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Energy Musings

Insights into the Energy Industry

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Energy Musings *contains articles and analyses dealing with important issues and developments within the energy industry, including historical perspective, with potentially significant implications for executives planning their companies' future. While published every two weeks, events and travel may alter that schedule. I welcome your comments and observations.* Allen Brooks

December 7, 2021

Europe's Decarbonization Goal Creates An Energy Mess

Both Germany and the U.K. are rushing to decarbonize their power sectors. In Germany's case, renewables cannot realistically replace fossil fuel power being shut down without consequences.

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Europe's Decarbonization Goal Creates An Energy Mess

The Omicron variant is attracting heightened attention by energy markets because it is highly transmissible, suggesting economic disruptions are the only way to stop it. Politicians are leaping to his conclusion, often out of frustration with how hard it has been to kill the coronavirus. "Shut the country down and limit travel" appears to be the new gameplan to protect citizens, regardless of whether they want or can tolerate such actions. While these actions are occurring in Europe, the continent's energy market challenges are being driven by longer-lasting policy actions, often put in place to address climate change fears. The focal point of European energy market turmoil is centered in Germany, although the United Kingdom is close behind.

In Germany, following two months of negotiations, the three leading political parties emerging from the September election have agreed to a coalition government structure. The center-left Social Democrats (SPD), the climate change Greens (Bündnis 90/Die Grüne), and the liberal Free Democrats (FDP) will jointly form the next government. It will replace the "Grand Coalition" government led by Angela Merkel, who is set to retire after a 16-year tenure as Germany's chancellor. Olaf Scholtz of the SPD is to become the new chancellor.

The new government is being referred to as the "traffic light coalition" because the colors of the three parties are red, yellow, and green. This coalition marks the first time these three parties have coalesced to form a government at the federal level. During Germany's first two post-war governments, factions of the three parties were part of federal governments, but nothing on today's scale.

The coalition negotiations among the parties involved 22 working groups and 300 negotiators. Surprisingly, there were no leaks of details being negotiated. Much of the negotiation was focused on climate and fiscal policy issues. The resulting coalition agreement is marked by making tackling the climate emergency a priority for each of the government's ministries.

The coalition's goal is for Germany to become climate neutral by 2045. That will require phasing out coal by 2030 (eight years ahead of the current schedule), outlawing internal combustion engine vehicles and replacing them with electric vehicles, ending natural gas power generation by 2040, expanding renewables to cover 80% of all energy needs by 2030, and committing 2% of the country's land mass to onshore wind energy. Their plan counts on natural gas supplying 20% of Germany's energy needs in 2030, but then declining to zero in the following decade. One social policy to be adopted by the government is in recognition that its plan will raise the cost of energy. Thereby, the government will provide a heating subsidy for low-income households.

During the election campaign, the three parties clashed over several key issues. The Greens proposed a huge investment program for climate change and to improve Germany's energy infrastructure. They also wanted to raise taxes and loosen debt rules to free up money to cover the increased spending. On the other hand, the FDP ruled out tax increases, and their party will control the finance ministry and likely will shape the government's fiscal and monetary policies. Scholz also announced that debt rules would not be relaxed.

The Greens did win the right to appoint the foreign minister and the head of a new "super ministry" for the economy and climate protection. They have a plan to "weaponize" foreign policy to force climate change initiatives on governments around the world. The Greens also won the right to pick the ministers for agriculture and environmental conservation. Sven Giegold, a Green member of the European Parliament and an important member of the party's coalition negotiating team, told the media, "We are in charge of all key energy and climate ministries and we have a whole roadmap for a post-fossil future based on renewable energy."

The coalition agreement must be approved by the SPD and FDP parties at their conferences, and the Greens will put it before their members for a vote. The new government is expected to be sworn in the week of December 6, with its first act to elect Scholz chancellor. He will then attend his first European Union (E.U.) meeting in mid-December, marking the start of a new era for Germany's role in E.U. politics.

The fact the new government will be one of Germany's youngest in terms of its members' ages should not be lost on analysts. This is the segment of the population most motivated by climate change and social justice concerns. It is also the segment that says it is opposed to having children because of environmental impact concerns. While these initiatives will impact long-term energy policies, the new German government may soon be facing a crisis, as the early months of winter are proving colder than normal. Could more wintry weather usher in power blackouts, as well as record electricity bills? Soaring power bills are becoming a genuine problem in the U.K., too, where reportedly 25% of Scottish citizens are living in "electricity poverty," having to choose between food and lights.

Interestingly, some climate activists were upset that Germany's new government's climate agenda was not aggressive enough. They had hoped the coalition would set an end date for natural gas usage. Gas is being used by Germany and other European countries as a "bridge fuel," a term popular in the early 2000s when gas prices were low, to power their economies until renewables can power them. The European Environmental Bureau, a network of climate activist groups and NGOs, called the plans for gas "highly disappointing" and "a missed chance for Germany to give clear indications" to energy markets. But as Green member Giegold said, the party is focused on ramping up renewables and their supporting technologies as quickly as possible so they can replace fossil fuels rather than putting exact dates on when those fuels will leave the energy mix. As he put it, "Honestly, it's not the phasing out, but the phasing in, which will inspire others to act." His language mirrors U.S. presidential climate envoy John Kerry's words at the final press conference at the IPCC's recent COP26 climate conference in Glasgow.

Before addressing the currently unfolding energy crisis in Europe, let's look a little more at the new German government's likely energy policies given the country's high greenhouse gas emissions because of its heavily industrial economy and greater reliance on coal. Projections show Germany's carbon emissions increasing 21% this year because of the economic rebound and the weak performance of renewables, forcing German utilities to revert to coal and lignite to make up the electricity shortfalls.

Here are the four key points in the German coalition's plan on climate.

1. Expanding renewable power:

   By 2030, 80% of Germany's power generation will come from renewables—up from around 40% today. The government plans to increase Germany's solar capacity five-fold to 200 gigawatts (GW), and offshore wind more than four-fold to 40 GW by 2030. It will also accelerate the designation of land for onshore wind power. The agreement further calls for an overhaul of Germany's electricity grid based on using more solar, wind, and hydrogen power.

2. Phasing out coal:

Germany is the world's fourth largest consumer of coal. Coal accounted for more than 25% of Germany's power production in 1H2021. The country has been slower to exit coal because it has relied on its large reserves of lignite to support its energy independence and to keep electricity bills down.

3. Cutting reliance on natural gas:

Germany, along with much of the rest of Europe, is highly reliant on natural gas for heating, a sector that accounts for 12% of the E.U.'s carbon emissions. The coalition agreement says that "all newly installed heating systems must be operated with 65% renewable energy by 2025." It is unclear how quickly buildings will be expected to replace their heating systems. The lack of an end date for gas usage leaves hydrogen developers unsure about how quickly their market might develop. The government is probably waiting on the E.U.'s review of subsidies and taxes for natural gas next year.

4. Putting climate at the center of government:

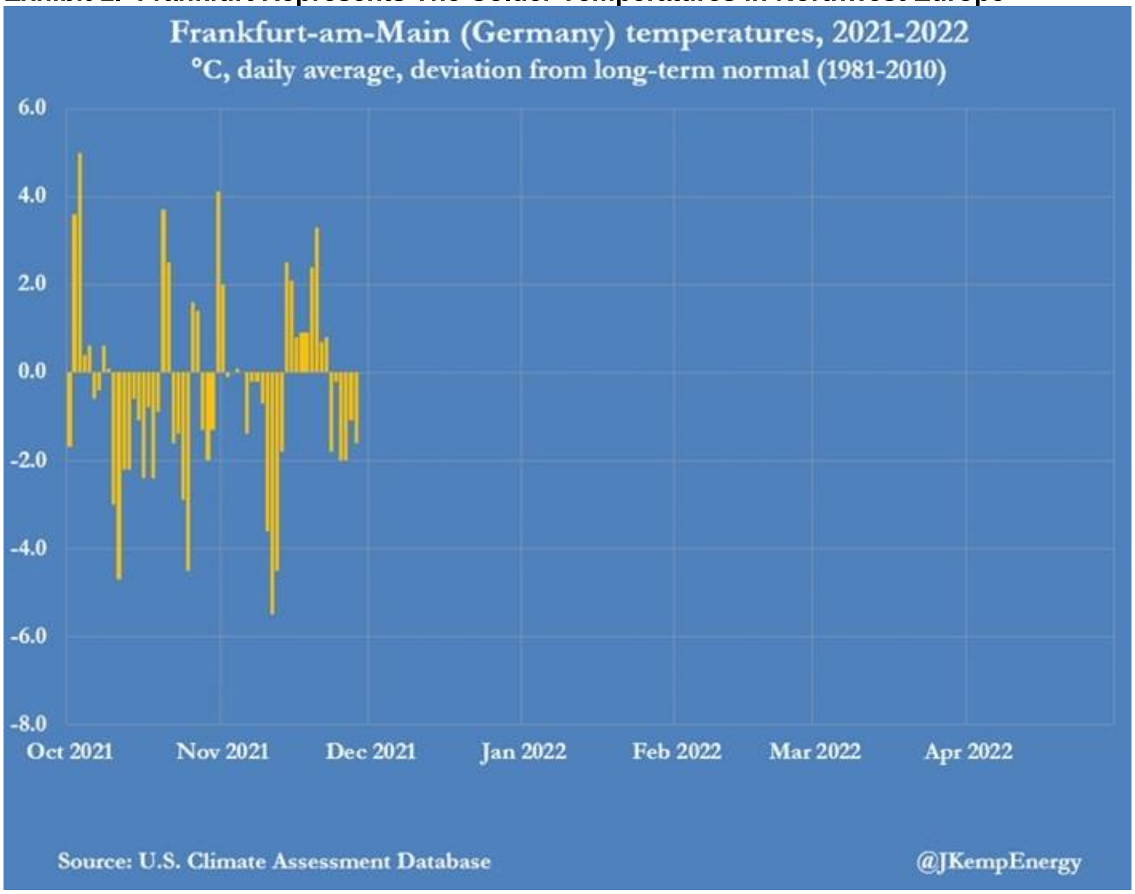
In an interview before the election, Annalene Baerbock, the co-head of the Greens, said her priority in negotiations would be changing the current "totally stupid" situation where "every ministry does what they want and the environment ministry does the environment." As foreign minister, Baerbock has pledged to align trade and foreign aid with climate goals, and to use Germany's leadership of the G7 in 2022 to encourage other members to accelerate their clean energy investments.

Without control of the finance ministry, the Greens may face a tougher time getting their aggressive climate policies implemented, given their likely cost. An industry lobby group said the new government must spend €860 ($971) billion by 2030 to achieve its emissions reduction target. Giegold, though, says that the consensus-based nature of German politics gives him confidence that the government will find the necessary funds. In the end, the financial cost question is what may derail the aggressive climate policy, as Germans already pay the highest electricity prices in Europe, a factor beginning to make its industrial sector less competitive globally.

In response to high electricity prices, the government moved in October to reduce the Renewable Energy Act surcharge on consumer power bills. The surcharge has been in place since 2000 to fund the expansion of solar and wind plants. It is scheduled to drop by more than 40% to 3.723 cents per kilowatt-hour starting January 1, 2022, according to a press release from Germany's grid operators. The subsidies will be made up by payments from the government, which will be financed by the carbon tax instituted at the start of 2021. However, the economy minister indicated that even with the reduced surcharge, customer bills are likely not to decline due to rising fuel prices. So far this year, wholesale natural gas prices have tripled, and oil and coal prices are also significantly higher. The economy minister has suggested that the surcharge should be eliminated completely to help keep electricity bills under control.

While the new German government will be working to set its climate and social justice plans in place, citizens will be more interested in what the government is doing to avoid an energy catastrophe in December, January, February, or even in March. Natural gas prices are climbing skyward in response to a colder-than-normal start to winter, which has resulted in the drawdown of gas storage. In fact, storage volumes currently sit at a level equal to the peak in 2013. Welcome the return of coal and lignite to the power fuel mix.

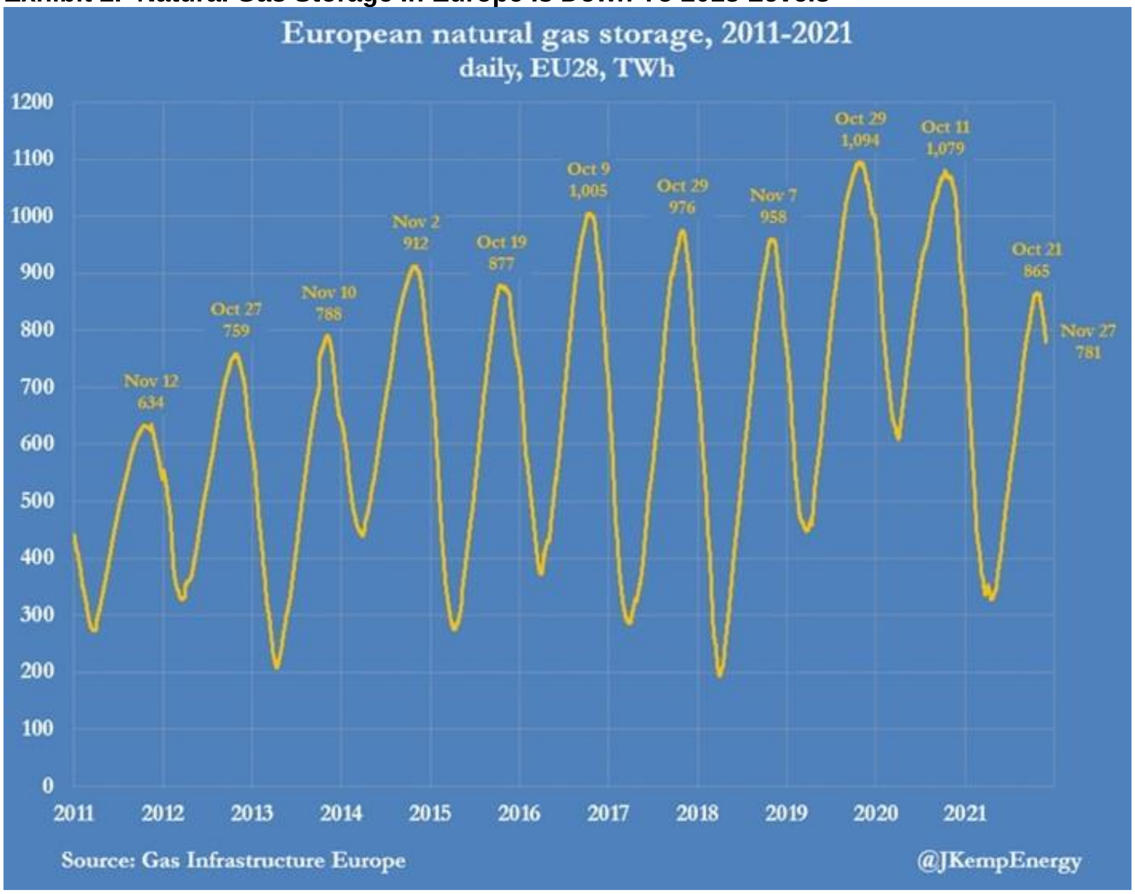
Exhibit 1. Frankfurt Represents The Colder Temperatures in Northwest Europe



Source: John Kemp

The chart above shows the temperature deviation for October and November from the long-term (1981-2010) average for Frankfurt, as representative of major population centers in Northwestern Europe. For the nearly two-month time span, the average temperature is 0.4º C (0.7º F) colder than normal. This certainly means increased power consumption, and more natural gas used for heating.

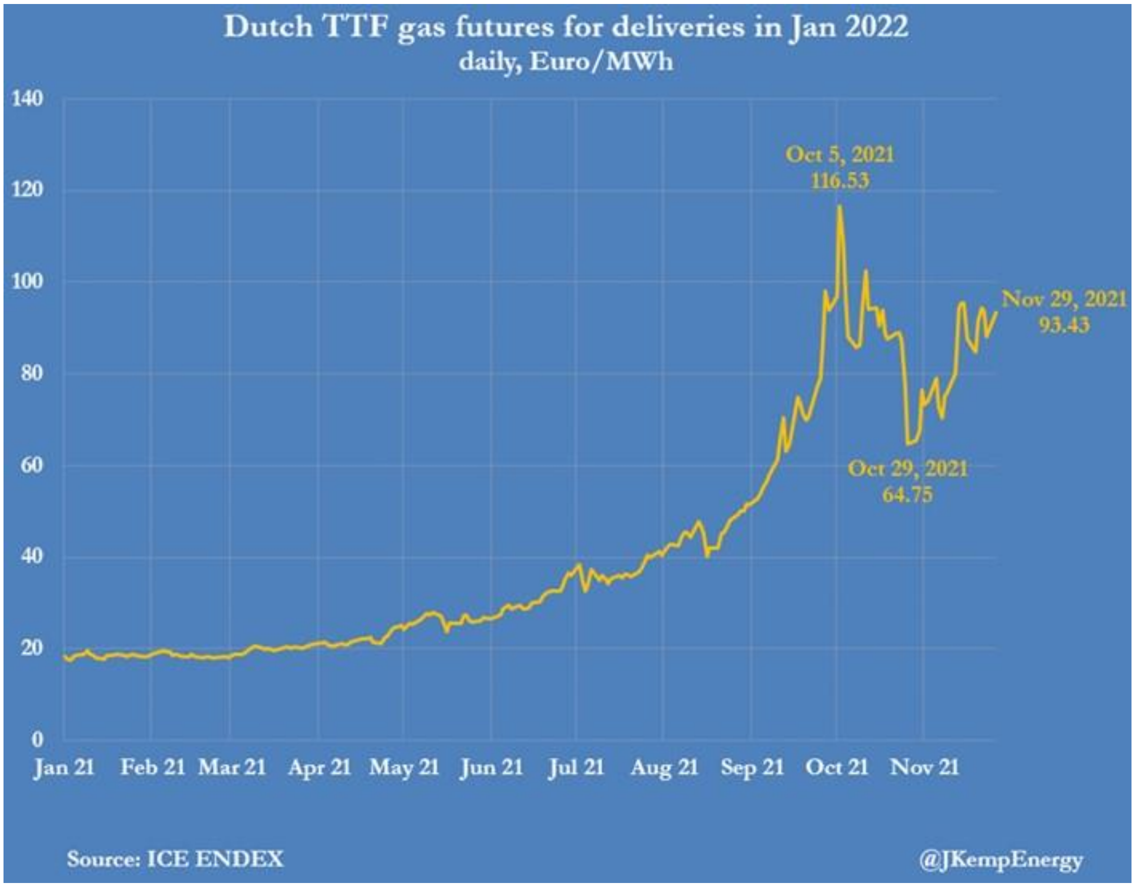
Exhibit 2. Natural Gas Storage In Europe Is Down To 2013 Levels



Source: John Kemp

The chart above shows European natural gas storage from 2011 to 2021. The increased freezing weather has caused gas volumes to be withdrawn, putting current capacity back to 2013 volumes. Current gas storage volumes are about 225 terawatt hours (TWh) below the same point in the past two years. Making up that storage shortfall is impossible as we move into winter, short of a heat wave breaking out.

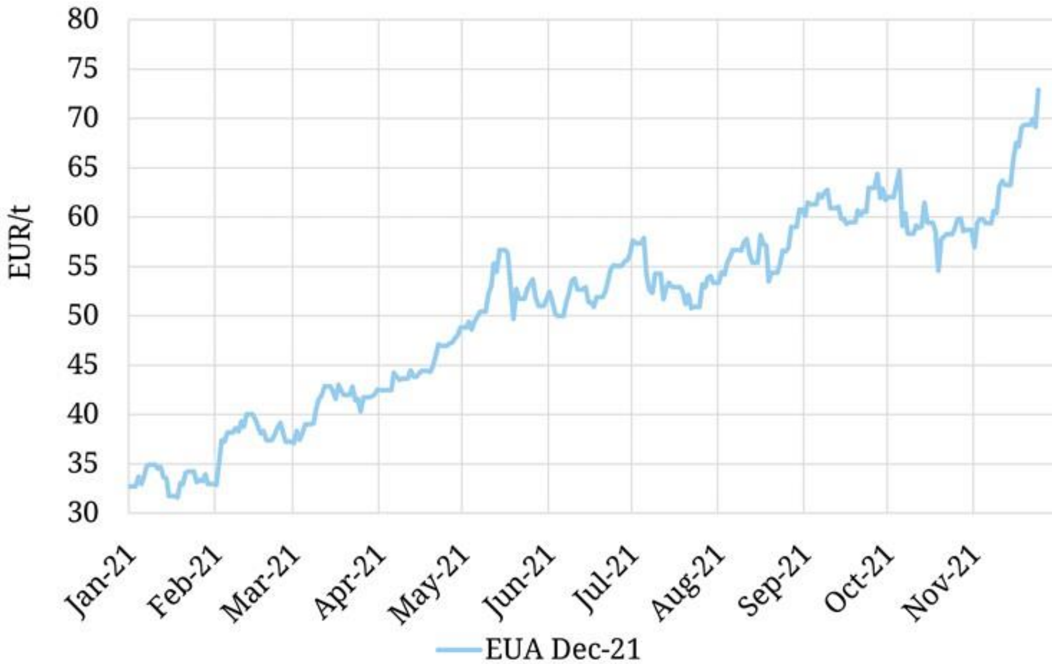
Exhibit 3. Gas Futures Prices Are On The Rebound With Colder Weather



Source: John Kemp

As shown in the chart above, gas prices in Europe peaked in early October at €116.53 ($131.55) per megawatt-hour (MWh). That peak coincided with a significant stilling of wind power, but once the wind began blowing again, gas prices dropped sharply to €64.75 ($73.09)/MWh. They have since rallied by more than 50% to €100 ($113A)/MWh as cold temperatures arrived. That is equivalent to oil at $190 per barrel.

Exhibit 4. Climbing Carbon Fees Are Helping Push Power Prices Higher

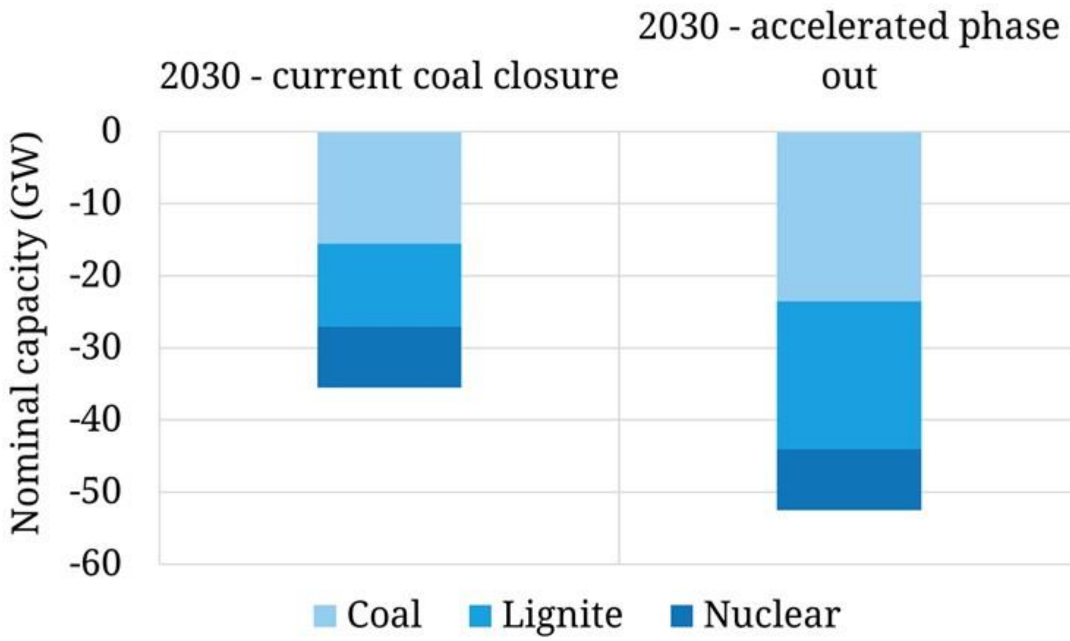


Source: ***Timera Energy***

A contributing factor for high natural gas prices is the rising cost of carbon fees in Europe. The sharp upturn in November is likely in response to both the early colder weather and the election of the Greens in Germany who have advocated higher carbon fees and border carbon adjustment taxes on trade.

In October, energy consultant *Timera Energy* wrote a two-part series on Germany's incompatible emissions target and timetable for phasing out coal by 2030, and especially if it accelerates the pace of coal mine closures. The two phase-out scenarios are shown in the chart below. Both bars also include the remaining nuclear power capacity being shut under Germany's energy policy. The difference in the two scenarios is that for the accelerated closures the decline in firm, dispatchable power goes from roughly 35 GW to over 50 GW, a 50% increase.

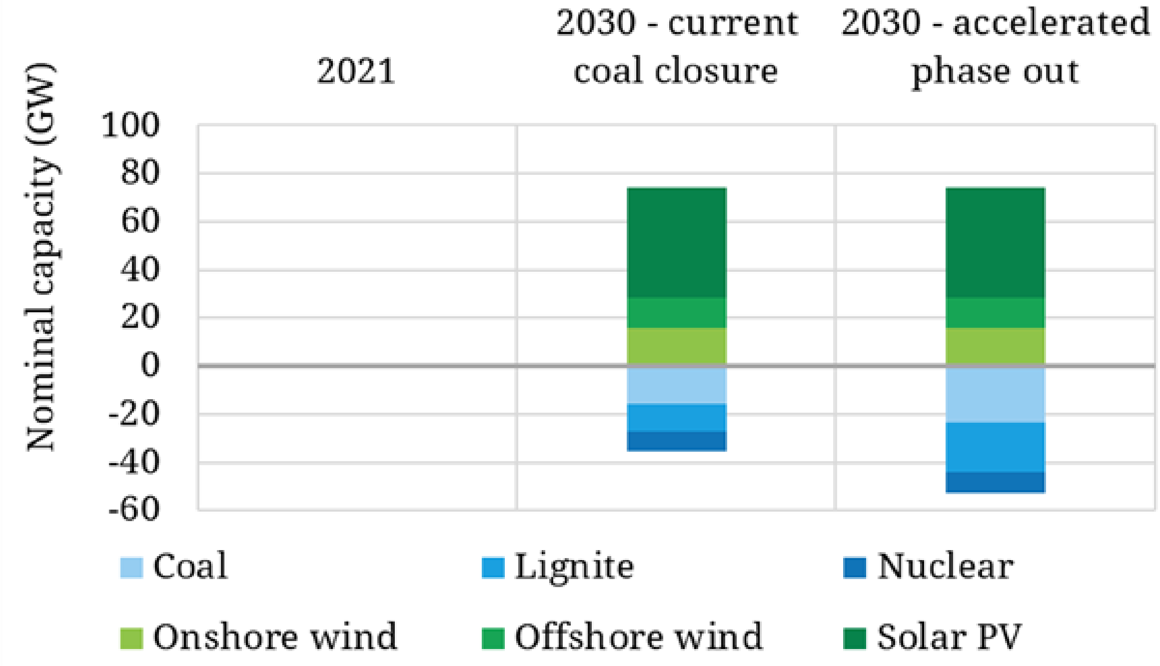
Exhibit 5. Germany's Fossil Fuel Generating Capacity Losses With Coal Exit



Source: ***Timera Energy***

The magnitude of the restructuring of Germany's generation fuel mix is shown in the following chart. The loss of coal and nuclear capacity is to be offset by building nearly 50 GW of solar and 30 GW of on- and offshore wind power. This chart does not reflect any closure of aging fossil fuel plants beyond the coal, lignite, and nuclear plants targeted, which would further shift the fuel mix.

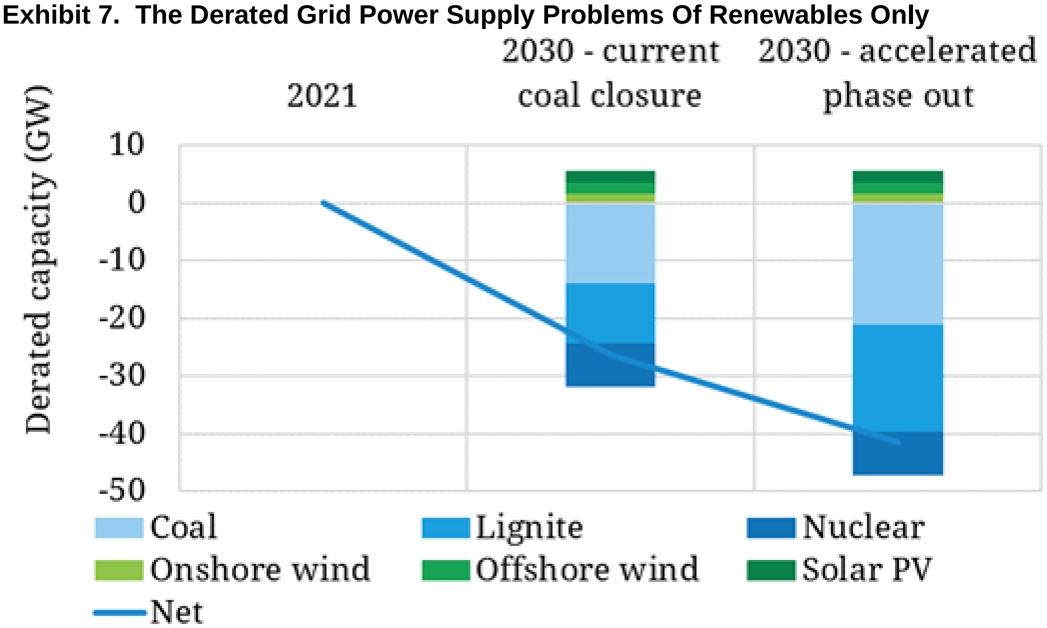
Exhibit 6. Germany Faces Little Challenge Replacing Fossil Fuel Power With Renewables



Source: *Timera Energy*

In the chart above, the capacities of each fuel are stated in nominal terms. When the additions of renewables are netted against the closures of fossil fuels, there appears to be no issue in meeting electricity demand.

Exhibit 7. The Derated Grid Power Supply Problems Of Renewables Only



Source: *Timera Energy*

However, the problem comes when the theoretical capacities of the respective fuels are translated into their realistic generating capacities. Wind and solar power produce substantially lower outputs than their rated capacities - around 20%-25% in the case of onshore wind and 10% for solar compared with 80%-85% for nuclear and coal. This dramatically changes the net derated capacity of the fossil fuel phase-out scenarios. In addition, the dispatchable nature of nuclear and coal power enables them to provide supply when needed, which is not the case with intermittent wind and solar power.

These derating factors combine to significantly impact the ability of renewables to contribute "firm" capacity to the grid. When planning for meeting grid delivery needs, derating factors are applied to nominal megawatts (MW) of renewable power to enable comparison across different capacity types on a consistent basis. The exact derating factor percentages vary over time and by location across Europe. However, coal and nuclear suffer lower deratings, usually only 10%-20%, as compared to wind with an 85%-90% and solar at more than a 95% derating.

The problem becomes, as shown in the chart above, that when the power sources are properly derated, the net of the renewables' additions against the firm fossil fuel closures leaves the grid with a 41 GW supply shortage in 2030. The *Timera Energy* forecast does not include flexible capacity projects currently under construction, but based on the pipeline of committed projects, this amount of additional power is small and does not close the supply gap.

Also not factored into the forecast is growth in peak electricity demand that will come from Germany electrifying its transportation, heating, and industry sectors as planned. For example, if Germany meets its economy minister's projection for 14 million electric vehicles to be in operation by 2030, *Timera Energy* says peak electricity demand could rise by 10 GW, further adding to the currently projected net power supply shortage.

Exhibit 8. The Options Available For Dealing With Grid Instability

Flexibility type	Description
1. Capacity (MW)	Flex to meet residual demand peaks (load – wind – solar)
2. Energy (MWh)	Flex to generate incremental energy output
3. Load shifting	Flex to shift energy 1. across time and 2. between different locations
4. Balancing services	Real time flex e.g. balancing, frequency response, fast reserve, inertia

Source: *Timera Energy*

As *Timera Energy* points out, electricity grid needs are complicated and different forms of capacity are required to meet different demand scenarios. In the table above, the consultants listed four flexibility characteristics needed to maintain grid stability in a decarbonized energy environment. For example, wind and solar can provide significant volumes of power, but they suffer from significant derated capacity, load shifting, and balancing services due to their intermittency and lack of dispatchability. On the other hand, the retiring electricity suppliers (coal and nuclear plants) provide capacity and power, while also being able to provide some balancing services depending on operational constraints.

Exhibit 9. Germany's Options For Closing It Electricity Generation Gap

Asset type	1. Capacity	2. Energy	3. Load shifting	4. Balancing	Considerations
Batteries					Very fast. Duration limitations. Net negative energy.
Interconnectors					Key to locational shift. Price dependent. Net zero energy.
DSR					Fast time shift. Duration limitations. Net zero energy.
Hydrogen					Flexible. Currently high cost. Green H_2 net negative energy.
CO2 abated gas					Low capex & flexible. Carbon footprint. CCS political hurdles.

Darker blue indicates higher contribution towards 4 types of flex required.
Red indicates a net negative energy contribution, i.e. asset uses more electricity than it generates.

Source: *Timera Energy*

In the table above are listed the various options Germany has available to close the net derated capacity gap. Each of the options has positive and negative attributes. The colors associated with each option shows its contribution towards the flexibility required. The darker the blue in the table, the greater that option's supply contribution. The red shows that the asset uses more electricity than it generates.

The outcome of this analysis is that Batteries & DSR (demand supply response) are useful balancing options, but they are net consumers of energy, and they typically only help in short duration needs. Interconnectors are helpful in load shifting but they rely on energy and flexibility being provided in neighboring markets, i.e., a zero-sum game. The advantage of interconnectors is likely to shrink, as all of Europe undergoes similar fuel mix transitions for their grids that will reduce cross-border flexibility for helping neighbors.

Hydrogen power plants may be able to scale and provide flexibility of supply, but they are likely to be expensive to run and are a net consumer of electricity if sourced from electrolyzers. Carbon abated gas-fired plants may appear to be an attractive solution, but they face substantial practical hurdles in the form of political unease with Carbon Capture, Utilization and Storage (CCUS) technology, dependency on CCUS infrastructure development, high capex costs, and a residual carbon footprint in both power and natural gas supply chains.

In *Timera Energy's* view, to decarbonize the German power market in an orderly manner, all these capacity options will be needed in some form. None of them represents a silver bullet. More importantly, the estimated price tag for this transition is likely understated. It will impose a significant additional financial burden on ratepayers, along with presenting disruption risks as such a major transition undoubtedly will experience missteps and timing issues. The great German decarbonization experiment should be closely watched by other governments, as the problems and issues that arise may be avoided with better knowledge, planning, and a more measured pace of implementation.

Lexus PHEV Crossover Review Gets Into Hybrid Economics

A recent *Wall Street Journal* automobile column, *Rumble Seat* by Dan Neil, reviewed Lexus's second-generation NX compact crossover, NX 450h+, which is a plug-in hybrid vehicle (PHEV). That means it has both electric motors to drive the wheels as well as an internal combustion engine for power.

Neil began his column commenting that he normally does not get into the "practical details of ownership" when he is reviewing "some six-figure personality disorder from Italy or Germany." He does not consider the buyers of those expensive cars as readers (probably true), but those considering the Lexus model are. Therefore, he felt he needed to explore this economic landscape in his Lexus model review.

Exhibit 10. The Lexus NX450h+ Electric Plug-in Hybrid

Source: ***hdcarwallpaper.com***

He was surprised that the all-electric range of the NX450h+ was less than Toyota's RAV4 Prime at 37 versus 42 miles per gallon (mpg), respectively. The Lexus was also slower than the RAV4 Prime, taking three-tenths of a second longer to go from zero to 60 miles per hour (6.0 versus 5.7 seconds). At a gross weight of 4,475 pounds in the XSE trim version, it was also 175 pounds heavier than the RAV4 Prime.

He devoted over half the column to an analysis of operating the NX 450h+ and its impact on the cost of ownership. Neil points out that the price of the NX 450h+ is $14,600 more than the non-plug-in NX 350h AWD, the closest comparable model. Even if the owner does not plug in his NX 450h+, it performs just as well as the alternative, and in line with the performance of other Lexus high-end models. However, the overall efficiency of the NX 450h+ drops sharply in that non-plug-in mode – "to an observed 35 mpg." That performance is 4 mpg below the performance of the NX 350h AWD. This sets up his discussion of the economics of ownership, which Neil points out is what he believes influences people's PHEV purchase decision.

The Environmental Protection Agency (EPA) rates the NX 450h+ at 84 mpge (miles per gallon equivalent that accounts for the battery-only mileage). At 15,000 annual miles, the difference between 84 and 39 mpg equals 206 gallons, which at the national average price of $3.41 per gallon of gasoline, comes to a savings of $702.46. That means the NX 450h+ premium is recouped in 249 months. Nearly 21 years!

The ideal case for the PHEV is charging it overnight and never driving beyond its daily electric vehicle (EV) mileage. In that case no gasoline is used. Compared to the 39-mpg vehicle, the annual fuel savings would total $1,322.54, or only 11.1 years to recover the vehicle's premium.

However, if you factor in the cost of electricity, assuming it is only charged at home and not at any expensive public charging points, at the national average of 14-cents per kilowatt-hour (kWh), the 3,750 kWh of electricity consumed would cost $525. That means the PHEV fuel savings compared to the NX 350h AWF would net out at $786.54, or a payback period of 18.6 years.

All these payback estimates for the premium of a PHEV or an EV, buyers must weigh this financial consideration in their purchase decisions. A key development for EVs and PHEVs is the proposal in the Build Back Better (BBB) legislation to extend and expand the tax credit for electric vehicle purchases. But the specifications for PHEVs to be eligible for the tax credit rules out the NX 450h+. First, this model has an 18.1 kWh battery pack and a 14.5-gallon gasoline tank. To qualify for the tax credit, the vehicle must have at least a 40-kWh battery and a gas tank no larger than 2.5 gallons. This restriction will hurt the business strategy for Lexus's owner Toyota, which is based on its highly successful hybrid vehicle technology. At one point, Toyota ended its EV development efforts in favor of PHEVs and fuel cell cars but was forced to restart it due to China's demand that only EVs would be allowed in the country once internal combustion engine (ICE) vehicles are banned.

PHEVs are being targeted by California and its 14 state followers seeking tighter regulatory requirements. These 15 states represent about one-third of U.S. light-duty vehicle sales. California's Air Resources Board is looking hard at real-world emissions, especially nitrogen oxide linked with cycling the PHEV engine. In Europe, environmentalists are invoking the Dieselgate scandal as a warning that PHEVs are merely another phony carbon emissions reduction scheme by auto manufacturers.

While the economics of PHEVs, regular hybrids, internal combustion engine vehicles, and EVs make customer purchase decisions more difficult, other considerations such as ease of refueling, as well as initial purchase price (or lease cost) carry some weight in the process. On the other hand, we have a new generation of car buyers that is less interested in driving and owning vehicles of any kind. They would rather live in a neighborhood where public transportation is readily available, or they will walk, bicycle, or use electric scooters. They are also big users of ride-hailing services. Based on these desires, our transportation future may be quite different from its past.

Just how different that future may be remains to be seen. A recent survey of 1,000 auto executives by accounting and consulting firm KPMG showed that they expect 52% of new vehicle sales in the United States, China, and Japan by 2030 will be EVs. They expect a lower percentage of EV sales in Western Europe, Brazil, and India. However, there are some widely different views among the respondents. For example, some auto executives expect China's EV sales by 2030 will be less than 20%, while some others think they could be as much as 80%. Think about the planning challenges with such a wide range of market share estimates.

Interestingly, 77% of respondents to the KPMG survey said EVs can achieve mass adoption within 10 years without government subsidies, as battery costs fall to parity with ICE vehicles. This is interesting because the current inflation in materials used to build EVs and the cost of developing new rare earth mineral mines and processing plants is making it hard to see how the recent decline in battery costs will continue. In fact, in other renewable fuel markets that rely on similar materials, costs, and prices, are rising, not declining.

Equally amusing was the report that 90% of the auto executives said they support government subsidies. We are sure they are cheering for the passage of the BBB legislation because without subsidies EV sales would have a miniscule market share. We think this sentiment is more reflective of how auto executives see the market unfolding and not love for the government.

Let's see what the EV subsidy may cost American taxpayers. Understand that what we are about to calculate may not comport with the draft language in the House and Senate BBB versions of the legislation. There are various gimmicks (adjusted income, vehicle price caps, etc.) to limit who can or cannot earn a tax credit for buying an EV and for how long buyers would be eligible. Then there are issues of components that are eligible, such as certain battery packs but not the entire vehicle.

In 2030, assume U.S. new car sales are 18 million units, comparable to a good sale year in recent times. At a 52% EV market share and no restrictions on eligibility, at the $7,500 per unit tax subsidy, this would cost taxpayers roughly $70 billion. That number would be higher if the EVs are made in American-owned, unionized plants, where the subsidy increases to a maximum of $12,500. If we assume that 30% of the EV sales meet the American ownership and unionization requirements, the higher tax credit on this portion of vehicle sales boosts the total subsidy to over $87 billion. The higher the share of unionized manufactured EVs, the larger the tax subsidy.

To put the amount of this subsidy into perspective, in 2030, our two market share scenarios lead to the EV subsidy amounting to 50%-60% of the total funds allocated for affordable housing over ten years in the BBB. For this reason, the September versions of the EV subsidy language in the BBB puts caps on total subsidies of $15.5 billion (House) to $31.5 billion (Senate). Furthermore, the House version would limit the tax subsidy program to a 10-year life, while the Senate's continues until EV sales exceed 50% of all annual U.S. passenger vehicle sales. The history of subsidies has taught us that once begun, they seem to never disappear, even though there are predictions of impending market doom when expiration dates loom. How long will these restrictions last?

The Biden administration is pushing EVs as a climate change initiative that allows it to reward its Democratic supporters in the auto unions. Without generous tax subsidies, the auto companies would be more skeptical of the future for EVs, after never having made a dime in profit on those models they did or currently do manufacture. Take the KPMG survey results with a grain of salt and pay more attention to the business strategy of Toyota.

In a recent interview with *Green Car Reports*, Cooper Ericksen, Toyota's vice president for product planning and strategy in North America, explained his company's focus on affordability rather than range. He said:

> "'Nothing happens until you sell a car' is an expression we have internally. To have a positive impact on the environment, you must sell a high volume of cars, so it's really important that the price point is such that we can make an actual business model out of it."

He went on to elaborate, saying:

> "The bottom line is, over time we view EV range similar to horsepower. People who are affluent and can afford a really expensive vehicle can afford a lot of horsepower. Batteries are expensive and the bigger you make the battery, the more expensive it is. So, the trick, I think long-term, is not all about range, range, range. The trick is matching the range and the price point to what the consumer can afford. And as people become more accustomed to operating an EV, I think the anxiety over range is going to dissipate."

Obviously, expanded networks of public charging stations will also help reduce range anxiety, and especially if we are talking about second or third cars. These public charging stations raise the cost of recharging, but if used only occasionally for peace-of-mind, the extra cost should be bearable for EV owners.

Erickson went on to comment on several key considerations for EVs with implications for their impact on the global economy and climate.

> "The low end to me is the more curious number. What's the lowest number that you can put out there that achieves the affordability and the use case for that customer? I think we have some examples in the market over the past five years or so that we can learn from. It's something we're going to have to figure out because it has a huge impact on resources. We have to be really careful if we build EVs with 200-kwh batteries and you can build four EVs for that one. We have to think about that as a society and as an industry to figure out what's best for consumers in the environment."

It was pointed out that Toyota has learned valuable lessons from its years of experience building hybrids. Making batteries that last for the entire life of a vehicle has proven critical to their success. When the Prius first came out, people were nervous about the cost of replacing a battery. But Toyota learned how to make those batteries last for 200,000 miles of driving or more. Addressing battery degradation is critical, and Toyota now has batteries that retain 90% of their capacity after 10 years. Not only does that provide peace-of-mind for the EV buyer, but the longer battery life adds to the vehicle's resale value, a crucial financial consideration in the purchase decision.

The EV era is on the cusp of blooming. Despite all its cheerleaders, EVs face some daunting challenges such as raw material availability, charging locations and time commitment, as well as vehicle pricing. We have also learned that the life-cycle environmental advantages of EVs require driving them for years to overcome the huge carbon emissions' legacy in their manufacture. Will EVs quickly dominate the automobile industry like electricity did in going from a 10% to a 68% market share in 21 years, or will they be like the dishwasher that needed nearly 56 years to go from a 1% share to 42%? As Neil's column showed, the economics of EVs and PHEVs may dictate that answer. It also puts the lie to U.S. Transportation Secretary Pete Buttigieg's comment that "families who buy electric vehicles never have to worry about gas prices again."

Hurricane Season Ends With A Whimper Not A Bang

The 2021 hurricane season ended November 30, and *Accuweather.com* scientists characterized the year as "Very active and very odd" in its wrap-up report. There were 21 named storms in the Atlantic basin this season, making it the third most active year on record, trailing the 30 storms of 2020 and the 28 storms of 2005.

The Colorado State University Tropical Meteorology Project has been preparing forecasts for the Atlantic basin hurricane season for 38 years, following its establishment by the late atmospheric scientist Dr. William Gray, and now headed by his former assistant and meteorologist Dr. Philip Klotzbach. In its recent summary report for the 2021 season, the following key events and trends were listed:

- Twenty-one named storms formed in the Atlantic this season. This is the 3rd most in a single Atlantic season on record, trailing 2020 (30 named storms) and 2005 (28 named storms).
- Four hurricanes (Grace, Henri, Ida, and Larry) formed in the Atlantic between Aug.18-Sept. 2 – the first time on record that more than three hurricanes have formed between these two dates.

- The Atlantic had no named storm activity between Oct. 3 and Oct. 30 – the first time since 2006 that the Atlantic had no named storm activity between these two dates.

- Hurricane Elsa was the earliest fifth Atlantic named storm formation on record (named on July 1). Elsa broke the old earliest fifth Atlantic named storm formation record set by Edouard (on July 6, 2020).

- Hurricane Ida made landfall with maximum sustained winds of 150 mph – tied with the Last Island Hurricane of 1856 and Hurricane Laura (2020) for strongest winds for a Louisiana hurricane on record.

- Hurricane Sam was a major hurricane for 7.75 days, tied with Hurricane Edouard (1996) for the fourth most consecutive days at major hurricane strength in the satellite era (1966 onwards).

As 2021 utilized all the pre-selected official storm names, in September a series of articles in the mainstream media began venting over what officials would do to deal with a shortage of names, given additional storms meteorologists were sure would soon develop. Although 2021 had begun with a named storm forming (Tropical Storm Ana - May 22) before the official start of the season on June 1, marking the seventh consecutive year of such an event, the name shortage fear proved unfounded. In fact, the season ended with a different record. But this time, it was for a lack of storms rather than a new record in seasonal storms.

According to Klotzbach, 2021 marked the first year since the start of the satellite era in 1966 in which there were no major hurricanes anywhere in the world between Sept. 25 and Nov. 19. Since Klotzbach made that observation, the absence of major hurricanes streak continued through the November 30 season end, a stretch of 66 days, and is continuing. People still point out that it is possible a December tropical storm might still develop. But there have been only 17 tropical storms formed in December in the Atlantic basin since records began in 1851. The most recent storm, an unnamed subtropical storm, emerged on Dec. 5, 2013. Of all the December storms, none have made a U.S. landfall.

Most tropical storm forecasts were on the mark this year. Below is the record of the CSU forecasts against the actual observed data. Besides the number of named storms, hurricanes, and major hurricanes, we have listed the estimates of Accumulated Cyclone Energy (ACE), which is a measure of the intensity of the tropical storm season. What the table shows is how remarkably accurate the initial storm forecast was when it was issued on April 8.

Exhibit 11. 2021 Hurricane Season Forecast Was Close To The Mark

Category	April 8	June 3	July 8	Aug. 5	Observed	Average 1991 - 2020
Named Storms	17	18	20	18	21	14.4
Hurricanes	8	8	9	8	7	7.2
Major Hurricanes	4	4	4	4	4	3.2
ACE	150	150	160	150	145	123

Source: CSU, PPHB

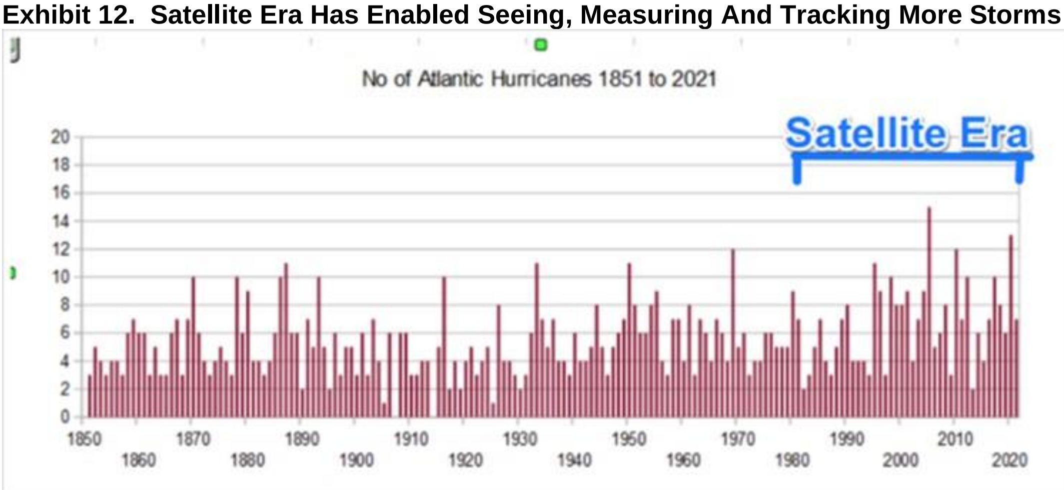
Many environmentalists tend to focus on the increased number of named storms in recent years as confirmation that climate change is helping to increase this activity. An examination of this topic will await another article. Suffice it to say that most of the studies prepared during the past

10-20 years show little relationship between the number of storms formed in a season and their intensity with climate change variables.

Some observers would point out that the ACE observed this year was 18% above the 1991-2020 average, which shows the climate change impact. However, 60% of the observed ACE was represented by two storms. What that means is that there were two strong storms, and the strength of other storms was considerably less. This does not suggest hurricanes are becoming more frequent or stronger.

What we know is that with the advent of satellites we can detect many more tropical disturbances that evolve into tropical storms and potentially into hurricanes than ever before. Prior to the use of aircraft and satellites, meteorologists relied on news of storms encountered by ships in the Atlantic Ocean and Caribbean Sea, as well as reports from coastal sites where storms approached or made landfall. The chart of the history of the number of tropical storms by year confirms the reality that we are finding more storms in the satellite era. Our increased ability to detect storms, especially weak and short-lived storms, makes it look like there are many more storms.

Exhibit 12. Satellite Era Has Enabled Seeing, Measuring And Tracking More Storms

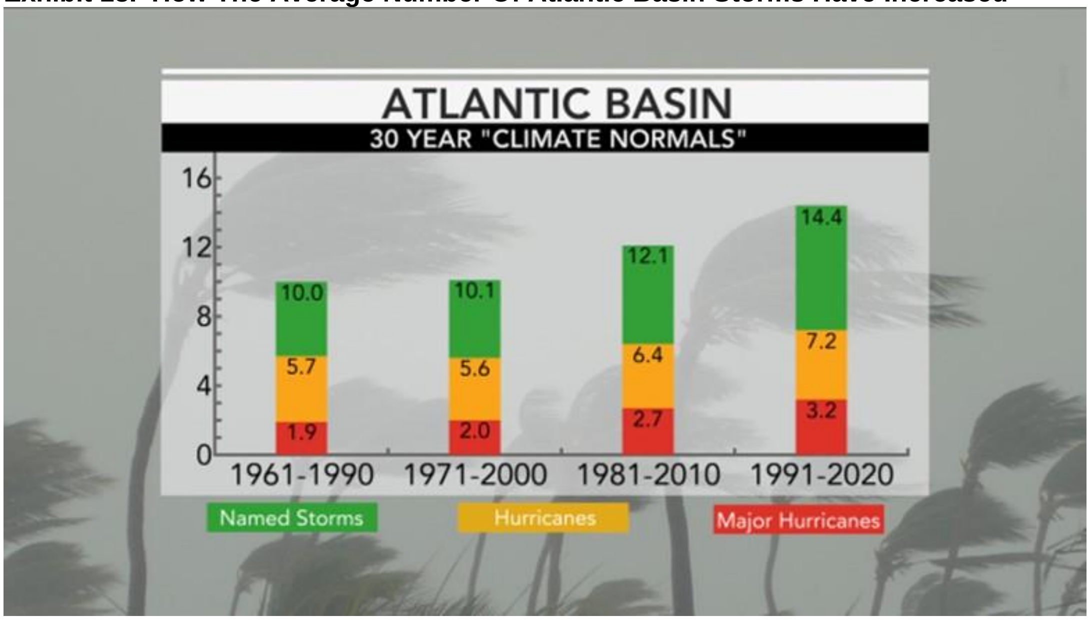


Source: Paul Homewood

What can be seen in the chart above is that in the satellite era, there appear to have been consistently larger numbers of storms each year than seen in earlier years. According to the Tropical Meteorology Project, the upturn in major hurricane activity since 1995, as well as the increase seen in major hurricane activity from the late 1940s through the mid-1960s, is attributable to the natural multi-decadal variability in the strength of the Atlantic Multidecadal Oscillation (AMO). This ocean phenomenon is usually accompanied by an increase in several favorable hurricane-enhancing parameters in the tropical Atlantic basin during the positive phase of this oscillation, while the AMO tends to suppress hurricanes during the negative phase of this oscillation. In other words, the natural cyclicality of the AMO is what influences the rise and fall in tropical storm activity.

With the advent of aircraft and satellites to spot, track, and measure tropical storms, we know much more about storm seasons. A recent study employed additional weather data to attempt to reconstruct the historical storm record prior to the satellite era. It concluded that we missed storms and that over multi-year periods, the true number of annual storms was not materially different from what is being experienced now. This assumes the authors of the study were adjusting for the AMO effect on storm formations. What we are seeing is that the long-term average storm totals are rising in step with the increased knowledge of storms. In some cases, storms we are identifying now would not have been classified as storms in earlier periods because of the inability to measure wind speeds and storm pressures as accurately as we are able to today.

Exhibit 13. How The Average Number Of Atlantic Basin Storms Have Increased



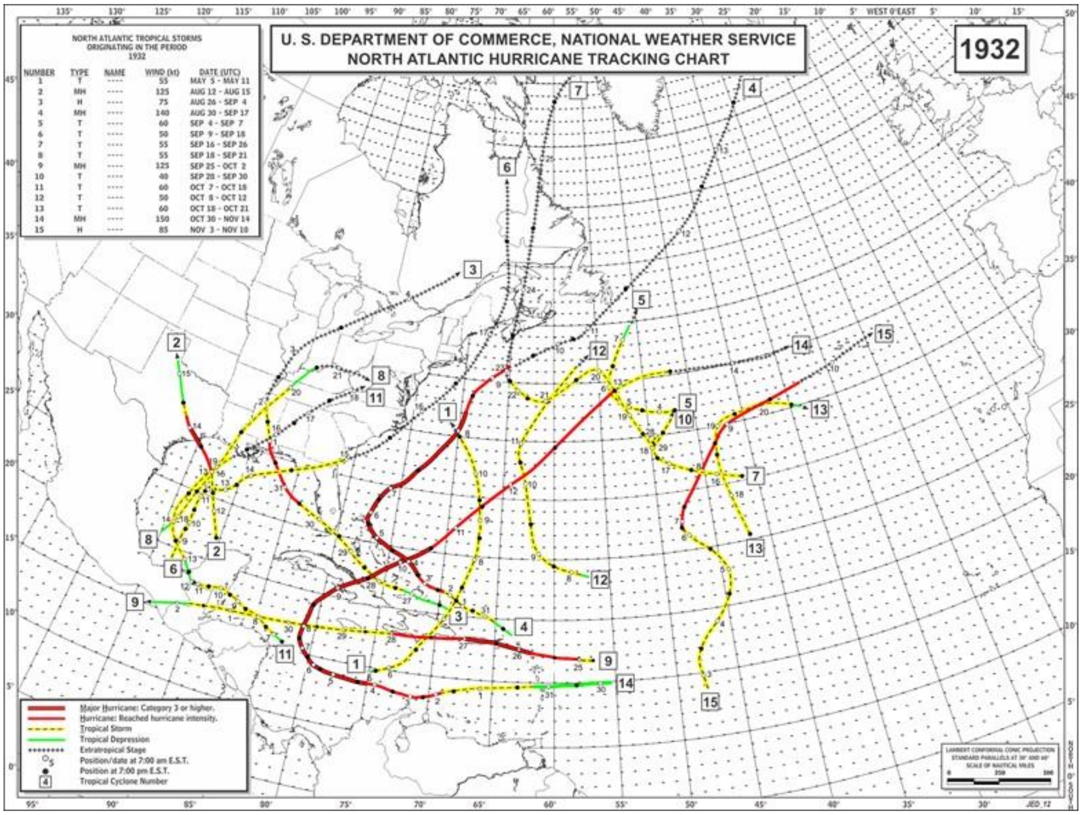
Source: ***WABF9***

To further demonstrate how our knowledge of the existence of storms and their characteristics have improved, we can compare the number and the tracks of named storms from an earlier AMO warm period to the current warm period. As the two charts below demonstrate, there were 21 named storms in 2021 and 15 in 1932, both were higher activity levels than their relative averages. In looking at the chart showing the annual number of hurricanes, 1932 stands out in that period for having 11 hurricanes. Note how many of the total storms in each of these years spent most, if not all their existence in the middle of the Atlantic Ocean and not threatening coastal regions.

Exhibit 14. An Above-Average 2021 Hurricane Season Record

Source: ***WFAB9***

Exhibit 15. The Hurricane Season Of 1932 Was In A Warm AMO Era



Source: Paul Homewood

The Tropical Meteorology Project releases its first assessment of the 2022 hurricane season in two days, December 9. While not a specific forecast, it will address the climate and weather patterns that will shape the upcoming storm season. Of great interest will be the scientists' views on whether El Niño conditions will develop in the Pacific Ocean, as that phenomenon tends to reduce the formation of tropical storms in the Atlantic basin. After the storm activity levels of the past two seasons, people would be happy for some relief. Stay tuned.

Energy Sector Hurt As New Virus Variant Spooks Markets

The last six months have been a trying time for the oil and gas industry, as it went through price ups and downs driven by near-term events, long-term structural issues, and political bashing. As our chart below shows, since the beginning of June, the West Texas Intermediate (WTI) oil price continued its 2020 recovery. Prices started slightly below $70 a barrel with debate raging over whether prices could climb to that level and what such an elevated oil price might mean. Oil prices continued rising, reaching $75, before the summer uptick in Covid-19 cases forced a reassessment of oil demand growth. At the same time, Wall Street analysts were beginning to discuss the structural issues impacting the industry's outlook beyond near-term supply/demand balance issues. They began focusing on the impact of years of under-investment in the industry and an absence of a more meaningful drilling response to high oil prices. Talk of WTI reaching $80 and even $100 per barrel soon became more prevalent, but that talk was tempered by the economic concerns of the lingering virus and Washington's call for mandatory vaccinations.

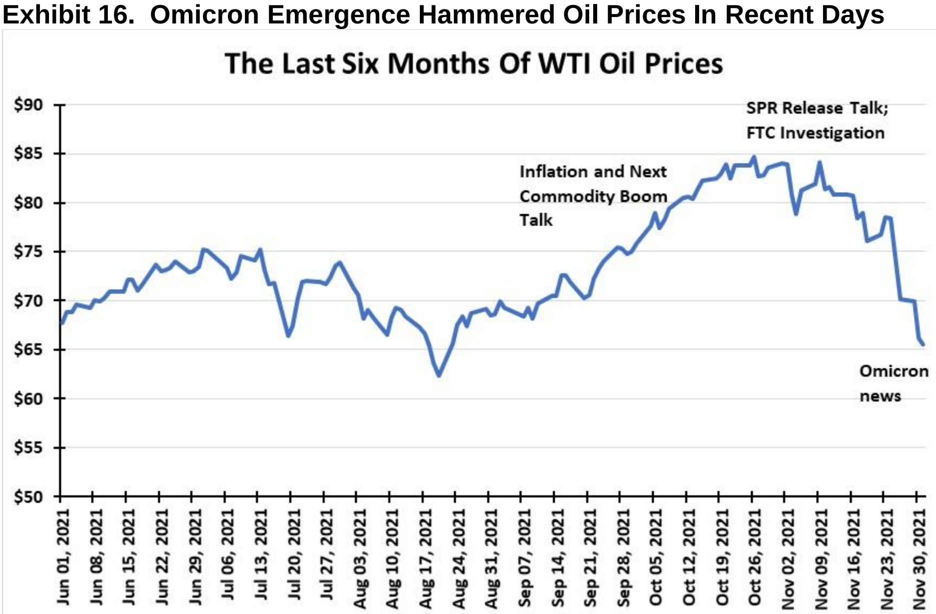
After slumping into the low $60s a barrel in response to the virus and growing concern about weakening economic conditions, prices rebounded, driven by an acceleration of inflation and economic recoveries in key southern states from their virus outbreaks. The next commodity boom and higher future oil prices came to dominate the news, the industry, and Wall Street. Oil prices marched straight up to $85, at which point the Biden administration began reacting to the heat from inflation and high gasoline pump prices. President Joe Biden started talking about investigating the oil companies for collusion in rising gasoline prices (a typical political reaction) and potentially releasing oil from the Strategic Petroleum Reserve, as if a shortage of crude oil was behind rising gasoline prices. That talk and threatened political action stopped the oil price rally and sent prices down.

At that point, news of the Omicron virus variant in South Africa emerged. A more transmissible variant, although early indications were that the symptoms were mild, scared the political players into radical actions – banning travelers from eight African nations, including one country with zero cases of Omicron. Pleas were issued for people to get vaccinated, and threats of increased testing and economic shutdowns - some were even enacted in Europe - caused a reassessment of oil demand growth projections.

In response to the Omicron news, the Friday after Thanksgiving Day saw oil prices crash – falling by nearly $8.50 a barrel, or almost an 11% drop. The holiday-shortened trading session, coupled with a lack of market liquidity, contributed to the price collapse. Traders having made significant profits trading oil in 2021 contributed to the selloff: Why fight the tape? Take your profits and run!

The day's trading action was followed early the next week by increased market volatility, as investors and traders attempted to assess the economic impact of Omicron and political reactions. From the upper $70s a barrel, oil prices seemed to settle in the mid-$60s. At this lower level, producers are still earning healthy profits, as various research firms have determined that oil producers have cut costs over the past year, further buffering their profit margins.

Exhibit 16. Omicron Emergence Hammered Oil Prices In Recent Days



Source: EIA, PPHB

As expected, oil prices this year have driven powerful performance by energy equities. The next chart shows the monthly performance of the Standard & Poor's 500 stock index industry sectors for June 2020 - November 2021. The data shows that energy (the green boxes -ENRS) was the second-best performing sector for May and June 2021, but then fell to the bottom for the following two months. In September, energy was the best performing sector and the second-best the following month, before dropping near the bottom for November. This monthly trading volatility was reflective of the volatile oil price environment outlined above, and the political talk it generated. Again, investors have made good money in energy stocks this year, so why not cash out, wait, and reassess the outlook?

Exhibit 17. S&P 500 Index Sector Performance Monthly June 2020 To November 2021

Jun-20	INFT 7.1%	COND 4.9%	INDU 1.9%	MATR 1.9%	S&P 1.8%	REAL 1.0%	FINL -0.5%	TELS -0.6%	CONS -0.7%	ENRS -1.4%	HLTH -2.5%	UTIL -5.0%
Jul-20	COND 9.0%	UTIL 7.7%	MATR 7.0%	CONS 6.8%	TELS 6.6%	INFT 5.6%	S&P 5.5%	HLTH 5.2%	INDU 4.3%	REAL 3.9%	FINL 3.5%	ENRS -5.4%
Aug-20	INFT 11.8%	COND 9.4%	TELS 9.1%	INDU 8.3%	S&P 7.0%	CONS 4.6%	MATR 4.2%	FINL 4.1%	HLTH 2.6%	REAL -0.1%	ENRS -2.1%	UTIL -3.1%
Sep-20	MATR 1.1%	UTIL 0.8%	INDU -0.8%	CONS -1.9%	HLTH -2.3%	REAL -2.5%	FINL -3.7%	COND -3.7%	S&P -3.9%	INFT -5.4%	TELS -6.5%	ENRS -14.6%
Oct-20	UTIL 5.0%	TELS 0.5%	MATR -0.8%	FINL -1.1%	INDU -1.5%	S&P -2.8%	COND -3.0%	CONS -3.0%	REAL -3.4%	HLTH -3.8%	ENRS -4.7%	INFT -5.2%
Nov-20	ENRS 26.6%	FINL 16.8%	INDU 15.6%	MATR 12.2%	INFT 11.3%	S&P 10.8%	TELS 9.5%	COND 8.5%	HLTH 7.8%	CONS 7.4%	REAL 6.8%	UTIL 0.3%
Dec-20	FINL 6.1%	INFT 5.7%	ENRS 4.3%	HLTH 3.7%	S&P 3.7%	TELS 3.1%	COND 2.5%	MATR 2.3%	CONS 1.5%	INDU 1.1%	REAL 0.9%	UTIL 0.3%
Jan-21	ENRS 3.6%	HLTH 1.3%	REAL 0.5%	COND 0.4%	UTIL -1.0%	INFT -1.0%	S&P -1.1%	TELS -1.5%	FINL -1.9%	MATR -2.4%	INDU -4.3%	CONS -5.3%
Feb-21	ENRS 21.5%	FINL 11.4%	INDU 6.6%	TELS 6.2%	MATR 3.7%	S&P 2.6%	REAL 1.4%	COND -1.0%	INFT -1.1%	CONS -1.5%	HLTH -2.2%	UTIL -6.5%
Mar-21	UTIL 10.1%	INDU 8.8%	CONS 7.7%	MATR 7.3%	REAL 6.4%	FINL 5.6%	S&P 4.2%	HLTH 3.7%	COND 3.6%	TELS 3.1%	ENRS 2.7%	INFT 1.6%
Apr-21	TELS 8.0%	COND 8.0%	REAL 7.6%	INFT 6.8%	S&P 5.6%	FINL 5.5%	UTIL 4.9%	MATR 4.8%	HLTH 4.0%	INDU 3.2%	CONS 1.6%	ENRS -0.5%
May-21	MATR 5.0%	ENRS 4.9%	FINL 4.7%	INDU 2.9%	HLTH 1.7%	CONS 1.7%	REAL 1.1%	S&P 0.6%	TELS -0.1	INFT -1.1%	UTIL -2.8%	COND -2.9%
Jun - 21	INFT 7.0%	ENRS 4.3%	COND 3.5%	REAL 3.2%	TELS 3.0%	HLTH 2.3%	S&P 2.3%	CONS -0.5%	UTIL -2.2%	INDU -2.2%	FINL -3.0%	MATR -5.2%
Jul - 21	HLTH 4.9%	REAL 4.6%	UTIL 4.3%	INFT 3.9%	S&P 2.4%	CONS 2.1%	MATR 2.1%	TELS 1.8%	COND 1.0%	INDU 0.9%	FINL -0.4%	ENRS -8.4%
Aug - 21	FINL 5.1%	TELS 5.0%	UTIL 4.0%	INFT 3.6%	S&P 3.0%	REAL 2.8%	HLTH 2.4%	COND 2.1%	MATR 1.9%	CONS 1.4%	INDU 1.2%	ENRS -2.0%
Sep - 21	ENRS 9.4%	FINL -1.9%	COND -2.6%	CONS -4.1%	S&P -4.7%	HLTH -5.6%	INFT -5.8%	INDU -6.2%	UTIL -6.2%	REAL -6.2%	TELS -6.6%	MATR -7.2%
Oct - 21	COND 12.1%	ENRS 10.3%	INFT 8.2%	MATR 7.6%	REAL 7.6%	FINL 7.3%	S&P 6.9%	INDU 6.8%	HLTH 5.1%	UTIL 4.7%	CONS 3.5%	TELS 0.2%
Nov - 21	INFT 4.4%	COND 2.0%	MATR -0.5%	S&P -0.7%	REAL -0.9%	CONS -1.1%	UTIL -1.6%	HLTH -3.0%	INDU -3.5%	ENRS -5.1%	TELS -5.2%	FINL -5.7%

Source: S&P, PPHB

The next S&P 500 sector performance chart shows annual results for 2003-2020 and 2021's year-to-date performance through November. We show this chart more for adding perspective on the long-term volatile nature of investing, and especially for energy. Therefore, we suggest in viewing the chart, merely focus on the location of the green squares and how their shifting fits with the changing energy environment.

Once can see that in the early years, when oil prices were booming and commodity stocks were doing well, energy was a top performer. With the emergence of the global financial crisis and recession in 2007, energy suffered, only to be hammered again in 2014 when Saudi Arabia stopped supporting OPEC's oil price. It took a sharp rebound in oil prices in 2016, offering hope to investors that the industry downturn was ending, to send the energy sector back to the top of the performance rankings. But the recovery was short-lived.

For most of 2007-2021, energy was in the bottom of the sector performance rankings, culminating in a run from 2018-2020 as the worst performing sector in the index. Since then, results have been much better, with energy scoring a 50% gain through the first 11-months of 2021.

Exhibit 18. The Long History Of Energy Sector Performance: 2003-2021

S & P 500 Sector Performance

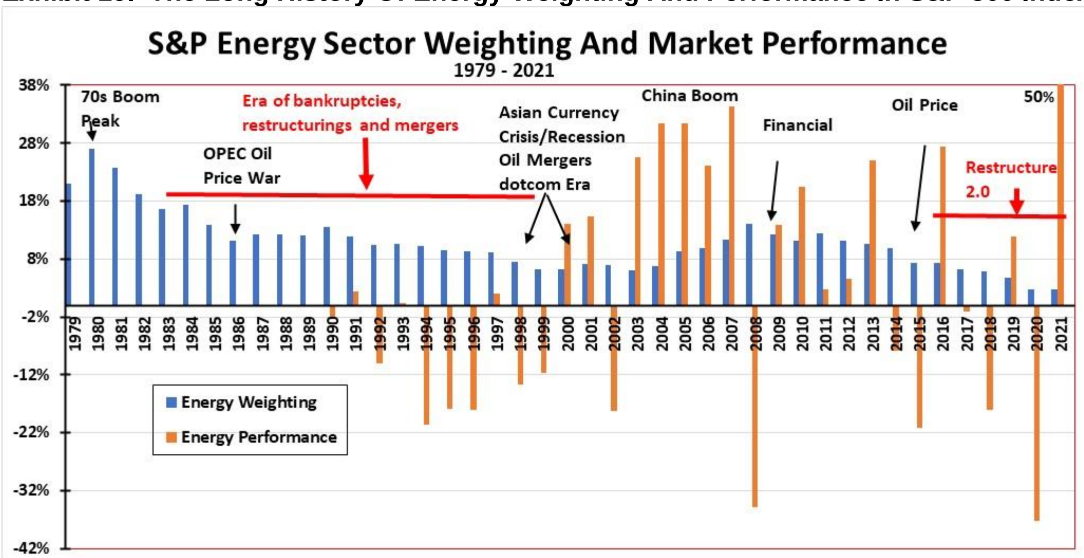
2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021 YTD 11/30/21
INFT 47.2%	ENRS 31.5%	ENRS 31.4%	TELS 36.8%	ENRS 34.4%	CONS -15.4%	INFT 61.7%	REAL 32.3%	UTIL 19.9%	FINL 28.8%	COND 43.1%	REAL 30.2%	COND 10.1%	ENRS 27.4%	INFT 38.8%	HLTH 6.5%	INFT 50.3%	INFT 42.2%	ENRS 50.0%
MATR 38.2%	UTIL 24.3%	UTIL 16.8%	ENRS 24.2%	MATR 22.5%	HLTH -22.8%	MATR 48.6%	COND 27.7%	CONS 14.0%	COND 23.9%	HLTH 41.5%	UTIL 29.0%	HLTH 6.9%	TELS 23.5%	MATR 23.8%	UTIL 4.1%	TELS 32.7%	COND 32.1%	REAL 32.6%
COND 37.3%	TELS 19.9%	FINL 6.5%	UTIL 21.0%	UTIL 19.4%	UTIL -29.0%	COND 41.3%	INDU 26.7%	HLTH 12.7%	REAL 19.7%	INDU 40.7%	HLTH 25.3%	CONS 6.6%	FINL 22.8%	COND 23.0%	COND 0.8%	FINL 32.1%	TELS 22.2%	FINL 30.7%
INDU 32.2%	INDU 18.0%	HLTH 6.5%	FINL 19.2%	INFT 16.3%	TELS -30.5%	REAL 27.1%	MATR 22.2%	REAL 11.4%	TELS 18.3%	FINL 35.6%	INFT 20.1%	INFT 5.9%	INDU 18.9%	FINL 22.2%	INFT -0.3%	S&P 31.5%	MATR 18.1%	INFT 30.1%
FINL 31.0%	COND 13.2%	COND 6.4%	COND 18.6%	CONS 14.2%	COND -33.5%	S & P 26.5%	ENRS 20.5%	TELS 6.3%	HLTH 17.9%	S & P 32.4%	CONS 16.0%	REAL 4.7%	MATR 16.7%	HLTH 22.1%	REAL -2.2%	INDU 29.4%	S&P 16.1%	COND 24.8%
S&P 28.7%	MATR 13.2%	S & P 4.9%	MATR 18.6%	INDU 12.0%	ENRS -34.9%	INDU 20.9%	TELS 19.0%	COND 6.1%	S & P 16.0%	INFT 28.4%	FINL 15.2%	TELS 3.4%	UTIL 16.3%	S & P 21.8%	S & P -4.4%	REAL 29.0%	HLTH 11.4%	S&P 23.2%
UTIL 26.3%	FINL 10.9%	MATR 4.4%	S & P 15.8%	TELS 11.9%	S & P -37.0%	HLTH 19.7%	S & P 15.1%	ENRS 4.7%	INDU 15.4%	CONS 26.1%	S & P 13.7%	S & P 1.4%	INFT 13.9%	INDU 21.0%	CONS -8.4%	COND 27.9%	INDU 9.0%	TELS 18.6%
ENRS 25.6%	S & P 10.9%	CONS 3.6%	CONS 14.4%	HLTH 7.2%	INDU -39.9%	FINL 17.2%	CONS 14.1%	INFT 2.4%	MATR 15.0%	MATR 25.6%	INDU 9.8%	FINL -1.5%	S & P 12.0%	CONS 13.5%	TELS -12.5%	CONS 27.6%	CONS 7.6%	MATR 18.3%
HLTH 15.1%	CONS 8.2%	INDU 2.3%	INDU 13.3%	S & P 5.5%	REAL -42.3%	CONS 14.9%	FINL 12.1%	S & P 2.1%	INFT 14.8%	ENRS 25.1%	COND 9.7%	INDU -2.5%	COND 6.0%	UTIL 12.1%	FINL -13.0%	UTIL 26.4%	UTIL -2.8%	HLTH 15.7%
CONS 11.6%	INFT 2.6%	INFT 1.0%	INFT 8.4%	COND -13.2%	INFT -43.1%	ENRS 13.8%	INFT 10.2%	INDU 0.6%	CONS 10.8%	UTIL 13.2%	MATR 6.9%	UTIL -4.8%	CONS 5.4%	REAL 10.9%	INDU -13.3%	MATR 24.8%	FINL -4.1%	INDU 15.0%
TELS 7.1%	HLTH 1.7%	TELS -5.6%	HLTH 7.5%	REAL -17.9%	MATR -45.7%	UTIL 11.9%	UTIL 5.5%	MATR -9.6%	ENRS 4.6%	TELS 11.5%	TELS 3.0%	MATR -8.4%	REAL 3.4%	ENRS -1.0%	MATR -14.7%	HLTH 20.8%	REAL -5.2%	CONS 7.6%
				FINL -18.6%	FINL -55.3%	TELS 8.9%	HLTH 2.9%	FINL -17.1%	UTIL 1.3%	REAL 1.6%	ENRS -7.8%	ENRS -21.1%	HLTH -2.7%	TELS -1.3%	ENRS -18.1%	ENRS 11.8%	ENRS -37.3%	UTIL 7.3%

Source: S&P, PPHB

While energy industry fundamentals are improving, the sector still suffers from distain by investors driven to invest based on environment, social, and governance (ESG) metrics. No matter how well energy companies score with the S and G metrics, they suffer from being associated with fossil fuels – the worst consideration for the E metric. This shift in investing philosophies to using ESG metrics, coupled with the volatile nature of oil and gas prices, has resulted in the sector weighting within the S&P 500 index shrinking steadily over time. This reality is captured in the next chart showing the shrinking S&P weighting, the annual performance of the sector, and our annotation of major industry events impacting the industry's environment.

From a peak energy weighting of nearly 29% in 1980, the sector weighting in the S&P 500 index shrank to a low in the 5%-6% range in the first years of the new century. With oil prices beginning to boom in 2004, the sector weighting rebounded but only to peak of 16% in 2008, before beginning a steady decline to its 2.2% low in 2020. The weighting is up to about 2.8% this year, but such a low sector weighting impacts investor interest in investing in such a tiny segment of the overall stock market. For money managers hoping to outperform their peers, they need to concentrate on companies with larger market capitalizations (more liquid) and in greater control of their own earnings' destiny.

Exhibit 19. The Long History Of Energy Weighting And Performance In S&P 500 Index



Source: S&P, PPHB

What we have seen so far in 2021 is that an improving energy industry outlook, coupled with demonstration of greater financial discipline in managing capital allocations, has led to strong earnings and stock performance. As energy stocks have rebounded, and with the prospect of a brighter future over the next several years, regardless of the long-term future for fossil fuels, investors are funneling more money into the sector. This is the natural outcome of the competitive environment for institutional investors. When performance lags and out-of-favor investments are scoring big gains, money managers are forced to start putting money into the sector. This is happening with energy and will likely continue. The questions are: How much money can flow into the energy sector? How long will the money stay in the sector given the history of oil and gas price volatility?

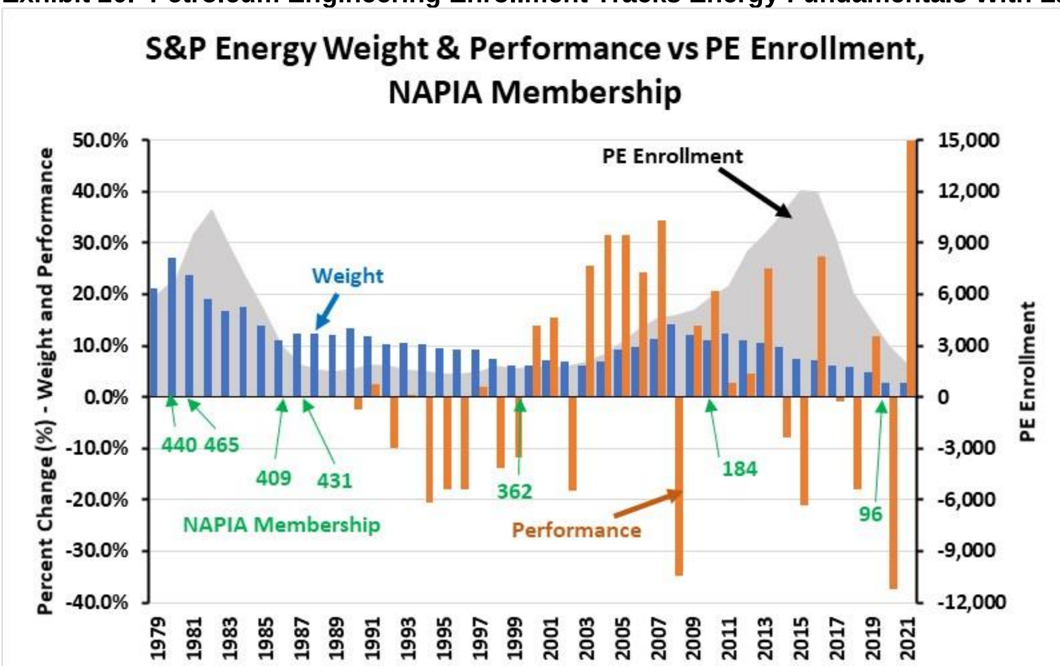
The answer to these questions hinges on how the under-investment in the energy industry over the last five years plays out in future oil prices and company earnings. If the financial discipline dictate of investors is adhered to by energy company CEOs, growth in new oil and gas production will be modest, which should sustain healthy oil and gas prices and company profits. The industry will continue to be the target of politicians and climate activists, but the structure of the world's economy has fossil fuels so imbedded in it that the world cannot shift to a renewables-only economy as quickly as projected. Virtually every responsible energy forecast by governments, industry, consultants, and NGOs shows oil and gas playing a substantial role in the global economy for the next 40-50 years.

The glaring vulnerability in the energy industry's future is its workforce. It was interesting reading the recent outlook for the recovery in jobs in Houston in 2022 presented by the Greater Houston Partnership. It is predicting 72,000 new jobs next year, with energy contributing 4,000 of them, or 5.5%. Houston is still known as the 'Energy Capital of the World,' but only adding a little over 5% of newly created jobs in a world of $70 oil? The low employment growth estimate reflects the assumption that the industry will adhere to financial discipline in managing its investments.

The shrinking number of energy companies – producers, pipelines, and service – is also taking its toll on the industry's job market. Consolidation in the sector means mostly assets and not people.

This questionable outlook for the industry's future is reflected by the number of students studying petroleum engineering. Texas Tech University Professor Lloyd Heinze has tracked enrollment in this discipline. Using his data enabled us to construct a chart we have previously published. We updated the chart through 2021 based on magazine articles quoting Professor Heinze's data and observations. What they show is that the decline in enrollment has continued in lockstep with the previous decline in oil prices. Heize says there is about a 2.5-3-year lag between the change in oil prices and shifts in petroleum engineering enrollment trends. If that relationship continues to hold, and we are not certain it will, then enrollment will turn up around 2024. The problem is that the petroleum education discipline is being curtailed, as universities cutback the offerings in response to demands for new educational disciplines more in-line with the work needs of the renewables industry, which is seen as the next great growth sector. Green jobs appeal to our youth. Who wants to work in the dirty fossil fuel business?

Exhibit 20. Petroleum Engineering Enrollment Tracks Energy Fundamentals With Lag



Source: S&P, NAPIA, Texas Tech, PPHB

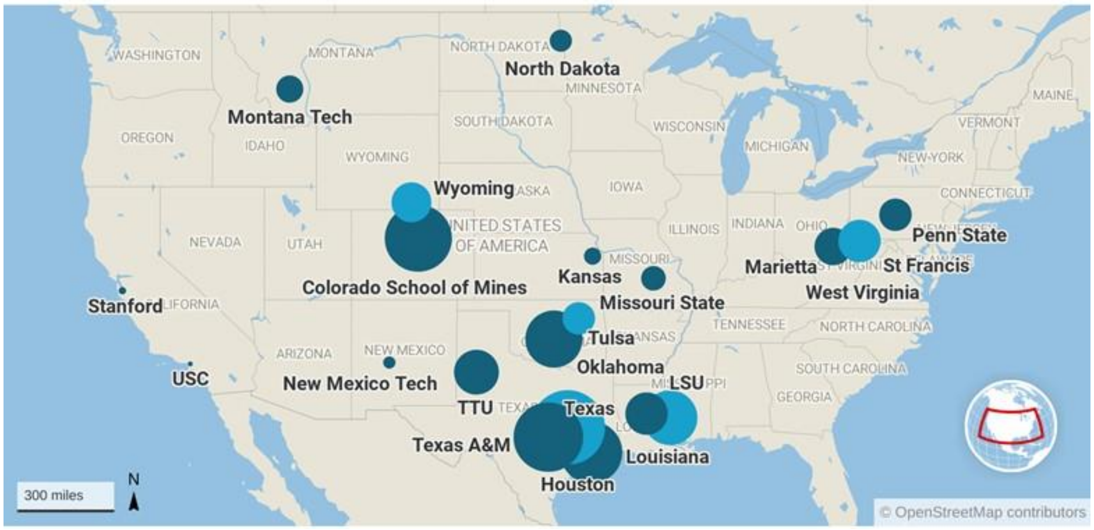
The aging of the petroleum industry's workforce has been a concern for a number of years. It was labeled the "Great Crew Change," and presented as a challenge for energy company human resource professionals. If the fossil fuel industry is no longer destined to grow, the future of employment is less bright. The number of new positions will shrink, especially as the push for efficiency and digitization reduces the number of workers required in virtually every employment discipline within the industry.

The decline in membership in the National Association of Petroleum Investment Analysts association shown on the chart reflects the shrinking weighting of energy in the stock market, as well as the contraction in Wall Street equity research. What will be interesting will be to revisit this chart in five years, especially if 2021 marks the first year of a bull market in energy investments. Just as we saw in the early 2000s, a string of years of strong energy stock performance coinciding with booming oil prices and elevated levels of industry activity causing petroleum engineering enrollment to rebound and stock prices to rise. History could repeat.

Exhibit 21. Leading Petroleum Engineering Programs In The U.S.

America's Petroleum Engineering Programs

Colleges and universities in the contiguous United States offering Bachelor of Science in Petroleum Engineering degrees. Circle sizes represent comparative 2019 undergraduate enrollment figures.



Source: ***JPT***

We found the chart above interesting considering the shifting trend in petroleum engineering enrollment. An article about 2019 enrollment in the *Journal of Petroleum Technology* contained both the chart and the following highlights.

> Four petroleum engineering programs were accredited by the Accreditation Board of Engineering and Technology in its inaugural accreditation year of 1936: Louisiana State University (LSU), Oklahoma University (OU), The University of Texas, and Texas A&M University. All four remain in the top 10 US schools in terms of enrollment, but Colorado School of Mines and the University of Houston have overtaken LSU and OU in the top four.
>
> The number of US college and university campuses offering petroleum engineering has dropped from 35 to 20.
>
> Non-US petroleum engineering programs have increased since 2016. In 2019, there were 11 non-US and 20 US-based accredited petroleum engineering programs.

We thought it interesting that with U.S. petroleum engineering programs in decline, programs abroad are increasing. This reflects the growing importance of international oil and gas markets and the dominance of national oil and gas companies and the desire of their governments to have the companies staffed with locally trained staff. It attests to the further globalization of the petroleum industry, a trend that will continue, if leaders of developed economies push to de-emphasize fossil fuels.

We may be a cockeyed optimist, but we remain convinced there is a future for young workers in the petroleum industry. The industry is changing and will continue to change. New technologies and operating processes are being adopted, so employees with technical skills and educations will be in demand. The industry will continue to experience ups-and-downs, but after the past decade, managers may have learned that more measured growth is better than booms and busts.

The petroleum industry needs to do two things besides providing better stewardship of investors' capital. First, it must do a better job of educating the public about the important role petroleum plays in improving the standard of living for the billions of people on the planet, and especially for those living in lesser-developed countries. Second, it must harness its technologies and talented workers and address the decarbonization of the world's energy system. The petroleum industry has the technology, talent, and scale to solve the global decarbonization challenge. These two missions go hand in hand, and together they will help change the industry's image, making it an attractive place to work for our youth.

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