually save consumers in Rhode Island." But, isn't that what all renewables are supposed to do – be cheaper than fossil fuels?

Currently, based on the Rhode Island energy web site, the best offer for power is for four months at 8.3-cents/kWh

Mr. Grybowski, Deepwater Wind's CEO, told the same reporter, "What I can tell you is that it's dramatically lower than the Block Island price. I think that people will be shocked at the price level." Currently, based on the Rhode Island energy web site, the best offer for power is for four months at 8.3-cents/kWh. The six-month offer from National Grid is 8.486-cents/kWh, which is the default offer against which all other offers are measured for savings or expense. Only one other offer was below National Grid's. We will be very interested in seeing what the power prices are.

The potentially bigger issue for the two states is which one will gain the most economically from becoming the center of the offshore wind industry

The potentially bigger issue for the two states is which one will gain the most economically from becoming the center of the offshore wind industry. In Massachusetts, the state has spent $113 million dredging the New Bedford harbor and expanding and reinforcing a 29-acre marine commerce terminal. The investment is in anticipation of this location being used for loading turbine components that can stretch to 600 feet long and weigh many tons onto special vessels for installation offshore. There will also be a need for fleets of crew and maintenance vessels to keep the turbines operating for the next 20-25 years. Deepwater Wind has already contracted for one vessel.

Following its new award, Deepwater Wind announced plans to invest $40 million for improvements at the Port of Providence, for port facilities in the Quonset Business Park, and potentially in one or more Rhode Island port facilities. The next day, Rhode Island Governor Gina Raimondo (Dem) announced that an agreement between the Rhode Island Airport Corporation and Quonset Development Corporation, which owns and operates Quonset State Airport on land leased from the Rhode Island Department of Transportation, to seek to close the alternate, cross-wind runway, so the land can be used for construction of port facilities for offshore wind activities.

The cross-wind runway in 2017 was used by 40% of the 9,493 general aviation flights. It is used primarily during bad weather. The 9,704 military flights, primarily by the Rhode Island Air National

Exhibit 13. Wind Investment To Alter Airfield And Use

Source: *Providence Journal*

It will also create 50 permanent operations and maintenance jobs for the 400 MW wind farm

Guard, use the main runway. The agreement will need to be approved by the Federal Aviation Administration, a regulator who does not favor closing airports but might approve the loss of a runway, especially since the Providence airport is nearby. This move is a sign of how important capturing the lead-position in the emerging East Coast offshore wind industry is for the respective states. Deepwater Wind suggested that its Revolution Wind project will need 800 construction jobs to assemble and install up to 50 offshore wind turbines. It will also create 50 permanent operations and maintenance jobs for the 400 MW wind farm. An article describing Massachusetts' 1,600 MW of offshore wind, of which Vineyard Wind is half the total, said it would create over 3,000 "job years," which was defined as one person working full-time for one year. On average that is 300 permanent jobs, however, because of the construction requirements, there will not be a large number of permanent jobs, but high numbers of short-term construction jobs. Massachusetts has a 3.575-million-person work force as of April 2018, of which 158,000 are construction workers. If all the wind jobs were in one year, it would boost the state's current construction labor force by just under 2%. If the jobs were averaged, the increase is miniscule. It is a quite different picture for Rhode Island. Its labor force is 533,000 workers, of which 18,500 are construction workers, so even the average jobs would add over 1.5% to construction employment.

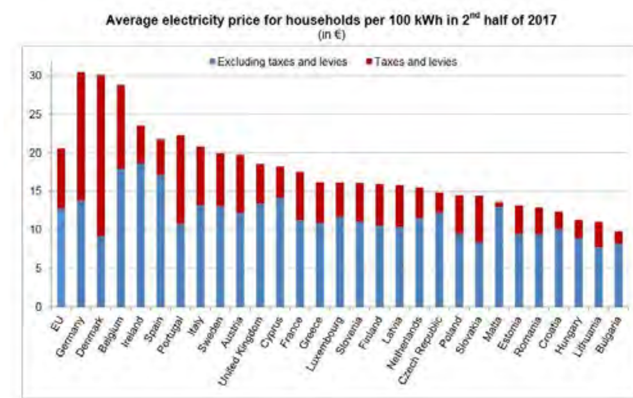
Round one of this battle for the offshore wind industry was the recent project awards. Round two will likely be the PPA agreements, which will impact whether and when the projects move forward. Round three will be project awards by other states, and potentially the next round of awards for Massachusetts and possibly Rhode Island. It is hard to envision offshore wind being as significant for New Bedford as the whaling business was 150 years ago. Prepare to watch the battle progress.

Germany's Clean Energy Revolution Hurts Its Residents

To achieve this goal, however, residents must bear the highest electricity prices in the EU

Germany and Denmark have been leading the green energy revolution within the European Union, driven by environmentalist pressure and fear of a nuclear power accident, which was prompted by the Fukushima disaster in Japan in 2011. The result is that renewable power has become a significant proportion of each nation's power. To achieve this goal, however, residents must bear the highest electricity prices in the EU. As shown in Exhibit 14, Denmark's electricity cost for the second half of 2017 averaged €30 for households using 100 kilowatt-hours (kWh) of power. Germany's power cost slightly more, but the important point was that these two countries' prices were 50% higher than the EU average.

Exhibit 14. Germany And Denmark Most Costly Power

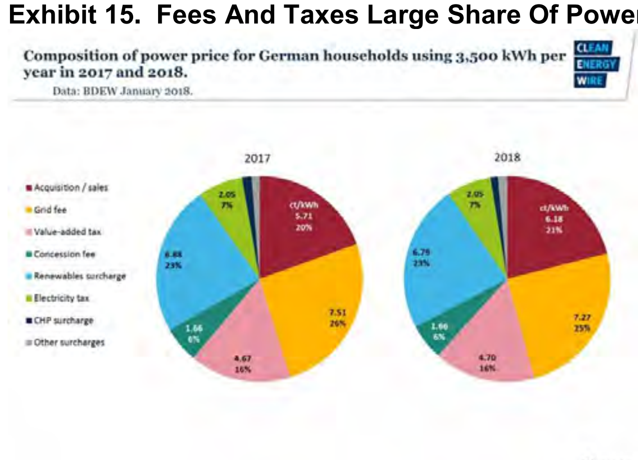


Source: Eurostat

Over half of the electricity price in Denmark and Germany consists of taxes and fees

Over half of the electricity price in Denmark and Germany consists of taxes and fees, as represented by the red portion of their bars in Exhibit 15. The German renewable fuel surcharge represents the

Exhibit 15. Fees And Taxes Large Share Of Power Cost



Source: ***Clean Energy Wire***

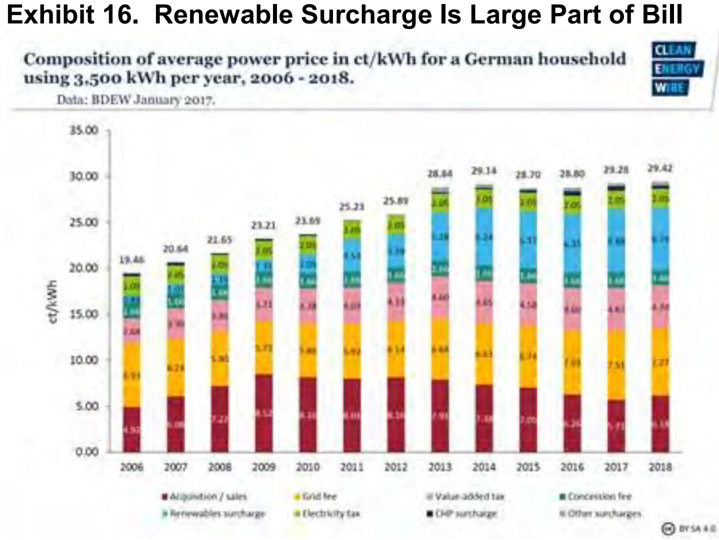
The renewable surcharge represents a cost of promoting solar and wind energy

second largest component of estimated 2017 and 2018 residential bills at 23%, after the transmission cost at 25% (Exhibit 15, prior page). When fees and taxes account for such a large portion of ratepayer bills, there is little impact on overall bills from fluctuations in fuel costs, but in this case, the renewable surcharge represents a cost of promoting solar and wind energy.

That fee has grown from 0.88-cents in 2006 to 6.79-cents/kWh today, a 7.75-fold increase

To appreciate the significance of this renewable fee on bills, Exhibit 16 shows how power prices have climbed over the past 12 years. The overall price has risen from 19.46-cents/kWh in 2006 to 29.42-cents, a 51% increase. What readers can see in the chart is the growth of the blue wedge, which represents the renewable fee portion of the residential electricity bill. That fee has grown from 0.88-cents in 2006 to 6.79-cents/kWh today, a 7.75-fold increase.

Exhibit 16. Renewable Surcharge Is Large Part of Bill

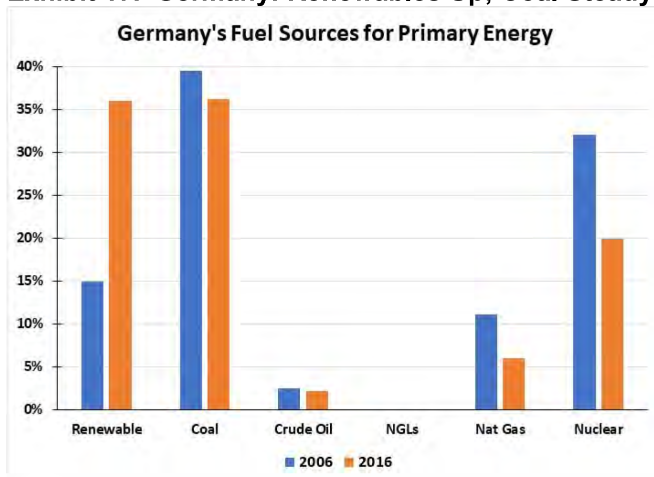


Source: *Clean Energy Wire*

In the case of Germany, we see renewables jumped from 15% to 36%, while nuclear fell from 32% to 20%

While boosting renewable fuels in Germany's electricity, the impact on the country's carbon emissions has not be as successful. We can see what has happened between 2006 and 2016 with respect to the fuel mix in Germany and compare it with the mix shift for the EU overall. In the case of Germany, we see renewables jumped from 15% to 36%, while nuclear fell from 32% to 20%. Significantly, coal's share only fell from 40% to 36%. Surprisingly, natural gas declined from 11% to 6%. We wonder how much of that decline was due to the geopolitical battle between the continent's countries and Russia, or if it was all due to the cost of natural gas.

Exhibit 17. Germany: Renewables Up; Coal Steady

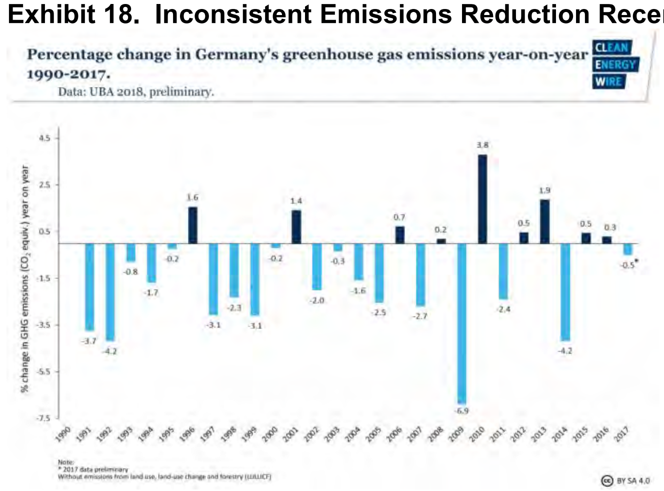


Source: Eurostat, PPHB

The impact of this shift in Germany's fuel mix has not produced a consistent reduction in its carbon emissions

The impact of this shift in Germany's fuel mix has not produced a consistent reduction in its carbon emissions. That has largely been due to the need for more coal-fired power. The amount needed has depended on annual power demand changes, since renewables are intermittent and require backup power supplies.

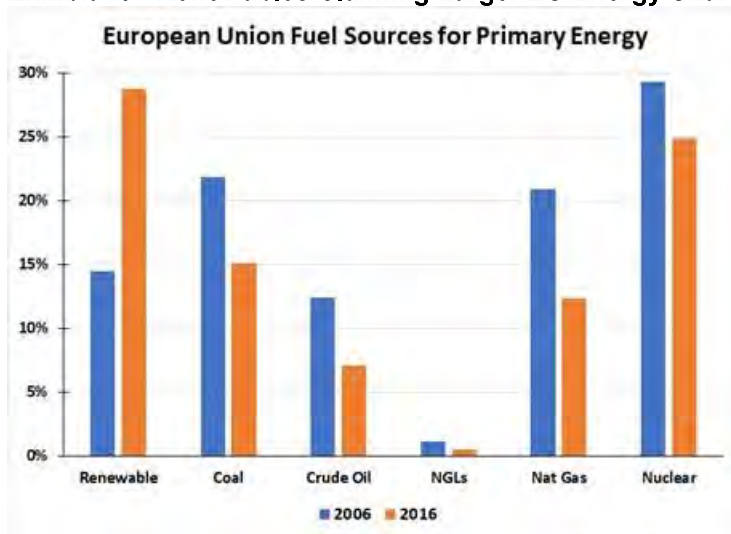
Exhibit 18. Inconsistent Emissions Reduction Recently



Source: *Clean Energy Wire*

In the EU, renewables represent a slightly smaller percentage of total fuel than in Germany. However, the EU uses slightly more than one-third of Germany's coal use, twice its natural gas use, 25% more nuclear power, and three times Germany's use of oil.

Exhibit 19. Renewables Claiming Larger EU Energy Share



Source: Eurostat, PPHB

Without government support, these turbines are uneconomic

The latest news about Germany's energy market is the realization that meaningful numbers of on- and offshore wind turbines are coming to the end of their guaranteed feed-in tariff support and will be shut down. Without government support, these turbines are uneconomic. Germany will need to build more wind capacity, which is becoming a political problem, at least onshore, due to the environmental concerns and the fact that excess power is shipped to neighboring country power grids making them unstable. The recent focus on offshore wind farm power contracts awarded without government support raises the question of how many of these "cheap" power sources are part of portfolios of companies operating subsidized facilities. Given the structure of Germany residential power bills, these cheap sources of power are not helping the consumer. Just how long can German families absorb these high electricity bills before they become an economic disrupter. How much has the government thought about this issue and its impact on its society and its economy?

The Race To Electrify The Global Vehicle Fleet; But When?

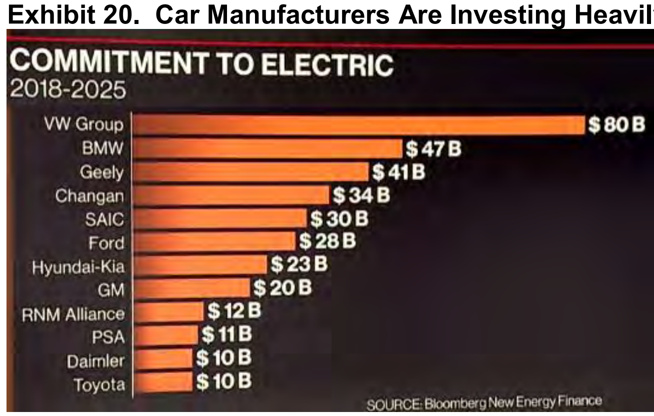
It plans to have 16 production facilities by 2022, at which point it plans to begin introducing one new EV model a month

Looking at the amount of money auto companies are investing to develop electric vehicles (EV), one would think that car buyers will only have EVs to select from in just a few years. One of the leaders in the auto manufacturer race is Volkswagen AG (VLKAY-OTC), which is still recovering from the diesel emissions cheating scandal and trying to redefine its future. The company has announced plans to be the global EV leader by 2025. It plans to have 16 production facilities by 2022, at which point it plans to begin introducing one new EV model a month with a goal of having 80 models by 2025 and producing three million vehicles, or 25% of its total vehicle output.

The company expects to have an electrified version of all its 300 models worldwide by 2030

The 80 EV models will include 50 battery-electric and 30 plug-in hybrid electric models. Ultimately, the company expects to have an electrified version of all its 300 models worldwide by 2030. To achieve this goal, VW initially announced a $25 billion deal for batteries for its China and European markets, but recently doubled that investment to $48 billion, which will include its North and South American battery needs.

Exhibit 20. Car Manufacturers Are Investing Heavily In EVs

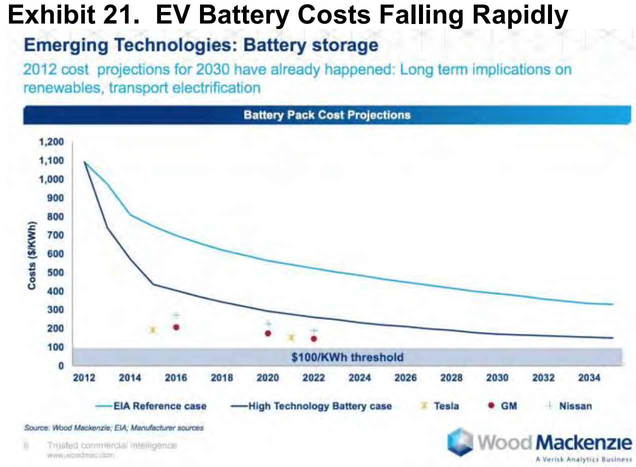


Source: Bloomberg New Energy Finance

VW's forecast calls for battery costs to fall to $90 per kilowatt-hour by 2022, which is below the $100/kWh threshold cited by Wood Mackenzie as a key price point for the industry

A key to the VW strategy was explained by Christian Senger, head of EVs, who told a *Reuters* reporter: "to stoke mass demand, VW is aiming to sell its EVs at the price of conventional combustion engine cars, drawing on MEB (standardization) synergies and falling battery costs." VW's forecast calls for battery costs to fall to $90 per kilowatt-hour by 2022, which is below the $100/kWh threshold cited by Wood Mackenzie as a key price point for the industry. This optimistic view of the EV market contrasts with that of BP plc (BP-NYSE), which sees EV and internal combustion engine car price parity arriving sometime before 2050. So why the wide gap in EV price expectations? Likely, it has to do with sharply different

Exhibit 21. EV Battery Costs Falling Rapidly



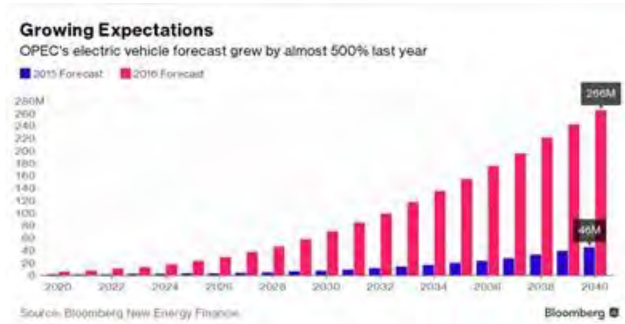
Source: Wood Mackenzie

battery price expectations, as BP sees battery costs nearly twice VW's target. Additionally, VW never said its EVs would be profitable at conventional vehicle price-parity. As we know, General Motors, Inc. (GM-NYSE) is selling its Chevrolet Bolt at comparable conventional car prices, but it reportedly is losing $9,000 a vehicle.

OPEC's EV numbers increased by 500% between its 2015 and 2016 forecasts!

The optimistic battery cost projections and the bold investment plans of auto manufactures is leading analysts to raise their forecasts for EV sales. It is a challenge to keep up with the latest forecast. But, as Bloomberg New Energy Finance reported, OPEC's EV numbers increased by 500% between its 2015 and 2016 forecasts!

Exhibit 22. OPEC's EV Forecast Soars!



Source: Bloomberg New Energy Finance

OPEC's 2017 forecast was even more optimistic

OPEC's 2017 forecast was even more optimistic, based on a "Sensitivity Case" it developed, in which it said:

> "Focusing on the penetration of EVs [electric vehicles] in the passenger car segment, an alternative sensitivity has been developed: the Sensitivity Case. In this sensitivity, a more optimistic view is taken on the penetration of EVs with the assumption that annual EV sales reach 80 million by 2040. This would mean that three out of every five cars sold in 2040 would be electric."

EV battery costs, as well as further government mandates around the world outlawing or heavily restricting the use of conventionally-powered vehicles, means EVs will grow more rapidly than previously thought. Whether the conditions necessary to achieve these optimistic forecasts come to pass remains to be seen. In the interim, the potential impact on energy markets needs to be monitored.

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