ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

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

Summary:

The Dynamic State Of The U.S. Power Industry

Total electricity consumption has remained stable for the past few years, while on a per capita basis it has been trending downward. Is this due to the transition in lighting from incandescent to CFL and LED lights? When that shift is complete, what happens to power demand?

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Why The Natural Gas Market Remains So Disappointing

After failing to rise in response to sharply falling gas storage volumes, prices are now under pressure as weekly storage injections are huge and portend a rapid replenishment of winter supplies. Is the gas market at risk of prices falling below historical price supports?

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Weak Auto Sales Could Be A Sign Of An Energy Challenge

Auto manufacturers are keeping a stiff upper lip in the face of weak 1Q 2019 sales. Maybe delayed tax refunds hurt sales, but there are underlying trends raising questions about the future of car sales as the Gen Zers become a more significant population and economic force. Is the love-affair with autos over?

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Alberta Makes Election History: New Energy Course?

The recent Alberta provincial election made Canadian history as, for the first time, a newly elected party has been unseated after only one term of service. For Alberta, will a more conservative government result in a changed outlook for the province's energy business?

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EVs And Wind Power Suffer Slings And Arrows Of Reality

Critical studies of EV carbon emissions and the math about wind power versus gas-fired combined cycle electricity generation facilities are driving home the issue of economic reality for these renewable electricity sources. Will economic arguments influence political pressures to address climate change?

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The Dynamic State Of The U.S. Power Industry

Thomas Edison is credited with taking electricity from the lab to the street

The last decade has turned out to be one of the most dynamic periods in the history of the United States electricity industry. Yes, we know some might point to the early age of electricity as its most dynamic period, when iconic figures in the industry's founding battled for their vision to dominate the future. Thomas Edison is credited with taking electricity from the lab to the street with his lighting company that eventually became General Electric (GE-NYSE) in 1892, engineered by financier J. Pierpont Morgan.

Electricity had been discovered decades earlier, but its mysteries were only unveiled by experiments such as Ben Franklin's kite-flying in an electrical storm in 1752. Michael Faraday in 1831 generated electricity by using magnets, which ultimately led to his perfection of the dynamo. This set the stage for development of the transformer, which supplemented the steam engine's mechanical force with an additional prime mover option.

In England in 1878, Joseph Swan was awarded the first patent for incandescent lighting

The first electric automobiles and locomotives appeared in the 1830s, both in the United States and Europe. These were crude versions of what would later emerge as highly sophisticated and powerful prime movers. The transitions were due to perfection of the hardware and technology, including the creation of devices such as the rechargeable battery. It was around this time that the first experiments with incandescent and fluorescent lighting began, but they remained in the laboratories of their inventors. At about the same time, arc lighting was developed by using steam-generated electricity. In England in 1878, Joseph Swan was awarded the first patent for incandescent lighting. This was one year after Mr. Edison had patented the phonograph. He was intrigued about the incandescent bulb, and he was ready for his next adventure, so he began by studying arc lighting and the gaslight industry.

The gaslight industry had emerged some 50 years earlier, driven by coal companies seeking additional monetization opportunities from their coal deposits. Coal gas was manufactured by heating coal in an oven that was sealed to keep oxygen out. The gas was purified by filtering, then pressurized and piped to homes, businesses and street lights. The manufacturing process is today what we refer to as "coal gasification."

The greatest advantage was that coal gas delivered five times the light for the same cost as candles and lamps

Residents were always seeking better lighting for their homes and coal gas became a cheap and easy source of light. The light mantles needed to be lit by hand, and the gas supply was controlled by valves that needed to be opened and closed by hand. Still, this was easier than the effort of lighting homes with candles and lamps fueled with either whale oil or tallow. The greatest advantage was that coal gas delivered five times the light for the same cost as candles and lamps, enabling the new industry to eventually dominate the city lighting market.

The key was finding a high-resistance filament that worked with a low current from a high-voltage system – the modern-day equivalent of a "killer app"

With knowledge of the arc light technology and gaslight market, Mr. Edison turned his inventive talents to solving the issue of creating and delivering a low-cost lighting system alternative to gaslighting. The key was finding a high-resistance filament that worked with a low current from a high-voltage system – the modern-day equivalent of a "killer app." While Mr. Edison had unlocked the mystery of delivering a superior lighting solution, commercializing it became a battle. Although he was involved in this battle, business skills were not Mr. Edison's greatest strength – inventing things was! He received 1,093 patents during his lifetime, which included 375 electrical patents, of which 149 were for incandescent lamps and manufacturing, 106 in electricity generation, 77 for electricity transmission and distribution, with the balance for various devices associated with the use and delivery of electricity.

What Mr. Insull did for the electricity industry was equal to what John D. Rockefeller did for the petroleum industry

As Mr. Edison's interest in electricity waned, he moved on to develop other devices such as the photocopier, alkaline battery and motion picture projector. The development of the electricity industry fell to others – people such as Elihu Thompson, Edwin Houston, Nikola Tesla and George Westinghouse, but importantly, to his private secretary, Samuel Insull. It was Mr. Insull who pioneered scale economies in the production and consumption of electricity, helped develop load-factor efficiency, created two-part rate making to promote consumption for a product that needed to be used when generated since it could not be stored, and fathered statewide public utility regulation by being willing to accept cost-based rate setting in exchange for franchise protection. What Mr. Insull did for the electricity industry was equal to what John D. Rockefeller did for the petroleum industry.

There was virtually nothing about the energy business that was off limits for regulators causing corporate strategies to be overturned with the stroke of a pen

In the final quarter of the last century, the structural problems besetting the nation's interstate natural gas industry due to price regulations forced a massive restructuring of the business. The period began just as the first oil crisis arose, causing governments to become more intimately involved in the domestic energy business. The era of significant government regulatory activity ushered in by the oil crisis enabled bureaucrats to determine crude oil and natural gas prices, how those commodities could be sold, and, importantly, how they could be used. There was virtually nothing about the energy business that was off limits for regulators causing corporate strategies to be overturned with the stroke of a pen. Massive sectors of the energy business were forced to restructure. In some cases, this required traversing bankruptcy and emerging as entirely different companies in vastly deregulated energy markets, assuming they emerged at all.

The remaking of the U.S. oil and gas producing, transportation and marketing businesses, as well as the national utility industry was eventually assisted by a change in government regulatory philosophies that encouraged deregulated markets. In the utility industry, traditional companies became subsidiaries of holding companies allowing the creation of sister companies structured to compete in deregulated energy markets. Often these restructurings involved breaking up integrated utilities with holding companies often selling some components and electing to concentrate in only one sector of the value chain associated with delivering power – generation, transmission or distribution. In most cases, the electricity and gas distribution business remained regulated as regulated monopolies were judged to be much more efficient for communities, and regulation protects customers from the utilities' monopoly powers.

Decarbonizing the world is considered of paramount importance, which means restricting the use of fossil fuels and instituting subsidies for carbon-free power sources and also adopting mandates for their use

As the energy deregulation phase wound down in the first decade of the 21st century, global warming and climate change emerged as the latest challenge in reshaping the electricity business. Decarbonizing the world is considered of paramount importance, which means restricting the use of fossil fuels and instituting subsidies for carbon-free power sources and also adopting mandates for their use. The use of subsidies and mandates is recognition that carbon-free power sources are not price competitive, nor are the financial returns for the power companies investing in them adequate for attracting capital. Mandates have become a popular tool to force utilities to reconfigure their operating systems to manage the operational challenges of intermittent power sources. Mandates do not remove the obligation and mission of utilities to always deliver power when customers desire it, but the practicality of ensuring that it will always happen haunts utility executives who fear the reputational backlash by failing to meet that obligation. Raising customer prices was the cost of improving the operational performance of renewable fuels.

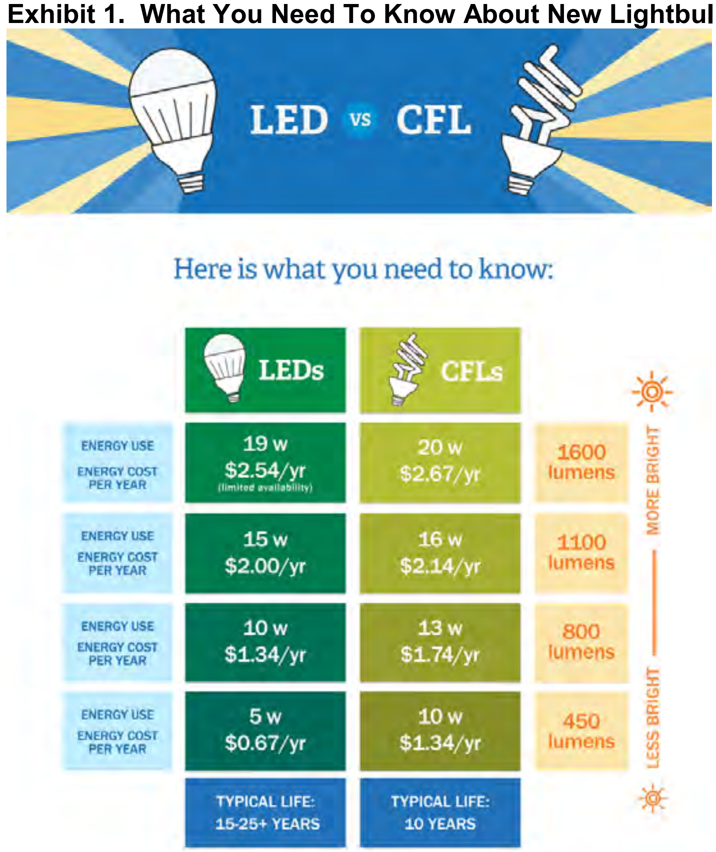
Since the first oil crisis in 1973, the United States has embraced the need to improve its use of energy. Mile-per-gallon standards for automobiles and trucks was one step, as was the adoption of energy-efficiency standards for appliances. Over the next 40 years, significant strides were made in improving overall fuel-efficiency. As part of this effort, the incandescent light bulb, the standard of the electricity business for over a century, was targeted due to its poor energy-efficiency.

Effective in 2014, the production of incandescent light bulbs of over 40 watts was phased out

Effective in 2014, the production of incandescent light bulbs of over 40 watts was phased out, with plans to gradually reduce that threshold as the technology of compact fluorescent lamps (CFL) and light emitting diode (LED) bulbs was expected to improve. One lighting web site described CFLs as the curly light bulbs and LEDs as the long light bulbs, but neither of these new light bulb choices produced the same satisfying light derived from incandescent bulbs.

LEDs produce light when electric currents pass through them. For CFLs, electric current flowing between electrodes at each end of a gas-filled tube causes a reaction that creates ultraviolet light and heat, which is then changed into light when it hits a phosphor coating on the bulb's interior. This process takes anywhere from 30 seconds to three minutes to complete, which is why it seems as if CFL bulbs take a while to become fully lit. The advantage of these two bulb technologies is that CFLs use 25-35% of the energy used by incandescent bulbs, while LEDs use 75% less energy and last 25 times longer than incandescent bulbs.

Exhibit 1. What You Need To Know About New Lightbulbs



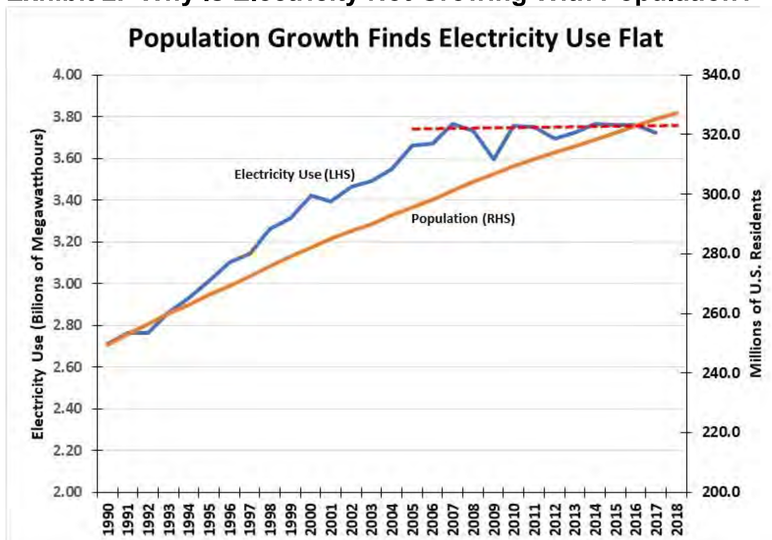
Source: ***sweethomelight.com***

The push for more efficient lighting, coupled with more efficient appliances, is having an impact on electricity consumption in the United States, and will further disrupt the utility business

Exhibit 1 provides a comparison of the energy cost per year, as well as the typical life for LEDs and CFLs rated by wattage. The chart also shows the lumens produced by each bulb, as this has become the new measure for choosing the appropriate light bulb for each application. While incandescent bulbs were not banned until 2014, the switch to more efficient light bulbs had begun earlier. The push for more efficient lighting, coupled with more efficient appliances, is having an impact on electricity consumption in the United States, and will further disrupt the utility business.

Most people are familiar with the concept that electricity consumption grows with our population. This is because electricity, as one form of energy, is responsible for creating our economies and societies, helping them to grow and improve the

Exhibit 2. Why Is Electricity Not Growing With Population?

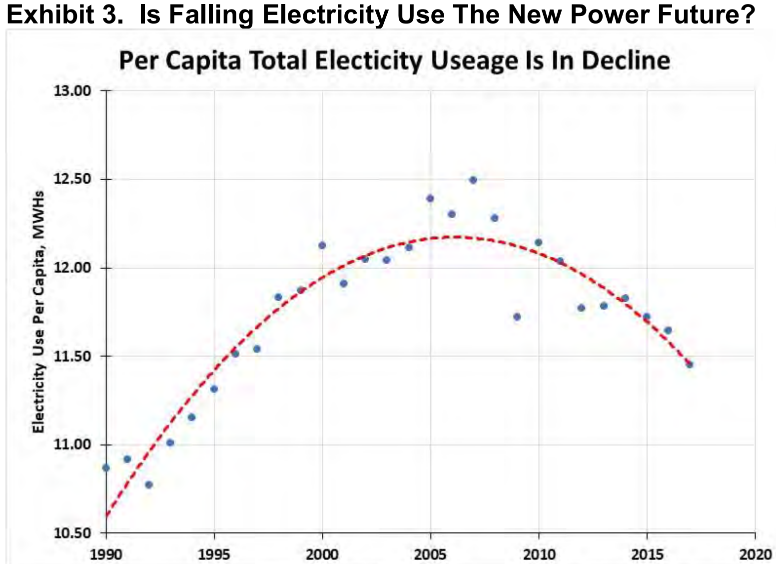


Source: EIA, FRED, PPHB

The shift in consumption from growth to stability has elevated the stress level of utility managers

lives of people. As Exhibit 2 shows, the U.S. population has grown steadily since 1990. Electricity consumption grew at a faster pace between 1990 and 2005, but since then, consumption has essentially remained stable. The shift in consumption from growth to stability has elevated the stress level of utility managers who are attempting to understand whether the traditional drivers of their business have changed, but more importantly, how they can forecast future demand to help them plan their power needs, especially given the different power generation choices available under clean energy mandates.

Exhibit 3. Is Falling Electricity Use The New Power Future?



Source: EIA, FRED, PPHB

Have structural shifts in our economy permanently altered electricity consumption patterns?

Another way of looking at electricity consumption creates even more questions. Exhibit 3 (prior page) shows annual electricity consumption per capita. This shows that peak per capita consumption occurred in 2007, but since then U.S. electricity use per person has been on a downward trajectory, essentially returning in 2017 to 1996 levels. Have structural shifts in our economy permanently altered electricity consumption patterns? Or, is this merely a phase we are going through due to the impact of the switchover from incandescent light bulbs to CFLs and LEDs? That question was posed in an academic paper several years ago.

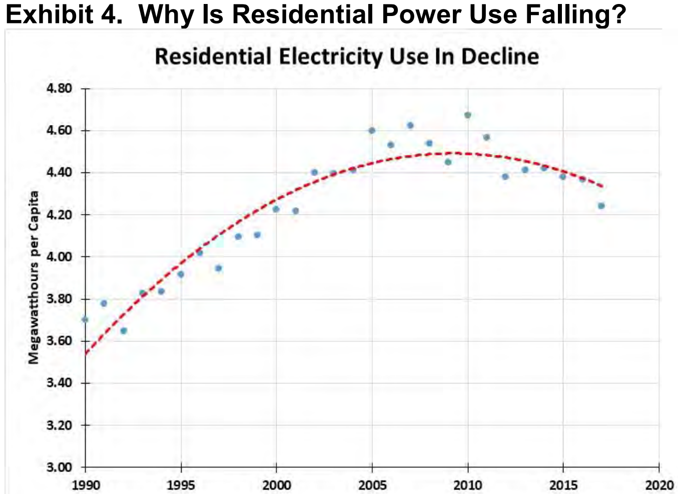
The abstract for this paper sets forth the conclusions from the analysis of the data. The paper was published in 2017, but was limited to data through 2015. The paper's abstract stated:

> "This paper shows that U.S. households use less electricity than they did five years ago. The decrease has been experienced broadly, in virtually all U.S. states and across all seasons of the year. This pattern stands in sharp contrast to steady increases throughout previous decades and has significant implications for household budgets, energy markets, and the environment. Several factors contribute to the decrease, but the rapid emergence of LEDs and other energy-efficient lighting has played a particularly important role.'

That relationship reflected an even more dramatic downturn in consumption than demonstrated when only residential electricity use was considered

Exhibit 3 (prior page) showed total electricity consumption per capita, but we see a similar pattern in per capita use of electricity by just the residential sector (Exhibit 4). This relationship was the focus of the paper, but we were shocked when we first created the chart showing total electricity use per capita. That relationship reflected an even more dramatic downturn in consumption than demonstrated when only residential electricity use was considered.

Exhibit 4. Why Is Residential Power Use Falling?



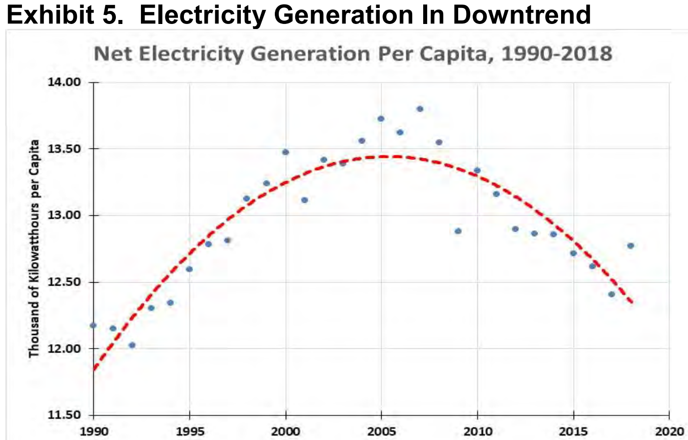
Source: EIA, FRED, PPHB

Solar power was becoming a more important source of residential power and it is often subtracted from total electricity sales due to utilities employing "net-generation" accounting

In comments about the paper following its publication, issues were raised over the role of solar power in the nation's energy use. The point commentators made was that solar power was becoming a more important source of residential power and it is often subtracted from total electricity sales due to utilities employing "net-generation" accounting. In our personal situation, National Grid (NNG-NYSE) in Rhode Island does not allow net-generation, so we have a 15-year contract to sell our solar power to the utility while we continue to pay for 100% of the power we consume. There are two meters on our home – one to measure our electricity use at 16-cents per kilowatthour (kWh), and one for our power sold to National Grid at 34.75-cents/kWh.

We wondered about this issue, so we examined the nation's total electricity generation by fuel type during 1990-2018. In the EIA's table of electricity generation by fuel, there is only one negative power source – hydroelectric pumped storage – but it never exceeded one- or two-tenths of 1% of total power generated annually. That should not distort the total amount of electricity generated, nor the share of generated power by fuel source, and especially when measured on a per capita basis.

Exhibit 5. Electricity Generation In Downtrend



Source: EIA, FRED, PPHB

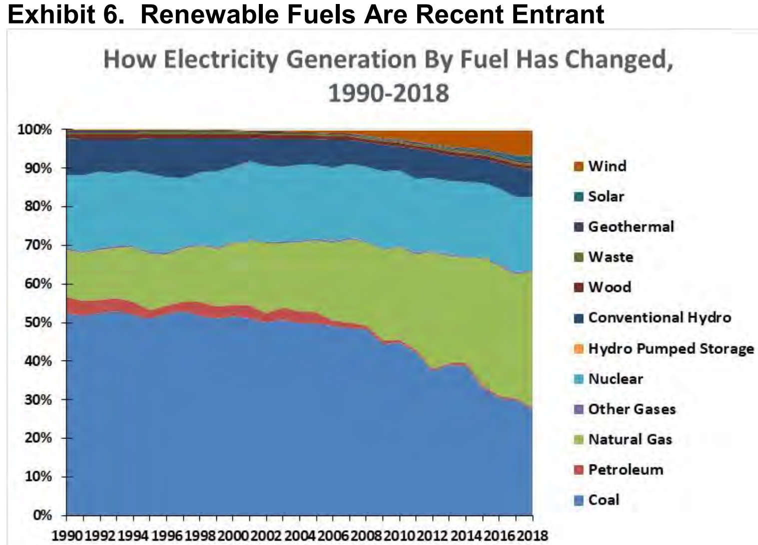
It will highlight the question of whether we are beginning to see the end of the electricity efficiency impact from switching to more energy-efficient light bulbs

When total net electricity generation per capita was plotted, it showed a similar downward trend following a peak in 2007. The most interesting question comes from the 2018 data showing a sharp jump up from 2017, creating a marked deviation from the trend established over the prior decade. Unfortunately, the electricity sales data for 2018 has not yet been posted by the EIA, raising the question of whether it, too, will show a rebound in total and residential electricity use per capita. If so, it will highlight the question of whether we are beginning to see the end of the electricity efficiency impact on consumption from switching to more energy-efficient light bulbs. Interestingly, the rebound in electricity generation per capita only returned that measure to approximately what it was in 2009, 2012-2014, as well as in 1996-97.

Solar only appeared in 2012 (0.1%) and only reached a 1% market share in 2016

Before dismissing the solar question, we examined the share of total electricity generated by fuel for 1990-2018. One can clearly see the major power market story of the shift away from coal, in favor of more natural gas. Nuclear and hydro shares remained stable over the time period, as did wood's, waste's and geothermal's shares. Solar only appeared in 2012 (0.1%) and only reached a 1% market share in 2016. Wind's share of electricity generation appeared earlier and was in the 3% range when solar first registered. It has continued to gain market share, reaching 7% in 2018, compared to solar only having a 2% share. We don't believe solar power's entrance into the market has distorted the calculation of the per-capita electricity use measures.

Exhibit 6. Renewable Fuels Are Recent Entrant

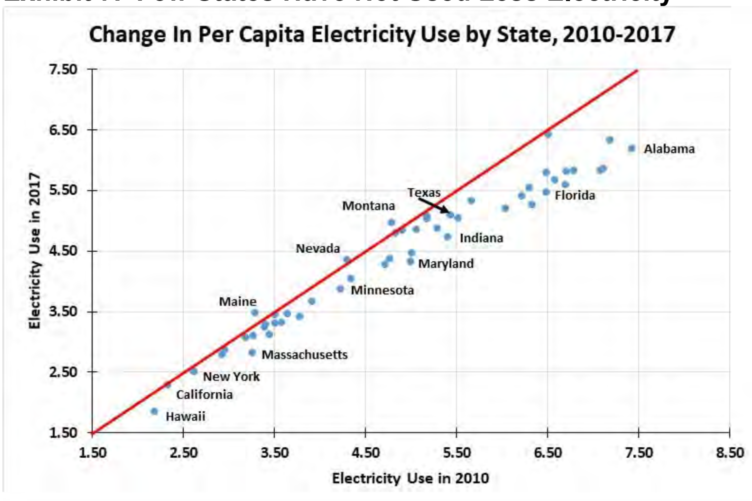


Source: EIA, PPHB

Virtually every state has experienced a decline in per capita residential electricity use

It is important to understand that what we have observed in the electricity market with respect to total and residential usage has been a nationwide phenomenon. We do see some differences among individual states based on geography and clean energy mandates. The bigger picture, however, is that virtually every state has experienced a decline in per capita residential electricity use. We plotted the change in electricity usage between 2010 and 2017 by state (Exhibit 7, next page) that shows only three states failed to demonstrate improvement. Those states were Maine, Montana and Nevada. All three have relatively small populations that can distort the measure, although it is possible the growth of Las Vegas has had a disproportionate impact on Nevada's power consumption. One sees how low Hawaii and California consumption rank, two states where solar is an important contributor to their electricity supply. Although Texas uses more energy per capita than many states, it showed an improvement during this period.

Exhibit 7. Few States Have Not Used Less Electricity

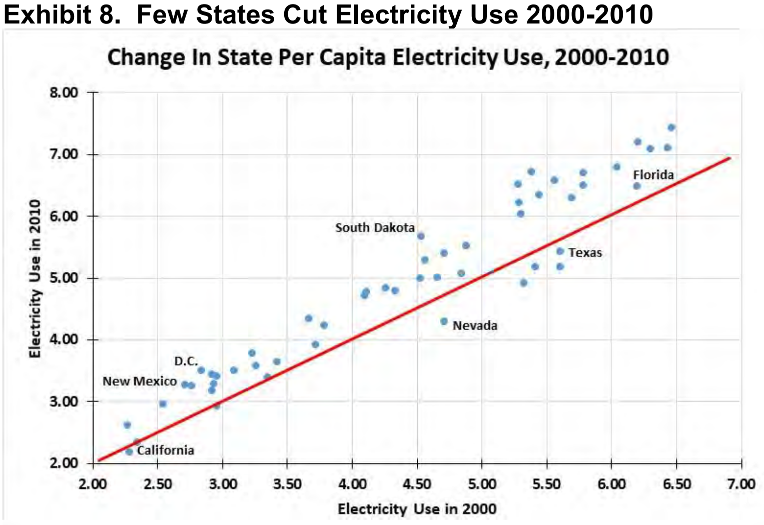


Source: EIA, FRED, PPHB

The state experienced an increase in use between 1990 and 2000, but experienced a decline between 2000 and 2010, as well as during 2010-2017

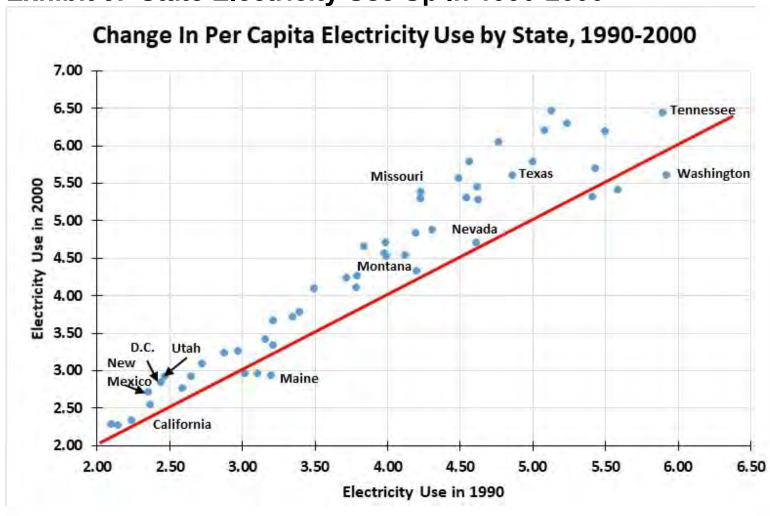
To show how different things are in the various states in recent years, we also calculated the per capita use of electricity between 1990 and 2010 by decades. The charts (Exhibits 8 and 9, next page) demonstrate that most states showed increases in electricity use during those decades. We have labeled the Texas data points to show how the state experienced an increase in use between 1990 and 2000, but experienced a decline between 2000 and 2010, as well as during 2010-2017.

Exhibit 8. Few States Cut Electricity Use 2000-2010



Source: EIA, FRED, PPHB

Exhibit 9. State Electricity Use Up In 1990-2000



Source: EIA, FRED, PPHB

Returning to the central question of whether the decline in residential and total per capita electricity use during 1990-2017 is due to more energy-efficient light bulbs, we considered what the EIA has said about the issue. The EIA estimates that in 2018, the U.S. residential and commercial sectors used about 232 billion kWh of electricity for lighting. This represented about 8% of the total electricity consumed by the combined sectors and about 6% of total U.S. electricity used.

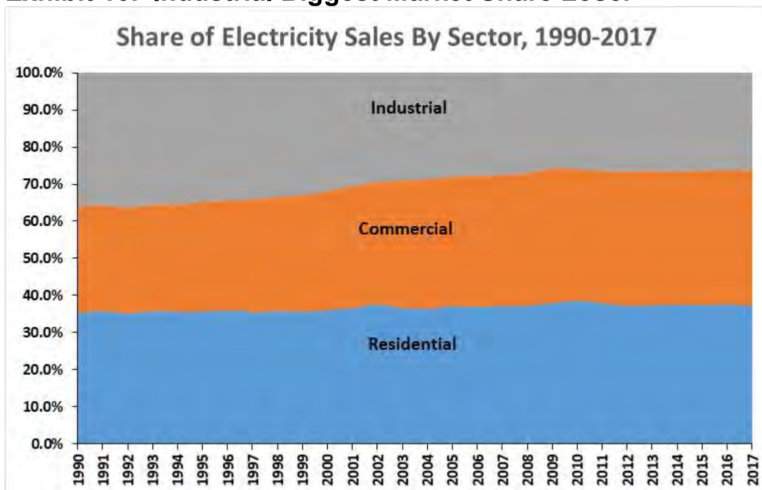
Electricity consumption for lighting by the residential sector totaled about 91 billion kWh or about 6% of total residential sector electricity consumption in 2018

Electricity consumption for lighting by the residential sector totaled about 91 billion kWh or about 6% of total residential sector electricity consumption in 2018. The commercial sector, comprising commercial and institutional buildings, as well as public street and highway lighting, consumed about 141 billion kWh for lighting, equal to about 10% of total commercial sector electricity consumption in 2018. The EIA does not have a separate total for public street and highway lighting.

Electricity for transportation in 2017 accounted for two-tenths of one percent of total electricity sales

Our conclusion is that the mandated use of more energy-efficient light bulbs has had an impact on residential electricity use. What remains unclear is whether the bulb switch is the primary factor in the per capita electricity use decline, or if something else is at work. This is an important consideration for the utility sector as it considers how to plan future generation needs. We examined the share of residential, commercial and industrial electricity sales over 1990-2017. As a side note, electricity for transportation in 2017 accounted for two-tenths of one percent of total electricity sales. That power would presumably be for electric vehicles, but likely it is for commercial operations such as trains and buses, rather than electric vehicle charging, which is usually done at home (residential) or at parking facilities (commercial).

Exhibit 10. Industrial Biggest Market Share Loser



Source: EIA, PPHB

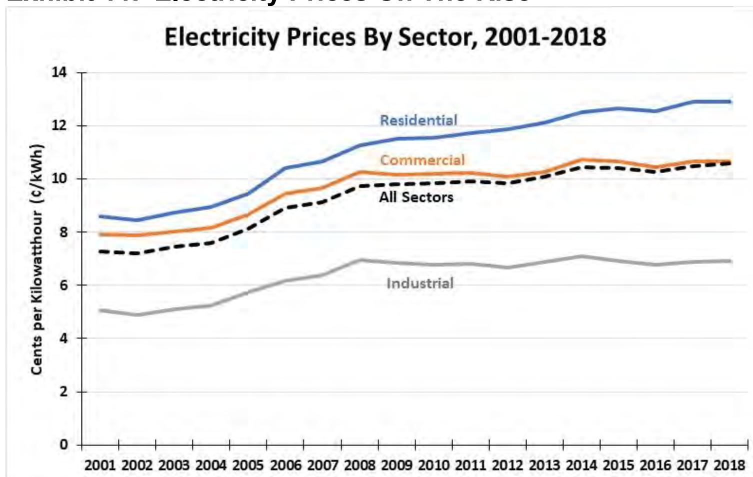
It is also likely that as industrial facilities have opted to supply their own electricity their sales are no longer captured by EIA statistics

The electricity sales data showed that the residential share was extremely stable during 1990-2017, but the commercial share rose as the industrial share declined. The decline of the American manufacturing sector during this period may help explain some of the lost industrial market share. It is also likely that as industrial facilities have opted to supply their own electricity their sales are no longer captured by EIA statistics. We do not know if there has been any reclassification of facilities between industrial and commercial, but, for purposes of analysis, we have assumed stability in sector classifications.

With mandated standards forcing consumers to purchase more efficient devices given the standards requiring increasingly greater energy-efficiency, power consumption will be under pressure, and likely decline on a per capita basis

The last consideration about the electricity per capita decline is how much consumer behavior may be influenced by price. As the share of electricity sales by sector shows, the industrial sector appears to be more price sensitive, although the history of prices does not reflect a serious increase over 2001-2018. On the other hand, residential and commercial price increases have been much more prominent during the period. In some states, such as Texas, residents can purchase their own electricity and have the local distribution company deliver the power. Elsewhere, people must purchase electricity in a bundled arrangement – the power and the distribution. In those arrangements, customers have little choice about the price they pay for their power. The only realistic option most electricity buyers possess is to reduce the amount of electricity they use. That would have them buying more energy-efficient light bulbs and appliances. With mandated standards forcing consumers to purchase more efficient devices given the standards requiring increasingly greater energy-efficiency, power consumption will be under pressure, and likely continue to decline on a per capita basis. We will be very interested to see the sales data for 2018 and whether it reflects a rebound, as we saw in the generation data.

Exhibit 11. Electricity Prices On The Rise



Source: EIA, PPHB

Utility executives wonder what electricity growth their territories will experience, and if they must prepare for an onslaught from electric vehicles all wanting to be recharged in the same daily time-window

After studying the data, we have a much greater appreciation for the challenges facing electric utility executives. Not only are they facing having to generate more electricity from clean energy fuels, but they must adjust operations to handle increased intermittency in their power supply. Utility executives wonder what electricity growth their territories will experience, and if they must prepare for an onslaught from electric vehicles all wanting to be recharged in the same daily time-window. Make one misjudgment about any of these variables and your company's future viability may be at risk. The data on demand does not provide assurance that electricity consumption growth is over. If the lighting switchover is finishing, power consumption may start growing again, forcing a reassessment of electricity generation needs. The next several years may provide a clearer view of the future for electricity consumption. What will not be resolved in that time period is how our future power generation will be fueled.

Why The Natural Gas Market Remains So Disappointing

The simple explanation is that gas production continues to grow and demand not so much

From promising to disappointing. The trajectory of the natural gas market has gone from good to bad as reflected by the recent drop in prices to $2.50 per thousand cubic feet (Mcf). The simple explanation is that gas production continues to grow and demand not so much. Supply has been growing so much that key basins lacking adequate pipeline capacity to ship the gas to markets have been forced to flare it – a wasteful and environmentally damaging step. To rectify this condition, midstream companies are racing to build new and expand existing pipelines to handle this growing gas output. For gas buyers, current prices reflect glut-like conditions, which they are thoroughly enjoying.

The market gradually grew comfortable in the industry's ability to deliver adequate gas supplies to meet consumption needs, as well as keeping storage from falling into disruption territory

Late last year the U.S. was hit with two polar vortex weather events that drained gas storage supplies and ratcheted up prices. Speculators seized on the fear that the U.S. would experience more polar vortex events, further imperiling gas supply. Total gas storage volumes slipped slightly below the 5-year average minimum storage level, but quickly rebounded back into the 5-year minimum-maximum band easing fears of a possible supply shortage. Although early in the year, storage withdrawals for several weeks were well above the 5-year average weekly withdrawals, the market gradually grew comfortable in the industry's ability to deliver adequate gas supplies to meet consumption needs, as well as keeping storage from falling into disruption territory.

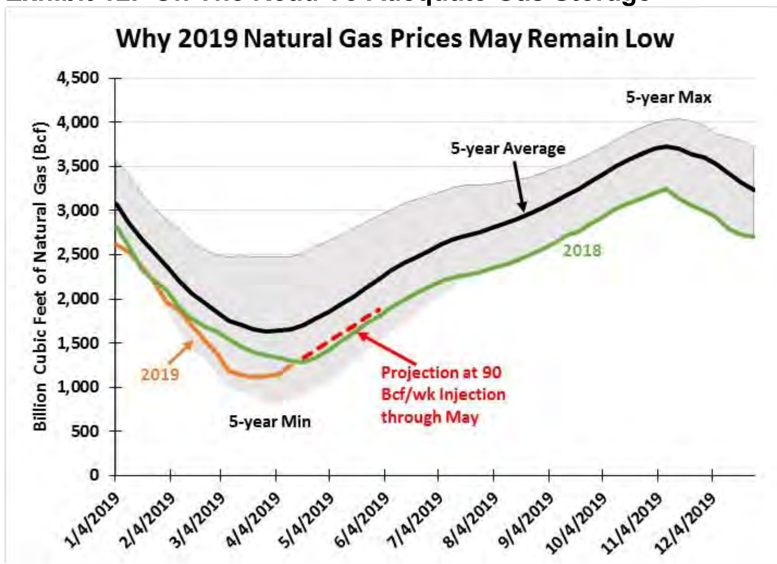
For the week ending April 12, the U.S. Energy Information Administration (EIA) reported that the industry injected 92 billion cubic feet (Bcf) of gas into storage, nearly five times the average weekly injection rate for the comparable week during 2014-2018. The news promptly sent gas futures prices down by 10-cents per Mcf. From Friday, April 12 to the closing price on Thursday, April 18, the day of the weekly gas storage report, the near-month gas futures price dropped 6.4% from $2.66 to $2.49/Mcf. Only about two cents of the 17-cent decline happened the day after the EIA issued its storage report. In other words, the market sentiment was negative (expecting a very large injection volume) heading into the report's issuance. According to one "consensus" estimate, analysts expected an injection of 85 Bcf, so the 92 Bcf injection was 108% of expectations.

Indications from futures prices suggest the market is assuming above-trend weekly gas injections can be sustained for weeks

The EIA's chart of gas storage volumes, compared to the 5-year history, shows how last week's injection of an additional 92 Bcf has created a sharp upturn in the 2019 storage volume line. As long-range weather forecasts for spring and summer call for moderating temperatures, expectations are for an absence of air conditioning load that would jack up electricity use, prompting more gas being burned by generators. There will be more liquefied natural gas (LNG) shipments, but we are already handling greater export volumes now. Indications from futures prices suggest the market is assuming that above-trend weekly gas injections can be sustained for weeks.

In Exhibit 12 (next page) we show the 5-year range for gas storage along with the 5-year average volume. We have also shown 2018's gas storage volumes (green line) and the 2019 volumes to date (orange line). As of the April 12 weekly report, 2019 gas storage was equal to 96% of the volume at the same time last year, and 75% of the 5-year average storage amount. If we target the week of November 1, 2019, as the end of the gas injection season, we have 29 weeks to rebuild storage. To reach the same volume of gas in storage as 2018, the industry needs to inject an average of 67.3 Bcf/week. In order to hit the equivalent 5-year average volume, the weekly injection rate would need to reach 84.6 Bcf/week.

Exhibit 12. On The Road To Adequate Gas Storage

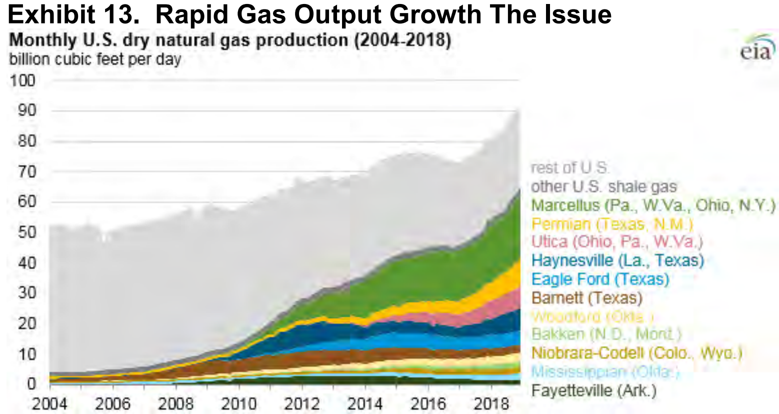


Source: EIA, PPHB

To reach the 2018 storage total as of November 1, the subsequent 22 weeks of the injection season, following our projection period, only needs to average 60.1 Bcf/week

To consider how the industry might fare, we projected weekly storage injections of 90 Bcf/week for the balance of April and all of May. That projection is shown as the red dotted line. It reflects storage volumes will grow in line with last year's pace of weekly storage injections, and lifting storage volumes above 2018's volumes. This scenario will be comforting for gas buyers. Importantly, to reach the 2018 storage total as of November 1, the subsequent 22 weeks of the injection season, following our projection period, only needs to average 60.1 Bcf/week. To hit the maximum storage volume, the industry would need to average a weekly injection rate of 82.9 Bcf/week, considerably more than needed to meet last year's total, but which turned out to be adequate to keep market prices in check.

Exhibit 13. Rapid Gas Output Growth The Issue



Source: EIA

Again, the reason for the market's confidence is gas producers continuing to deliver healthy growth in gas production. The EIA prepared a chart (prior page) showing monthly gas production since 2004 (start of the shale gas boom) by basin through 2018. Attention should be directed to the slope of total gas production since the start of 2017. That is the sharpest growth rate during the entire period.

The market's problem, however, may be production growth in 2020

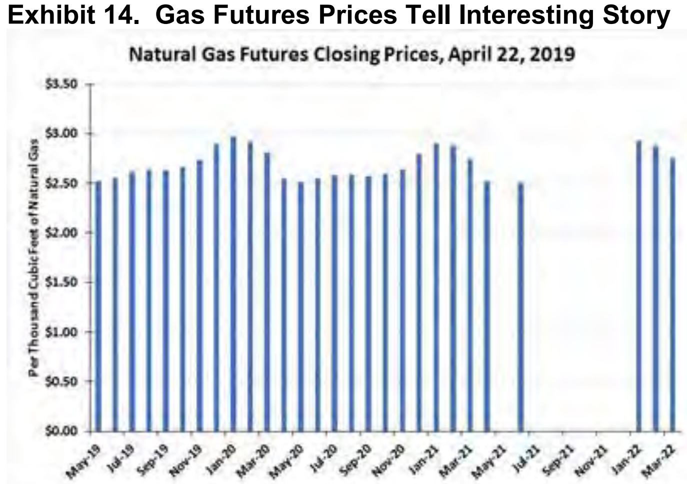
The EIA remains confident in gas production growth, at least for 2019. Based on the April Short Term Energy Outlook (STEO) projections from the EIA, Lower 48 marketed gas production, including the Gulf of Mexico, is expected to climb from 95.09 Bcf/day in March 2019 to 98.01 Bcf/day in December 2020, a 3 Bcf/day increase. The market's problem, however, may be production growth in 2020. According to the STEO, December 2019 production will be 98.53 Bcf/day, which then climbs slowly to 99.01 Bcf/day in August 2020 before declining to 98.01 Bcf/day to end 2020. That will actually reflect a decline in gas output for 2020.

Production is expected to grow between the two periods by 8.28 Bcf/day, but only 1.43/Bcf/day in 2020

To assess how well the gas industry will handle demand growth this summer while rebuilding gas storage for next winter, we used the STEO forecast for 2019 and 2020 compared to the average monthly figures for April-October 2018. Production is expected to grow between the two periods by 8.28 Bcf/day, but only 1.43/Bcf/day in 2020. When we subtract volumes to reflect forecasts for LNG export growth and net pipeline import volumes, the cushion of supply shrinks to 5.49 Bcf/day in 2019, and actually turns negative in 2020 by 0.92 Bcf/day.

Unless there is a significant growth in domestic gas consumption due to higher gas-fired electric power generation demand, there appears little to be feared about a natural gas supply shortfall this year. That outlook may change in 2020, but the forecasts of the variables may be revised before then.

Exhibit 14. Gas Futures Prices Tell Interesting Story



Source: EIA, PPHB

The 2021-2022 winter peak price fails to breach the magical $3/Mcf threshold thought to be crucial for the future of the industry

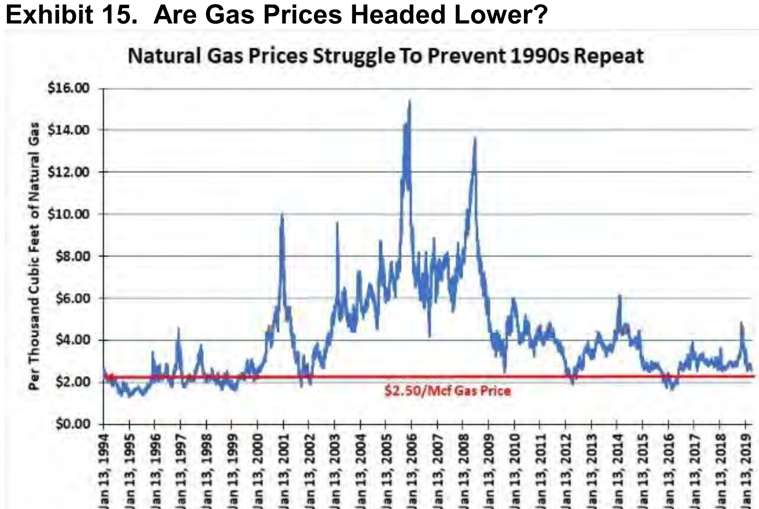
Given the seemingly huge cushion of gas supply for 2019, but potential questions about 2020's supply outlook, traders and forecasters will spend hours arguing over the current shape of the future natural gas price strip. When we examined gas futures prices at the close of trading on Monday, April 22, the January 2020's price of $2.973/Mcf was the peak for any future price, at least through early 2022. The 2021-2022 winter peak price fails to breach the magical $3/Mcf threshold thought to be crucial for the future of the industry. The May 2020 price of $2.517/Mcf was the lowest monthly futures price until early 2021. That May 2020 price was below the May 2019 price of $2.523/Mcf.

Future winters still fail to stimulate the gas market. The winter of 2020-21 showed January 2021's price below that of January 2020 by 6.8-cents/Mcf, at $2.905/Mcf. Even the January 2022 price fails to reach $3/Mcf, clocking in at only $2.928/Mcf. This futures pricing structure signals significant complacency among gas buyers.

Gas prices have only fallen below $2.50/Mcf four times since the late 1990s

We may actually be approaching a critical point for the natural gas market. A look at gas futures prices since mid-January 1994, we see that gas prices have only fallen below $2.50/Mcf four times since the late 1990s. During that period, the futures price only fell below $2.00/Mcf twice. None of the excursions below those price thresholds lasted for any length of time.

Exhibit 15. Are Gas Prices Headed Lower?



Source: EIA, PPHB

What traders know is that any supply shortfall, assuming gas production growth truly slows as much as forecast, could be cushioned by a delay in LNG shipments

Barring a significant supply or demand shock, the current weakness exhibited by natural gas prices appears justified by the projected health of production. The uncertainty for the gas market is the 2020 supply outlook, but gas traders and speculators seldom look that far ahead when trading commodity futures. What traders know is that any supply shortfall, assuming gas production growth truly slows as much as forecast, could be cushioned by a delay in LNG shipments or greater gas imports from Canada and reduced gas exports to Mexico. The critical variable is the EIA's future production growth forecast. There are plenty of moving parts in all the natural gas scenarios. The variability in these scenarios gives energy [pardon the pun] to gas traders and speculators.

Weak Auto Sales Could Be A Sign Of An Energy Challenge

Maybe autonomous vehicle technology is arriving at the right time, although few industry executives would argue that case as it denigrates the value of the remainder of the automobile business

The past several weeks seem to have been all about automobiles, or at least personal transportation. On Wall Street, the focus of investors was on the initial public offering (IPO) of the ride-hailing company Lyft, Inc. (LYFT-Nasdaq). The talk has also been about the upcoming IPO of Uber Technologies, Inc., Lyft's leading competitor. At this same time, the New York auto show opened with auto company executives talking positively about their new vehicles and how vehicle sales would remain healthy in 2019, despite first quarter weakness. Elon Musk recently held forth on the success Tesla, Inc. (TSLA-NYSE) is having in developing its self-driving car technology, which he predicts will lead to the company putting a fleet of robotaxis on the road next year. This comes at a time when Uber indicated it is close to raising $1 billion for its self-driving unit, and investors are talking about Lyft's true future being success in autonomous vehicles, not ride-hailing. Maybe autonomous vehicle technology is arriving at the right time, although few industry executives would argue that case as it denigrates the value of the remainder of the automobile business.

Projections call for car sales in 2019 to total 16.6-16.8 million units, down from the 17.2 million sold last year

Ward's Automotive reported that new car sales between January and March fell 2% compared to last year, representing sales of just over four million vehicles. Projections call for car sales in 2019 to total 16.6-16.8 million units, down from the 17.2 million sold last year. That is certainly not a disastrous outlook given the strong sales that have existed for the past several years. What is bothersome for executives is the challenges facing new vehicle sales. These issues include vehicle costs and how buyers are financing their purchases, especially given the uptick in interest rates on car loans.

The pool of new car buyers is shrinking due to higher vehicle prices and affordability concerns

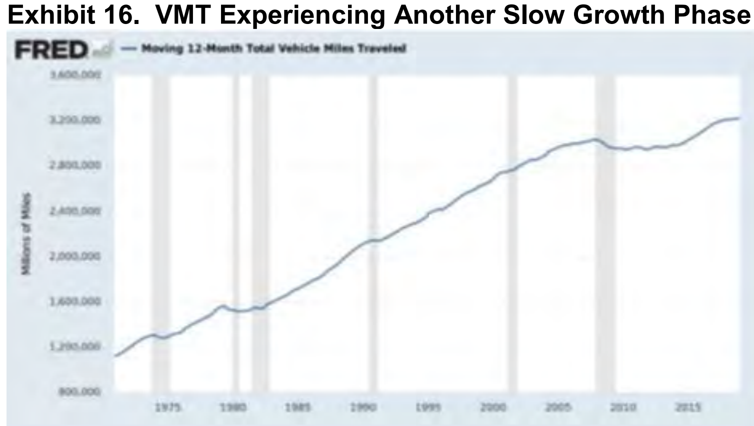
According to Jonathan Smoke, the chief economist at *Cox Automotive*, the weakness in auto sales has been on the retail side. Sales incentives are low and auto loan rates have not improved. As a result, the pool of new car buyers is shrinking due to higher vehicle prices and affordability concerns. So far this year, average new vehicle loan payments are up 3.5% at $567 per month, while average lease payments have increased 2.8% to $500 per month. The ability to reduce monthly payments by extending loan terms appears to have hit a wall at 72 months, although occasionally loans for 84 months are available. These hurdles are pushing people into purchasing used cars, where the average loan payment is $414 per month, up only 1% from a year ago. This buyer shift is a reason for the recent strength in used car prices.

While many investors are focusing on near-term challenges for the automobile industry, executives are wrestling with numerous macro trends that could significantly reshape their industry and its fortunes

While many investors are focusing on near-term challenges for the automobile industry, executives are wrestling with numerous macro trends that could significantly reshape their industry and its fortunes. Issues such as how vehicle miles traveled (VMT) may shift as populations age, what impact will autonomous vehicles have on VMT, how about the impact of ride-hailing on the need for vehicles, and what if the love-affair between youths and cars has ended? These are only a few of the key questions, but their outlook will shape the types and powering of vehicles the industry builds.

The auto industry was in shambles during the financial crisis and recession of 2008-2009. Conditions were so devastating that major auto manufacturers such as General Motors (GM-NYSE) and Chrysler LLC were forced into bankruptcy restructurings with government-sponsored support. One aspect of that period was a sharp decline in VMT. The decline and subsequent years of flat VMT raised questions about whether the public had reached capacity for buying and driving cars. It wasn't until the second half of 2013 that VMT began to trend upwards, only to reach a new plateau in 2017. Many analysts spent much of the 2010-2013 period attempting to ascertain whether the youths at that time had permanently rejected their historical relationship with driving and car ownership. It was easy to say it had, as we now had ride-hailing, working from home and Internet shopping, all negating the need to own or drive a car.

Exhibit 16. VMT Experiencing Another Slow Growth Phase



Source: St. Louis Federal Reserve Bank Research

The delays were shattering decades-long patterns of youths getting driver's licenses when they turned 16 years old

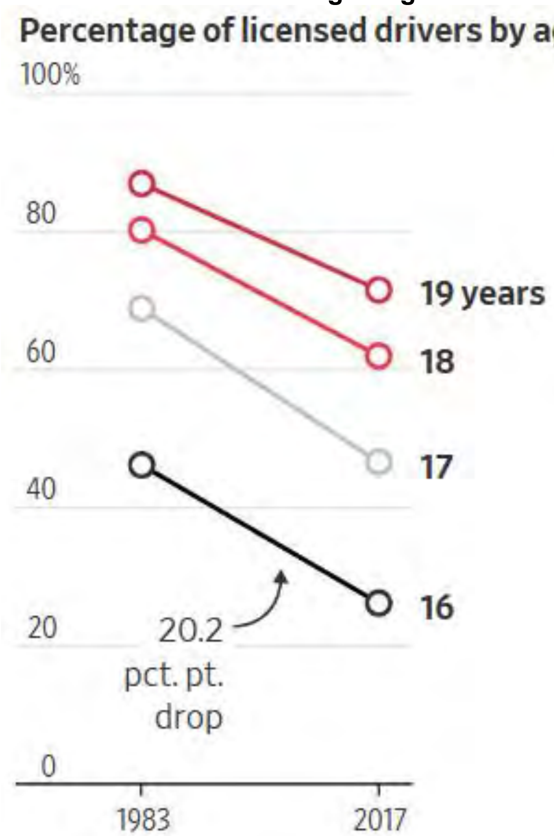
Great attention was directed to how youths were delaying securing their first driver's licenses. The delays were shattering decades-long patterns of youths getting driver's licenses when they turned 16 years old. Purchasing new or used cars often followed, but certainly that was tied to employment and living arrangements. In this era, students graduated from colleges and moved back into their parents' homes. Questions were raised about the shape of our future society and how it would impact economic activity and the transportation industry.

The Internet and social media negate the historical need for kids to visit their friends in person – they can now do it online

Today, this debate has begun again, as new car sales are weak and the hype over ride-hailing ventures and autonomous vehicles is growing. *The Wall Street Journal* recently wrote a long article about the shift in attitudes of youths toward driving and vehicle ownership and how auto companies are reacting. The article, titled "Driving? The Kids Are Over It" focused on all the issues discussed above. The Internet and social media negate the historical need for kids to visit their friends in person – they can now do it online. Who needs a car when ride-hailing services are available? When they reach their 20s, kids often move to urban areas with mass transit, so owning a car is neither a necessity nor practical. When these youths do take the vehicle ownership step, purchasing a used car is their preferred option due to high new car prices, according to *J.D. Power*.

The article captured many of these trends in charts. The lack of interest in driver's licenses is reflected in the significant decline in the percentage of teenagers, by age, holding them. We can attest to this as our two youngest granddaughters have yet to secure their licenses as they reached 17-18 years old.

Exhibit 17. Youths Waiting Longer For Licenses

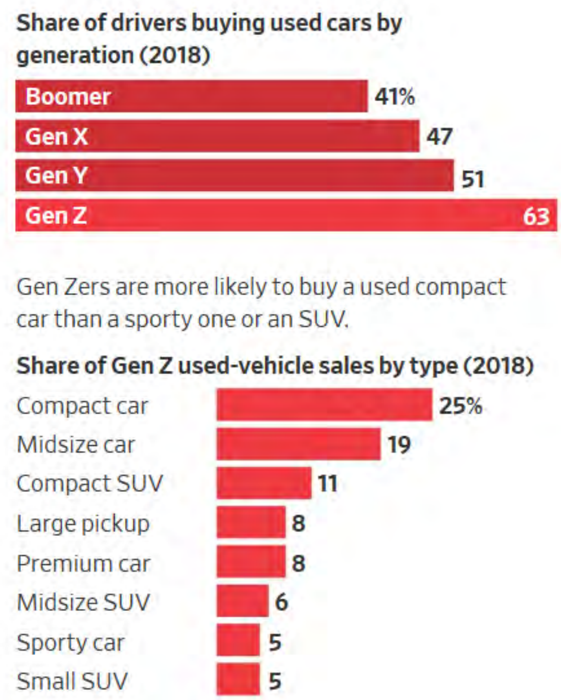


Source: ***J.D. Power, WSJ***

It has led Japanese car makers to keep small sedans into their lineups in hopes of providing an entry point that may cement a long-term commercial relationship

The car purchasing trends are supported by charts showing used car buying by age category and the tendency of the youngest buyers (Gen Z) to purchase the smallest, and presumably cheapest, cars. The article pointed out that auto executives are aware of these trends – even noting them among their own families. It has led Japanese car makers to keep small sedans into their lineups in hopes of providing an entry point that may cement a long-term commercial relationship. Detroit auto manufacturers remain convinced that today's Gen Zers will eventually marry, have families and move to the suburbs, prompting them to purchase SUVs and trucks. That strategy appears to be working as the latest statistics do show growth in millennials marrying, starting families and moving to the suburbs.

Exhibit 18. How Youths Approach Car Buying



Source: ***J.D. Power, WSJ***

They provided 13 households with free chauffeur service for 60 hours for one week

The issue of VMT is more vexing. As personal transportation changes, given the emergence of ride-hailing and autonomous vehicles, will the world have fewer vehicles, but more in constant motion? What might that combination mean for VMT – more or fewer? An experiment conducted by researchers at the Energy Institute at HAAS attempted to answer that question. They provided 13 households with free chauffeur service for 60 hours for one week. That meant someone else would drive wherever the person wanted to go, and was even available to run errands. The household still had to pay for the gas and lease payments, which was mimicking autonomous ride-hailing services.

The experiment was not perfect as an autonomous vehicle would have all seats in the vehicle available, not one less due to the chauffeur. Secondly, historical studies have shown that when people are closely observed their actions may change, such as not wanting to take a trip and have someone watching them in the vehicle. The chauffeur is also a human driver, subject to accidents and routing problems. Lastly, those selected for the study were not picked randomly, and the sample was small.

Overall, VMT increased by 83% for the sample – ranging from a 4% increase for a millennial and a 341% increase for a retiree

Nevertheless, the results of the experiment provided some ballpark estimates of what may happen to VMT with autonomous vehicles. Overall, VMT increased by 83% for the sample – ranging from a 4% increase for a millennial and a 341% increase for a retiree. Everyone sent the car off without them at least once, which was responsible for a third of the VMT. Two-thirds of those VMT were with only the chauffeur.

The usage pattern shifted to a 60% increase in trips, and more trips at night (90% increase). Longer trips were also noted – a 90% increase in trips of over 20 miles. Seniors don't drive as much normally, but when provided with the chauffeur, they were out, especially at night, and going on longer trips. Interestingly, one-third of the subjects decreased their walking, while the other two-thirds increased. (This was an interesting point since other studies of ride-hailing services show that walking and the use of mass transit in urban areas declines.)

The study, as unscientific as it was, suggests that the transportation freedom offered by autonomous vehicles may be more aggressively seized by seniors rather than youths or young families

While this study is not something that can be extrapolated into a national impact measure, it certainly provided some interesting reference points, especially about aging populations. The conventional wisdom is that as we age, we drive less due to no longer needing to commute to work and not being comfortable driving at night. The study, as unscientific as it was, suggests that the transportation freedom offered by autonomous vehicles may be more aggressively seized by seniors rather than youths or young families. What we don't know is how autonomous vehicle services will be priced. One of the more interesting facts to emerge from the prospectuses for Lyft and Uber is their lack of profitability, and questions about whether their drivers are actually subsidizing the companies by receiving less income than if they had regular jobs.

Automobile executives are under mandates about how their vehicles are to be powered, increasing the challenge of matching technology with the desires of the car-buying public. At the same time executives are dealing with government rules, they are faced with unclear social trends impacting the car-buying population. It has become increasingly clear that energy company executives need to pay attention to the trends reshaping the automobile and personal transportation businesses, as they will impact consumption of oil. Ignoring these trends could prove dangerous.

Alberta Makes Election History: New Energy Course?

As historical as that was, political polls predicted the outcome

Alberta's provincial election on April 16th established a record. For the first time ever, an incumbent provincial government was turned out of office after just one term of service. As historical as that was, political polls predicted the outcome. With polls showing Jason Kenny's United Conservative Party (UCP) leading by 8% over Rachel Notley's New Democrat Party (NDP), the new legislature's makeup will be more dramatically altered. There will be 63 UCP representatives compared to only 24 NDPers. No other political party secured a seat. This election marked a huge swing, as the NDP held 52 seats going into the election, while the UCP held 25.

We wrote previously of the negative tone of the campaign. That was due to the NDP's reliance on identity politics rather than substantive economic issues as used by the UCP. It appears the UCP's platform was more appealing to the voters than targeting individuals. How will it translate into Alberta's economic future and its energy industry's outlook?

It is important to recognize how Alberta's election fits into the evolving Canadian political narrative. Alberta now is the fifth province with a conservative government. Collectively, the five provinces account for 60% of Canada's population. Mr. Kenney plans to work closely with the other four conservative provincial leaders (Saskatchewan, Manitoba, Ontario and New Brunswick) to challenge the economic and social policies of the Liberal federal government headed by Prime Minister Justin Trudeau.

Repealing the Alberta carbon tax will be the UCP's first act

The five conservative provinces oppose carbon taxes. Repealing the Alberta carbon tax will be the UCP's first act. The UCP said Bill 1 - The Carbon Tax Repeal Act - would scrap the tax on "everything" and create 6,000 jobs. It plans to replace the tax with a program targeting large carbon emitters. The UCP is calling the new program Technology Innovation and Emissions Reductions, or TIER, and plans to have it effective Jan. 1, 2020. Under the plan, facilities with emissions greater than 100,000 tons of CO2 will have to reduce their emissions intensity by 10%, initially, and increasing by 1% per year. Those unable to reduce their emissions can buy credits or offsets, while also being able to pay into a fund to study ways to curb greenhouse gas emissions. The UCP has also promised to file a court challenge to the federal government's backup carbon tax no later than April 30.

Other UCP economic plans include enacting a new farm safety act to deal with the economic pressures faced by farmers and ranchers. It will require employers to maintain workplace insurance for farm workers, while providing employers the freedom to purchase insurance anywhere if the policies meet basic coverage standards. The UCP will also attack regulations to reduce costs and speed up approvals of various projects. It will also maintain or increase health spending and maintain a universally-accessible, publicly-funded system. However, the UCP will also explore private delivery options for some procedures. Importantly, the UCP promises to move Alberta into a profitable financial state by 2023, a year earlier than projected by the NDP.

For the oil industry, the most important issue is the UCP's plan to cancel Ms. Notley's oil-by-rail plan

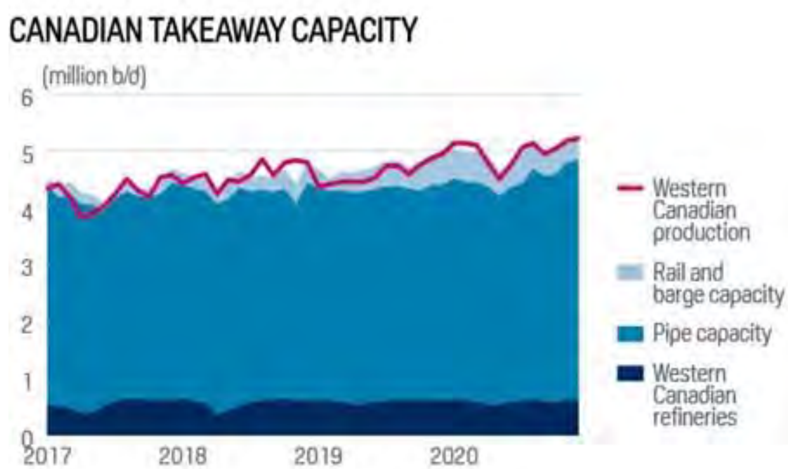
For the oil industry, the most important issue is the UCP's plan to cancel Ms. Notley's oil-by-rail plan, which involved leasing 4,400 tank cars and necessary locomotives to ship 120,000 barrels per day of Canadian oil to the U.S. The C$3.7 billion ($2.8 billion) plan is designed as an intermediate step for boosting Alberta's oil exports until the Trans Mountain Pipeline expansion project is built, which could be three years away.

Based on the plan, the first oil train of 20,000 barrels per day (b/d) is expected to roll by July. The full 120,000 b/d capacity will be achieved by mid-2020, suggesting increments of 20,000 b/d and likely every two months. Therefore, by the end of 2019, Alberta should be shipping 60,000 b/d. The government plans to buy crude from Alberta producers and then sell different grades to various destinations including the U.S. Gulf Coast. The Alberta Petroleum Marketing Commission has inked contracts with CN and CP for service, staff and track capacity, as well as the rail tank cars and capacity to load oil into the cars. Contracts to unload oil at the railways' destinations have yet to be disclosed.

One wonders whether there is much that can be done at this point to upset the oil-by-rail program

Premier-Elect Kenney has said he wants to review the contracts, but one wonders whether there is much that can be done at this point to upset the oil-by-rail program. When we examine Exhibit 19 showing Canada's oil takeaway capacity, we can see how in the second half of 2018 the province's production (red line) exceeded its domestic needs and export capacity. That was temporarily rectified with the

Exhibit 19. Egress Capacity Is Critical



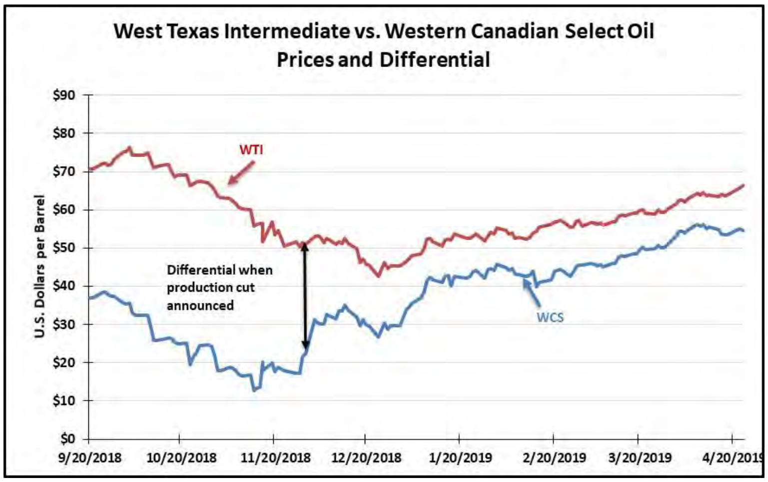
Source: Platt's, *Globe and Mail*

mandatory production cut and the addition of some rail capacity by oil producers. If the Platts' chart is correct, by the end of 2019/early 2020, Canadian oil production will again exceed egress capacity for a short while. If the Alberta government's rail capacity is eliminated, or even reduced, the production surplus might arrive sooner and continue longer, likely to depress wellhead prices.

What we have learned from Alberta's mandatory production cut experiment is that it has worked to boost WCS wellhead prices and shrink the discount from WTI prices

What we have learned from Alberta's mandatory production cut experiment is that it has worked to boost Western Canadian Select (WCS) wellhead prices and shrink the discount from West Texas Intermediate (WTI) prices. Of course, not everyone in the Canadian energy business was happy with that step, as fully integrated producers enjoyed the record price discounts for WCS as they sold cheap refined products into strong consumer markets, reaping profits that have now disappeared.

Exhibit 20. How Production Cut Has Narrowed Oil Prices



Source: ***Oil Sands Magazine*, PPHB**

Repairing the health of its energy industry will require fixing the egress issue

While the next few months will be interesting as Alberta's government returns the province to a more conservative governing philosophy, but repairing the health of its energy industry will require fixing the egress issue. Pipelines are the most efficient and safest method to move crude oil, but until the political battles between Alberta and its neighbor to the west – British Columbia – and the province and the federal government, this option will be foreclosed. Canada's next national election is scheduled for this fall. Watch for the battles between the conservatives and the liberals to begin before long.

EVs And Wind Power Suffer Slings And Arrows Of Reality

Earth Week presented an opportunity for critics to weigh in on weak points in the green solutions for decarbonizing our world. *The Wall Street Journal* offered an editorial: "Germany's Dirty Green Cars."

"Considering Germany's current energy mix and the amount of energy used in battery production, the CO2 emissions of battery-electric vehicles are, in the best case, slightly higher than those of a diesel engine, and are otherwise much higher"

The editors utilized a new study from Germany's ifo Institute's Center for Economic Studies, a government funded think-tank that concluded: "Considering Germany's current energy mix and the amount of energy used in battery production, the CO2 emissions of battery-electric vehicles are, in the best case, slightly higher than those of a diesel engine, and are otherwise much higher." The gist of the study, which we have not read, was that when the CO2 emissions from manufacturing and operating a battery electric vehicle (BEV) for 10 years - a Tesla Model 3 compared to a Mercedes C220d diesel sedan – the BEV's were greater. The scientists estimated the Mercedes emitted 141 grams of carbon dioxide per kilometer driven, including the carbon emitted to drill, refine and transport its fuel. For the Tesla, the figures came in between 156 and 181 grams.

A prominent supporter of electric vehicles, electrik.co immediately challenged the report as flawed by its metrics and stating the conclusions have been "debunked" by previous studies

As expected, a prominent supporter of electric vehicles, *electrik.co* immediately challenged the report as flawed by its metrics and stating the conclusions have been "debunked" by previous studies. We won't get into the arguments, but the critique specifically stated that the study did not include the CO2 from producing the diesel fuel. We will trust the *WSJ* to have had someone in their German bureau read the report, and probably talk to the scientists. As a result, that claim is false. Yes, part of the debate is about how Germany fuels its electric grid with a large amount of brown coal (lignite), some of the dirtiest coal available. Using lignite has become a necessity due to the push to shut down the German nuclear power industry and replace it with wind and solar. Not only has this effort led to dirtier air in Germany, its citizens pay among the highest retail electricity prices in Europe. Powering BEVs with France's heavily nuclear-generated electricity would yield a much cleaner car.

In calculating fleet emissions, EVs are awarded a zero for emissions, which seems unrealistic, but politically acceptable

The point of the editorial and the report, based on our reading of ifo's press release, is criticism about how the European Union has tilted the regulatory field in favor of electric vehicles (EV). In calculating fleet emissions, EVs are awarded a zero for emissions, which seems unrealistic, but politically acceptable. The *WSJ* and ifo wish to see Germany and the EU be more supportive of all forms of cleaner automobile technologies, and not push one particular technology.

The Chinese government cut EV subsidies by more than expected last month and the market, including all its participants are suffering

On the same day of the *WSJ* editorial, its "Heard On The Street" column carried a story about Umicore N.V.(UMICY-OTC) a significant player in the electric-vehicle supply chain in China. The company issued a profit warning sending its shares down 15%, followed by another 5% the following day. Umicore, which manufactures cathodes, a key component of lithium-ion batteries, as well as tailpipe catalysts for conventional cars, is suffering from the weak Chinese car market and demand for EVs. The Chinese government cut EV subsidies by more than expected last month and the market, including all its participants are suffering. Not only are they hit by a weak market, but the bright future of EVs in China, given the government's support, brought lots of competition, which is further disrupting the market and pricing. As the author of the column put it: "Driven by government policy more than profit, the growth of electric cars was never an easy theme to invest in. It just got a bit harder."

The op-ed argued that building more transmission lines would make our electric grid more efficient

Around the same time, Donn Dears wrote on his blog "Power For USA" about an op-ed in *Power Magazine* written by a representative of the American Wind Energy Association (AWEA). The op-ed argued that building more transmission lines would make our electric grid more efficient. The plea was for building more transmission lines to connect the wind resources in the west with the cities in the east. While acknowledging some truth to the argument, Mr. Dears, a life-time executive in the power business of General Electric (GE-NYSE), dismantled the AWEA's case with numbers.

Mr. Dears compared building a new natural gas combined-cycle power plant near an urban area to a wind farm in the west that would produce a comparable amount of electricity, along with the transmission line to bring the power to Chicago. The cost of an 800 megawatt (MW) natural gas plant would be $800 million (800,000 kilowatt [KW] * $1,000 per KW), but it has an 85% capacity factor. In contrast, the cost to build a wind farm would be $3,800 million (1,900,000 KW * $2,000 per KW). The greater capacity is necessary since the wind farm's yield will only be 36%. He calculated the plant costs based on the total generation of 6 billion kilowatt-hours (kWh) being the same for both the wind farm and the natural gas plant.

This brings the total cost for the natural gas plant to $900 million versus $4,900 million for the wind farm

To construct a new 230 kilovolt (KV) transmission line today costs approximately $1 million per mile. The distance from Casper, Wyoming, near where excellent wind conditions are found, to Chicago is 1,092 miles. He used 1,100 miles, or $1,100 million for the transmission line. Comparatively, the electricity from the natural gas power plant would only need to be moved 100 miles for a cost of $100 million. This brings the total cost for the natural gas plant to $900 million versus $4,900 million for the wind farm. The incremental investment for a wind farm will need to be recovered through rates charged to electricity consumers. Will they be asked about their willingness to accept the much higher cost of wind power delivered half way across the continent when a cheaper, and relatively clean, power alternative exists?

Fossil fuels have delivered our modern life style

Each article points out the same issue. The blinders attached to the Green New Deal that ignore alternative emissions mitigation solutions at significantly lower costs harm the Deal's best intentions. Our economy and society are where we are today due to the application of technology and innovation over the years. Fossil fuels have delivered our modern life style. It has not been achieved in a straight line, but often with trial and error. To demand 'command and control' solutions for climate change at the expense of encouraging new technologies and innovations will ultimately do more harm than good. It should not be all about power.

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