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ENERGY INVESTMENT BANKING

# MUSINGS FROM THE OIL PATCH

**April 21, 2020**

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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:

### Thinking About Energy's Future Means Considering Choices

The energy market is a mess. The dramatic demand collapse, pulling oil prices down to levels not seen in 20 years or more, is wrecking balance sheets, cash flows, profits, and activity. We know this will end as the global shutdowns cease, but what will the recovery, and more importantly, energy's long-term future look like?

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### Could A Hurricane Create More Havoc For Energy In 2020?

Early 2020 hurricane forecasts are out and they call for above-normal activity. That is not good news, given what the U.S. economy and energy business are going through. The scariest thought is a repeat of 2005 with major hurricanes Dennis, Katrina, Rita and Wilma. Hopefully, all the storms will remain in the Atlantic Ocean.

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### Lurking Demographic Issues Could Impact Energy's Future

As we contemplate energy's and the world's long-term future, we assume they will be marked by more people and rising living standards. That might not be the case, as Jeremey Grantham points out. Declining fertility runs the risk of pushing the rate below replacement, meaning a shrinking population. Its impact on energy?

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**We trust everyone is well and staying home. Stay safe.**

# Thinking About Energy's Future Means Considering Choices

**For the global oil business, it is confronting a combined demand and supply shock, something it has not experienced in 90 years**

The energy world remains mesmerized by the daily gyrations of WTI and Brent oil prices. Will oil prices fall further as global supply overwhelms demand reduced by economy shutdowns in fighting the coronavirus? We are hearing that as wellhead prices fall into low single digits despite oil futures trading in the $20s a barrel. The low wellhead prices reflect quality and location discounts, but also the struggles for the industry of getting output into storage. For the global oil business, it is confronting a combined demand and supply shock, something it has not experienced in 90 years. The industry's immediate challenge is restoring the global supply/demand balance as quickly as feasible. Without a quick response, global oil storage will be overwhelmed, forcing operators to have to shut in substantial production, as we are seeing in West Texas. Shutting down wells runs the risk of reducing their future productive capacity when they will be needed in the future, something that reduces their long-term value for the producer, at the same time reducing his income, which is critical in an environment of low wellhead prices.

**The industry cannot manufacture demand, as it traditionally does by lowering pump prices, since world economic activity is stopped by governments fighting a rapidly spreading and deadly virus**

The recent OPEC+ agreement to cut production, with the active support of Brazil, the United States, Norway and Canada, should help slow the tsunami of crude oil heading at the world's consuming markets. Unfortunately, the agreement won't protect the market from being overwhelmed with too much supply and low oil prices that will wreck the industry's landscape in the near-term. The industry cannot manufacture demand, as it traditionally does by lowering pump prices, since world economic activity is stopped by governments fighting a rapidly spreading and deadly virus. Forcing citizens to stay at home, is not a recipe for boosting oil use. The world is careening towards an economic depression.

Goldman Sachs estimates U.S. economic activity will fall by 11% in 2020's Q2, with Q3 and Q4 forecasts showing -8% and -5% declines, respectively. Other estimates are worse, while some are slightly better. The London-based Centre for Economics and Business Research estimates world GDP will fall by at least 4% this year — albeit with a "huge margin of error." A more optimistic OPEC only sees the world's economy slipping by 1.5% this year.

**It forecasts the global economy contracting 3% in 2020, which contrasts with its January forecast for a global GDP expansion of 3.3%**

The International Monetary Fund (IMF) just issued its latest outlook in which it forecasts the global economy contracting 3% in 2020, which contrasts with its January forecast for a global GDP expansion of 3.3%. Advanced economies will shrink 6.1%, while emerging economies will experience at least a 1% decline. Critical to the IMF forecast is that it sees the U.S. economy contracting by 5.9% this year, as the Eurozone shrinks by 7.5%. China, however, is anticipated to grow by 1.2%, although its first quarter results saw its economy shrink by 6.8% compared to last year, and the first quarterly decline in decades. The European countries most impacted by Covid-19, Spain and Italy, are projected to suffer

greater economic declines, -8% and -9.1%, respectively, than the average for the Eurozone. The U.K. is projected to experience a 6.5% decline. Unanimously, 2020 will be a dismal economic year.

For 2021, the IMF had estimated 3.4% growth for global GDP, which it has revised upwards to 5.8% growth, albeit from a sharply lower base due to the projected 2020 contraction. Gita Gopinath, the IMF's chief economist commented that "A partial recovery is projected for 2021, with above trend growth rates, but the level of GDP will remain below the pre-virus trend, with considerable uncertainty about the strength of the rebound." That outlook raises the question of whether long-term GDP growth rates may be different from what economists and businessmen had been assuming prior to the arrival of Covid-19.

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To be of value to our readers, we must break away from the stock and commodity market screens and begin thinking about the future for energy, not tomorrow, but later this year and next, but importantly for 5-7 years from now. Remember, capital committed to the energy business supports some of the longest-lived producing assets in the world. Whether and how much to commit to this industry will depend on its long-term future. If the economic environment will be different than we thought, will it be guided by inflationary or deflationary forces? The answer to that question has significant implications for energy's future. As American novelist Chuck Palahniuk wrote, "The future you have, tomorrow, won't be the same future you had, yesterday."

**Thinking about the next 18 months.**

Forecasters are always looking for a shorthand description of their projections. The easiest way is to pick a letter whose shape conveys the pattern envisioned by the forecast. So, are we looking at a V, U, W, S or L shape for the U.S. economic and energy industry recoveries? Let's assume the Goldman Sachs pattern for U.S. economic activity for the balance of 2020 is also reflective of how global GDP will unfold. If we plug in the rebound projected by the IMF for 2021, we are describing a U-shaped recovery.

**So, are we looking at a V, U, W, S or L shape for the U.S. economic and energy industry recoveries?**

We also cannot ignore the potential the recovery will take the shape of a W, especially if there is a resurgence of the virus in the fall, as projected by Morgan Stanley, necessitating another bout of mandated shutdowns. That scenario cannot be discounted, given the absence of a vaccine, coupled with the isolation of large segments of the population from exposure to the virus in the current pandemic. On the other hand, the speed with which the pharmaceutical industry is producing tests, especially rapid testing, may mitigate the virus' impact in the fall.

**Exhibit 1. How Covid-19 Might Play Out In 2020**


**Source: Morgan Stanley**

**There is little doubt the United States economy, as well as that of the world, is in terrible shape**

Economic figures released last week suggest we are in the worst economic environment since the Great Depression. For the past four weeks, 22 million workers have sought unemployment assistance. March retail sales fell 8.7%, the worst decline since the report started in 1992. The homebuilder sentiment index dropped to 30 versus an anticipated decline to 55; the lowest reading for the index since it was begun in 1985. The New York Empire State Manufacturing Survey fell 56.7 points to a -78.2% reading. At the same time, Gallup reported that its U.S. economic confidence survey dropped 54 points for +22 to -32, the largest monthly decline since 1992. We could go on, but there is little doubt the United States economy, as well as that of the world, is in terrible shape. Right now, economies require substantial support to prevent a greater social calamity. That support will also help energy to recover.

The global oil market is working hard to climb out of its abyss. The first step was securing an agreement between Russia and Saudi Arabia to end their oil war and lead OPEC in a significant output cut. Those two countries reluctantly agreed, but are counting on the support of key non-OPEC producers, including Norway, Canada, America and Brazil, to contribute to the cut. For three of the four countries, their governments lack the power to force their nation's oil companies to stop producing. Brazil can dictate to its national oil company, even though it has international oil companies present.

**The near-term question for oil prices is how low wellhead prices go as global oil storage approaches capacity**

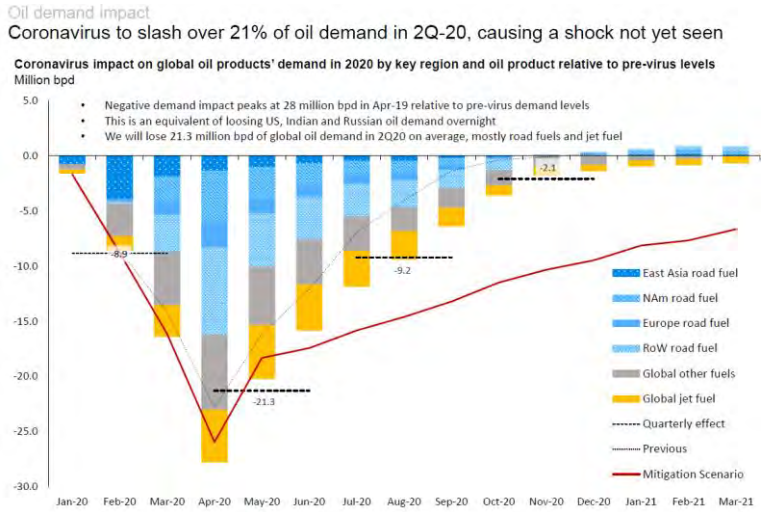
Current crude oil futures prices reflect a belief that the oil supply/demand imbalance will be corrected over time. The problem is that it may be a long time. The near-term question for oil prices is how low wellhead prices go as global oil storage approaches capacity. Estimates of how much storage is available, and how full it is currently, vary widely. Most forecasters project global storage reaching capacity sometime within the next two months. Others believe full capacity may be reached sooner. The timing difference reflects varying assumptions about the physical fill rate. Additionally, there is no solid figure as to the exact amount of oil storage, as estimates vary depending on guesses as to how many tankers may

be used for floating storage, let alone how many railroad tank cars. What is unknowable is how much additional storage capacity might be added to the global system through innovative steps such as filling unused and/or previously abandoned pipelines. Who would have thought that all the pipelines crisscrossing North America might become storage sites? Swimming pools, anyone?

**The oil market believes the OPEC+ agreement provides a roadmap for an oil price recovery**

The oil market believes the OPEC+ agreement provides a roadmap for an oil price recovery. The existence of such a roadmap is crucial given the dramatic destruction of oil demand due to the virus fight, and the likely slow recovery in economic activity this summer and fall. Visualizing how far oil demand has fallen and how slowly it is projected to recover highlights the challenge oil and gas companies face. Energy consultant Rystad Energy's forecast for oil demand for 2020 through 2021's first quarter is shown. It provides estimates of the where the demand impacts have been felt the most.

**Exhibit 2. We Are At Maximum Oil Demand Loss**

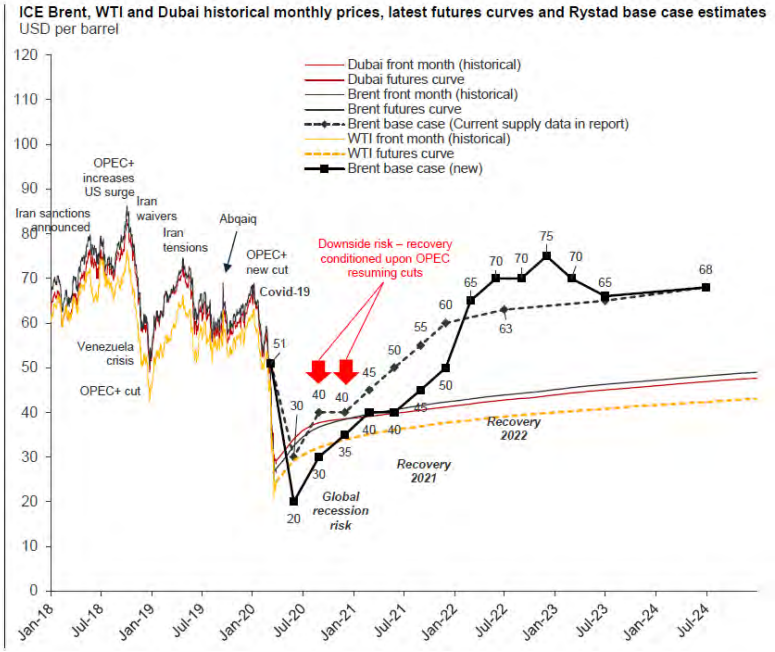



**Source: Rystad Energy**

**These forecasts project future oil prices ranging between a low of $63 a barrel to as high as $75 by the end of 2022**

Rystad Energy has also presented a scenario (Exhibit 3, next page) showing how the greatest demand collapse in history (wiping out 10 years of global growth, according to the International Energy Agency) sets the stage for a potential recoil in demand and oil prices. This projection was made prior to the new OPEC+ agreement. As shown, the black dotted line and the black line with boxes show forecasts of price rebounds, assuming a positive response to the virus from effective quarantine efforts that may lead to sharply higher oil prices in 2021 and 2022. The black line with boxes represents the firm's worst-case scenario reflecting greater demand destruction and challenges in managing the build-up in global inventories. The two forecasts also assumed that OPEC+ would return to their prior output cut agreement commencing in June 2020. These forecasts project future oil prices ranging between a low of $63 a barrel to as high as $75 by the end of 2022.

**Exhibit 3. How Crude Oil Prices May Recover**




**Source: Rystad Energy**

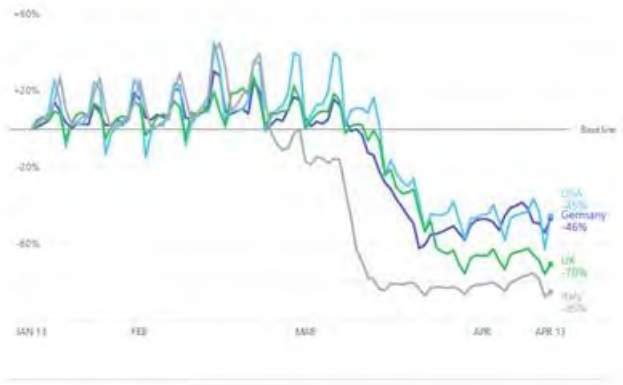
**If you are an oil company CEO planning your future, you have to discount the optimistic prediction and plan for the worst imaginable price scenario**

Contrast those high oil price projections in 2022 with the three colorful lines below that show the futures prices for Dubai, Brent and WTI. By July 2022, the spread between WTI futures and the Brent recovery scenario prices forecasted by Rystad Energy ranges from $30 to $40 a barrel. Given that we are not aware of any oil price forecasts that have proven accurate, if you are an oil company CEO planning your future, you have to discount the optimistic prediction and plan for the worst imaginable price scenario. That is what is driving the renewed oil and gas company capital spending cuts on top of those announced previously. When you can't make money at today's oil prices, stopping spending is the equivalent of the answer of what to do if you are in a hole – stop digging!

**The question is how quickly mobility will rebound, which has significant implications for transportation fuels consumption**

If we assume OPEC+ has presented a path to higher oil prices, what about the demand side of the equation? How quickly, and when, will global economies re-open? Germany is considering reopening now, and we know China has resumed a more normal life. When we look at Apple's Mobility data, we can see the impact of the virus and the government shutdown responses on traffic since the middle of January. Germany's decline matches that of the United States, but they were less impacted than the U.K. and Italy. The question is how quickly mobility will rebound, which has significant implications for transportation fuels consumption. Shortly, we may have data on how rapidly Germany's traffic has recovered. In the interim, expect to see pictures of Germany's highways and city streets, contrasted with when they were empty during the shutdown.

**Exhibit 4. How Country Travel Has Been Impacted**

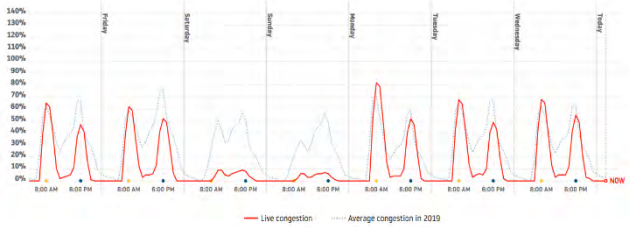



**Source: Apple Mobility**

**Their relative comparability may signal that businesses are open and operating, and that people are returning to work, but their pre-virus lifestyles have not been totally restored**

When we look at traffic congestion data from GPS provider Tom Tom for Beijing for the seven days prior to last Wednesday, we see it is approaching congestion levels experienced in 2019. The two weekend days, however, showed sharply lower congestion levels versus last year, which may reflect the hesitancy of citizens to travel other than for work. As the other days are work days, their relative comparability may signal that businesses are open and operating, and that people are returning to work, but their pre-virus lifestyles have not been totally restored. Will they ever?

**Exhibit 5. How Beijing Traffic Has Recovered**




**Source: Tom Tom**

**Since every country is on its own timetable, it is difficult to envision a rapid restoration of global economic activity to levels comparable to those prior to Covid-19 anytime soon**

From now through the end of 2021, the economic recovery will reflect Vs and Us, as the re-opening of the world's economies will not be done all at once, just as the shutdowns weren't. Countries shut down activity as they felt compelled to deal with the health emergency. Since every country is on its own timetable, it is difficult to envision a rapid restoration of global economic activity to levels comparable to those prior to Covid-19 anytime soon. By the end of 2021, it is likely most pre-Covid-19 activity will have restored, except for the hesitancy of government officials to allow mass meetings, until they are sure the health risk from another virus outbreak has been eliminated. That likely means rapid and nationwide testing for the virus, and/or the successful development of a Covid-19 vaccine, something that may take 18-24 months from now. Some doctors and politicians question how we can meet such an aggressive

timetable, given that proving vaccines for other diseases have needed 4-20 years. Covid-19 is one of the family of coronavirus, and we have dealt with previous virus outbreaks. According to the World Health Organization, the coronavirus family of viruses includes the common cold, as well as the MERS coronavirus, which is Middle East Respiratory Syndrome coronavirus, and SARs, the Severe Acute Respiratory Syndrome coronavirus. We have been trying to eliminate the common cold for decades, unsuccessfully. But we have experience with MERS and SARS, which may help us in developing a vaccine against Covid-19.

**We have to be careful about assuming greater than normal economic activity in 2021 merely because the IMF projects a faster growth rate**

If substantial economic activity is restored by the end of 2020, the question will become the pace of further economic activity improvement during 2021. We have to be careful about assuming greater than normal economic activity in 2021 merely because the IMF projects a faster growth rate. That faster rate is because we are coming from a lower base. Economic activity in 2021 will continue to be impacted by the natural cautiousness of people who have just experienced a traumatic event, as well as the mandated "social distancing" measures. Not only will people be hesitant to embrace a full return to pre-Covid-19 activity, they may not be able to due to mandates. For example, will restaurants only be allowed to serve a third or half their current authorized capacity? Forecasting when or if we return to full pre-Covid-19 activity levels is virtually impossible, but caution dictates adjusting forecasts lower.

**Rapidan Energy Group's Robert McNally has forecasted WTI to only average $15 a barrel in 2020's Q2, before rising to $18 in Q3, and reaching $28 in Q4**

What does this economic activity pattern suggest for future oil prices? Second quarter oil prices are likely to average in the low $20s per barrel for WTI, or possibly below. Rapidan Energy Group's Robert McNally has forecasted WTI to only average $15 a barrel in 2020's Q2, before rising to $18 in Q3, and reaching $28 in Q4. His assumption is that the delay in cutting global oil supplies will create significant dislocations in the oil market due to near-term storage challenges, driving oil prices to very low levels that are necessary to force production shutdowns. That then creates a small oil price bounce by the end of the year. It is a logical scenario. The uncertainty of the timing of events impacting a recovery this year, makes forecasting 2021 oil prices that much more challenging.

**The next 3-5 years; and forever?**

When we shift our focus beyond the near-term horizon, we need to shift the nature of our discussion, too. The long-term economic and energy outlook is shaped by factors such as demographics, GDP growth, social trends, and economic realities. We can highlight issues within each of these broad categories and their possible impacts, but settling on an event's measurable impact on oil prices, or oil and gas demand, is beyond the scope of what we can do now. Raising these various issues, however, and how they might interact with economic activity and energy demand, will allow us to comment on how current long-term energy forecasts may be reshaped.

**Global GDP is a function of population growth, the distribution of the population by age-groups and sex, and its productivity**

Global GDP is a function of population growth, the distribution of the population by age-groups and sex, and its productivity. With respect to population growth, where people live and what national birth rates are will also influence GDP growth. In addition, living standards and people's desire for improvements play a role. Keeping it simple, more people and higher living standards means greater GDP. Later in this issue of the *Musings*, we have an article about a lurking demographic development that is having, and may have a significant impact on future population growth and age pyramids. This condition will not materially shift the world's population profile within the next decade, but thereafter, it could begin reshaping the population profile, which will alter economic growth and energy consumption.

**The degree to which each component changes will vary for each country depending on its economic, social and political structure**

GDP is the total of a country's contributions from four components: personal consumption; business investment; government spending; and net exports. Each component will be different after Covid-19 than previously anticipated. Each will change as people recognize they do not want to have to go through another national shutdown to deal with a future pandemic, therefore they will adjust how they live. The degree to which each component changes will vary for each country depending on its economic, social and political structure.

For the U.S. economy, personal consumption expenditures represent 70% of GDP. The figure varies widely among developed and developing economies. Much of that variation is a function of the economic structure of the countries. Those countries where government represents a large component of its economy and provides various personal services, actual personal consumption expenditures tend to be low. This is evident among many of the Scandinavian countries. China is quite low at 39%, but there, incomes are low and many desired goods and services are severely limited.

Last week's national retail sales report for March showed an 8.7% decline from February and a 6.2% decline from March 2019. Among spending categories with the largest year-to-year declines were gasoline (-18%), clothing (-51%), furniture and home furnishings (-25%), and restaurants (-23%). Spending was up at grocery stores (+29%), health and personal care (+4%), and non-store retailers (+10%). None of these spending changes were surprising given how lives have been disrupted by the government stay-at-home mandates.

**One begins to wonder how people will spend their incomes in the future**

These spending trends will moderate over time, but one begins to wonder how people will spend their incomes in the future. There will certainly be changes, but certain categories may never recover to their pre-Covid-19 levels. The current dismal spending data is a result of the Depression-era unemployment levels due to the shutdowns of non-essential businesses. As a result, many people are unable to pay their rent and mortgages, while putting food on

their tables, while remaining at home. The government is stepping in to assist the unemployed, but that is temporary. We still do not know how long this temporary support will last, or will be needed, but it will end eventually. Many of the financial relief programs are merely postponements of expenditures, which will require them to be repaid at some point in the future. That will add an additional financial burden on people as they recover. The problem is that the upending of the economy has resulted in employers divesting their employees as they attempt to try to salvage their enterprises. How many of the unemployed will be able to return, especially as many small businesses and restaurants may go broke and close?

**We still do not know how long this temporary support will last, or will be needed, but it will end eventually**

If people who lose their jobs, or are only able to marginally navigate the financial pain of the economic shutdown, when they regain employment, how will they spend their money? In considering that question, we are reminded of the 2019 Federal Reserve survey showing that 40% of Americans couldn't afford a $400 emergency. Will people continue to spend as they have in the past, or will they begin to save money? If they save, what happens to spending, especially discretionary spending on things such as entertainment, dining out and attending sporting events? What is the long-term outlook for the travel and leisure industry?

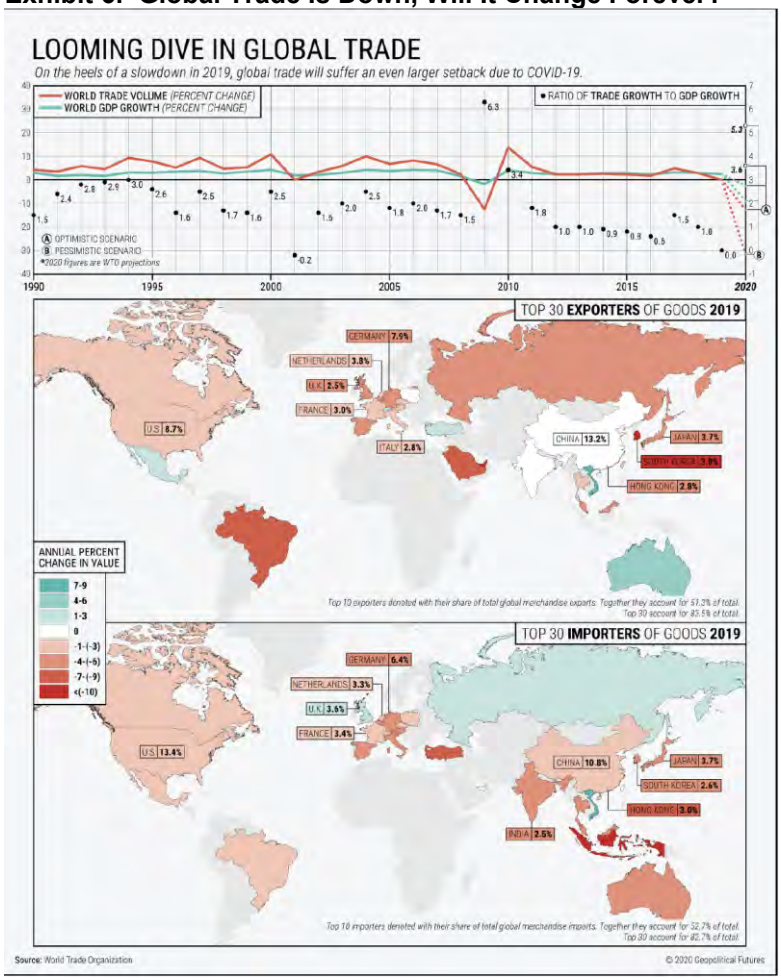
**Will people continue to spend as they have in the past, or will they begin to save money?**

Another trend primed for change is the structure of business supply chains. Management of these supply chains has received heightened attention in recent years as our culture is now dictated by "just-in-time" deliveries of everything we could ever want, witness the rise of Amazon Prime. Supply chain management is critical not only for the delivery of final products, but for profit margins for companies. At the same time, the Covid-19 experience showed how, as a nation, we have allowed the hollowing out of sectors of our economy in response to our desire for low-cost products that can arrive just in time – medical supplies and equipment, medicines, and personal protection devices, for example – which proved critical in our battle against Covid-19. The current administration's pushback against the rise of China as our de facto manufacturing center, which was partly behind the election of President Donald Trump, has had the impact of causing some American corporations to return some of their offshore manufacturing operations to the U.S. This trend plays into the issue of business investment, but also trade and the net export component of GDP.

**Management of these supply chains has received heightened attention in recent years as our culture is now dictated by "just-in-time" deliveries of everything we could ever want**

While global trade has dropped due to the global economic shutdown, the issue of its long-term future is unclear. The World Trade Organization's optimistic scenario for global merchandise trade this year calls for only a 13% drop compared to 2019, while its worst-case scenario suggests a potential 32% decline. This has significant implications for the world's shipping industry – both sea and air. Both of those businesses have been experiencing booms, boosting demand for marine bunker and jet fuels, meaningful components of global oil demand. The effort to clean up the

**Exhibit 6. Global Trade Is Down, Will It Change Forever?**




**Source: Geopolitical Futures**

**If shipping contracts by 20%-25% as a result of adjustments to lifestyle changes, that means potentially 800,000 to one million barrels a day of reduced demand**

pollution from ocean-going ships was stepped up on January 1st with the commencement of the low-sulfur fuel mandate of the International Maritime Organization. In the years leading up to the start of enforcement of this rule, there was widespread concern over the adequacy of supplies of low-sulfur fuel, which is essentially diesel. The fear of fuel price explosion due to competition between trucks and ships for scarce diesel appears to be a non-issue now, and maybe less of an issue going forward. Shipping consumes about four million barrels a day of fuel, or about 4% of world oil demand. If shipping contracts by 20%-25% as a result of adjustments to lifestyle changes, that means potentially 800,000 to one million barrels a day of reduced demand. The knock-on effect will be fewer ships and crews will be needed, and that means few new ships need to be built. The dominos begin to fall.

Many people are ignorant of the amount of money airlines earn flying high-valued cargo in the underbellies of passenger airlines,

**If airlines commit to social distancing, or are mandated, does that mean no one will ever fly in a middle seat again?**

and now in their passenger seats, at least temporarily. If supply chains are revamped, there will be a knock-on effect on airline profitability, and potentially the number of international flights that are subsidized by this cargo. Will higher passenger fares be needed for these flights to be profitable in the "post-Covid-19" world? This doesn't even begin to address the issue of "social distancing" seating on airplanes. If airlines commit to social distancing, or are mandated, does that mean no one will ever fly in a middle seat again? Hallelujah! Will 34-inch width seats become the equivalent of 6-foot social-distancing on airlines? If planes are no longer chocked full of passengers, how will the airline make money? Oh yes, they will raise prices. What will that do to airline travel?

A revamping of supply chains, and an increase in domestic manufacturing should lead to an increase in business investment. How much and for how long is uncertain, but the impact will be to boost near-term energy consumption as construction and refurbishment efforts are undertaken. Traffic routes will shift, as fewer trucks will be hauling goods from coastal ports to consumers, while new routes that spread out across the country from more centrally-located manufacturing plants grow. Will this only boost employment among those states in the Midwest and Southeast where many plants are likely to be located and/or expanded, or will they become magnets for migration of workers from other regions of the country?

**Eventually, the surge in liquidity injected into financial markets sets up the economy for a surge in inflation**

An important question about business investment will be what happens to financial returns. The inability of the Federal Reserve to ever end its low-interest rate environment, that is now being driven by the need to keep the economy afloat, will keep rates low and reduce the threshold required to justify investment in new business assets. Eventually, the surge in liquidity injected into financial markets sets up the economy for a surge in inflation. We avoided it after 2008-2009 because most of the money whet to banks and was used to rebuild their capital, while also paying the fines for their malfeasance in handling mortgage-backed securities. This time, we see an awfully large amount of government money being put directly in the hands of people, which means it will be spent. That is the idea. But too much money could eventually result in an elevated level of inflation. Might this lead to another era such as the stagflation experienced in the 1970s? Let's hope not.

**The U.S. operates on two long cycles – the socioeconomic cycle and the institutional cycle**

As George Friedman discussed in his The Storm Before The Calm, the U.S. operates on two long cycles – the socioeconomic cycle and the institutional cycle. The first works on a 50-year time frame, while the other is about 80-years long. The socioeconomic cycle's last shift "happened around 1980, when the economic and social dysfunction that began in the late 1960s culminated with a fundamental shift in how the economic and social systems functioned." This is referred to as the Reagan Revolution, which brought lower tax rates that addressed a crucial issue facing the

**Today, we suffer from too much capital and a lack of investment opportunities**

U.S., which was a lack of capital. Today, we suffer from too much capital and a lack of investment opportunities, which Mr. Friedman attributes to a decline in productivity growth as we experience a falloff in innovation. There have been a number of studies and books written about why the nation's productivity has declined.

The institutional cycle deals with how the federal government's operation and relationship to society changes. It's first 80-year cycle began with the Revolutionary War and the drafting of the Constitution and ended with the Civil War in 1865. The second cycle extended to World War II. The current cycle will end around 2025, about the same time the current socioeconomic cycle will end, leading, in Mr. Friedman's view, to extreme chaos that will force changes on the nation that will bring social calm and economic prosperity in the 2030s, and thereafter.

Mr. Friedman makes a compelling case in studying how our economy, government, society and geopolitical role in the world have evolved and changed since the arrival of the first colonists in the late 1500s and early 1600s. Without expounding on his discussion, the nature of cycles, something we pay attention to in the business, investment and energy worlds, has driven us to think about how the future may evolve.

**Government, and its spending, has become a wildcard in considering how our future may evolve**

Government, and its spending, has become a wildcard in considering how our future may evolve. The fight against Covid-19 is leading to the belief that governments everywhere will become larger as they are needed to support and guide our economic survival and recovery. On the other hand, many people may rebel against the idea of a larger government, feeling the edicts of unelected bureaucrats have caused millions of people to lose their jobs, entrepreneurs potentially their businesses and lifesavings, and retirees their incomes due to the policies employed to fight the virus. The question of the competence of government is being raised in the Covd-19 fight, but one might suggest the Russian conspiracy episode of the past four years, and the government's arbitrarily shutting down the Gulf of Mexico at the time of the Macondo well accident represent other examples of government run amuck.

**This group is rapidly becoming the leading decision-making power within the economy, and soon in the political world**

If the data bears out that Covid-19 mostly impacts older people and those with underlying health issues, the younger and healthier segments of our population may believe they have been victimized by the government's efforts in fighting the virus. This group is rapidly becoming the leading decision-making power within the economy, and soon in the political world. How will they want the U.S. economy and society to work? Probably not as it is working now. Get ready for an extended struggle that may come to dominate our news cycles.

Futurists and energy forecasters have wrestled with the attitudes of this younger generation about where they will live, how they will live,

what types of jobs they take and how those are performed, how they will communicate, whether they will secure drivers licenses and purchase cars, and if they will embrace traditional social patterns with respect to marriage and having children? For a while, these questions have been answered that the younger generation only postponed these decisions as they struggled with the economic fallouts from the Financial Crisis of 2008. Looking back, this generation may conclude their fate was dictated by government incompetence.

**Looking back, this generation may conclude their fate was dictated by government incompetence**

For many of this generation, living in cities has been the norm – actually a goal. They like the benefits of city living, while putting up with its negatives, or finding novel ways of dealing with them. Covid-19 has raised the question of whether increased density in cities has contributed to the rapid spread of the virus. People packing into mass transit, crowding on sidewalks and living cheek-by-jowl reflect life in many big cities. As future studies address the density question, the push for greater innovation from our health industries may be an outcome. But we could also see younger workers abandoning cities and moving to the suburbs, shunning crowded mass transit, and increasing their social isolation. That will certainly change the current thinking about energy trends. A recent study, "How Many Jobs Can Be Done At Home?", reported on by *The Wall Street Journal*, says that only about 37% of U.S. jobs can plausibly be done at home. Maybe the younger generation will figure out how to boost that percentage, as it fits their desired future lifestyle.

**We could also see younger workers abandoning cities and moving to the suburbs, shunning crowded mass transit, and increasing their social isolation**

On the same day, *The New York Times* carried two articles touching on this issue. One article, by a technology writer, dealt with working at home. His headline was "A good internet link, communication apps and entertainment are all we really need. Ever." He might need some food, clothing and electricity, but he probably wasn't thinking about his entire life, as his article focused on what technology devices people should buy. However, universally, people working at home are clamoring for better and faster internet connections to end the horror of frozen faces with mouths wide open or eyes closed on their Zoom screens.

**"A good internet link, communication apps and entertainment are all we really need. Ever."**

On the other hand, another *NYT* article talked about the closing of a manufacturing business in a rural community in New Hampshire. The plant was critical to employment and to the city's tax revenues. They titled the story, "This Is Going to Kill Small-Town America." When the plant shut down, people lost jobs, all support businesses were hurt, and the city's tax revenues, especially its sewer and sanitation department were devastated, as the plant was the largest source of its revenues. Will younger people when considering where to live evaluate the relative economic risk of how their local government is financed and what might happen if another pandemic arrives? Will it be safer to live in rural or urban areas? How important will medical services be versus the availability of grocery stores and a solid communications capability?

**Will it be safer to live in rural or urban areas?**

**Climate change has brought into perspective the issue of the good and bad that comes from fossil fuels**

All of these questions will alter energy demand. Exactly how much is unknown, but we should prepare for a different energy future than we have been envisioning in recent years. Climate change has brought into perspective the issue of the good and bad that comes from fossil fuels. While much has been made of pictures of pollution levels in regions and cities before versus during the virus shutdowns, that may be less of an issue in a recovery. In light of the pandemic, climate change may fade as the risk of death near-term from a virus overwhelms concerns over dying decades in the future.

**Will we continue to electrify our economies as a way to decarbonize them?**

More people and rising living standards across the planet underly the belief that energy needs will continue to grow. Increased global trade and tourism have also been considered a given in energy forecasts. Electricity demand grows with larger populations and increased consumer electronics, even as more energy efficient appliances fill our homes. Will we continue to electrify our economies as a way to decarbonize them? Covid-19 is altering many of these assumptions, as we have seen a fall in electricity demand virtually everywhere in the mature economies around the world with the economic shutdowns. The peak in daily electricity demand also has shifted as stay-at-home mandates have altered people's daily schedules. That is forcing utilities to adjust how they operate and even their fuel supply mix. Shutting businesses has contributed to the reduction in power use, but that is likely to change when economies re-open. The amount of power demand that returns will be reduced by the bankruptcies of businesses, of which we can expect many. If power demand growth rates are permanently lowered, this will mean fewer new power plants will be necessary. Will it reduce renewable electricity?

**We caution that another bout of triple-digit oil prices will only accelerate the shift to renewables**

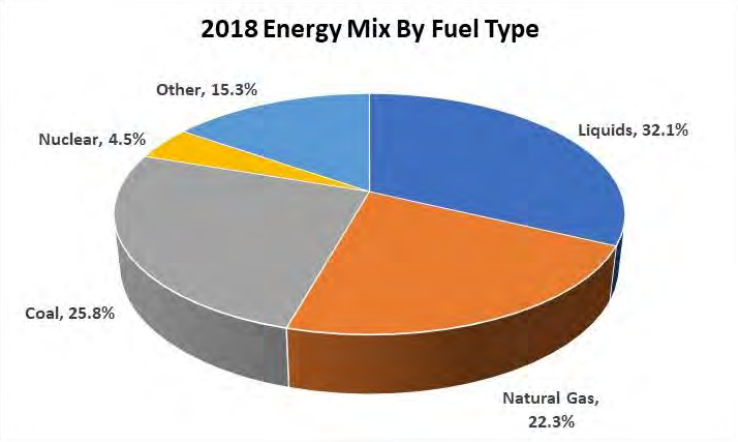
As we mentioned earlier, there are various scenarios from energy analysts who base their future trajectories for future crude oil prices on the assumption that the current significant oil and gas company capital spending reductions will reduce the volume of hydrocarbon supplies that will be available to come to market when demand increases. Some of these forecasts point to $100+ per barrel oil prices as the threshold price necessary to generate the funds to support increased drilling and completion activity needed in order to bring additional oil supplies to market. They see an oil supply shortage developing sometime in 2022. Higher oil prices, as the global oil market tightens, should be expected. However, we caution that another bout of triple-digit oil prices will only accelerate the shift to renewables, as people, still struggling with tight budgets inflicted on them by this pandemic, will revolt against sharply higher fuel prices. Renewables offering stable prices – even if higher than the current ultra-cheap oil and gas prices – will gain favor, regardless of their role in the popular climate change push. Clean air will only be a side benefit for many of these people. They want stability in their lives! Long-term energy price stability, even though below historical oil and gas returns, will attract the investment capital that is currently shunning the petroleum sector.

**We are already seeing European politicians arguing for backing off on their green energy initiatives due to their cost**

Growth in renewable energy investments will slow this year. This is due to uncertainty about overall growth in electricity demand, especially due to lower projected increases in electric vehicle fleet growth, the lack of expansion of the charging infrastructure, impacts on supply chains for equipment for new renewable projects and weakened financial positions of project sponsors. This should be viewed more as a pause than a change in trend. Whether the renewable power sector experiences a ramp up in future growth will depend on the rebound in oil prices, as mentioned above. Additionally, the clean air impact of the global economic shutdown has become a weapon for climate change proponents who are arguing that if we can significantly manage global economic activity to fight a virus, why can we not do more to constrain carbon emissions. The negative to that positive impact is the cost of the effort, given the financial strain of citizens. We are already seeing European politicians arguing for backing off on their green energy initiatives due to their cost. This struggle is one we will be monitoring closely going forward.

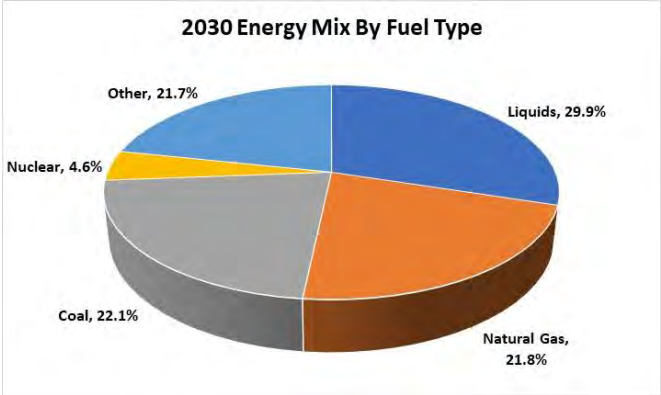
Considering how energy markets may change in the long-term, we turn to the Energy Information Administration's International Energy Outlook 2019. Exhibits 7 and 8 (next page) show the mix of energy sources for 2018 and 2030, as projected in January of this year. While the forecast extends to 2050, we are ignoring the post-2030 period, as it is well beyond the strategic planning focus of energy company executives.

**Exhibit 7. How Global Energy Supply Is Divided**




**Source: EIA, PPHB**

**Exhibit 8. The Future Global Energy Supply Mix**

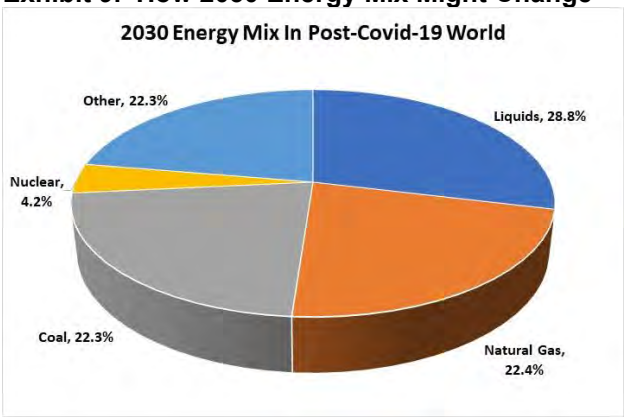



**Source: EIA, PPHB**

**The change in our energy mix is not radically different from the EIA forecast, but the emerging trends likely will materially alter the 2050 fuel mix**

Based on our views of how the competitive fuel markets may unfold – slower oil growth, more natural gas, slightly lower coal growth, stable nuclear power, and slightly faster renewables growth – we have made some modifications to the forecast. The world's future energy mix, after these adjustments, is shown in Exhibit 9. The change in our energy mix is not radically different from the EIA forecast, but the emerging trends likely will materially alter the 2050 fuel mix. If our adjustments come to pass, energy company executives need to be thinking about how they might need to reposition their companies during the next few years to capture the opportunities and protect against market share losses that will emerge. As the share from oil declines but natural gas increases, the investment necessary to achieve the shifts will depend mostly on the oil and gas industry's internally-generated cash flow. Renewable energy is likely to start growing faster as we pass 2025, as technological improvements reduce their costs and infrastructure investments improve access and storage. The most important change is that the stable returns of renewable fuels will attract investment capital, allowing this energy sector to grow faster.

**Exhibit 9. How 2030 Energy Mix Might Change**




**Source: PPHB**

**Significantly reduced cash flows for every company is the single greatest challenge facing the industry**

The energy world has been upended by the two 2020 oil black swans – a demand collapse and a supply surge. Surviving 2020 has become the primary focus of energy company managements. Those loaded with debt face a daunting outlook, with the ability to survive questionable for many. Significantly reduced cash flows for every company is the single greatest challenge facing the industry. This environment provides an opportunity for the strongest companies to become even stronger via the elimination of competitors and the possibility of acquiring high-quality assets and business lines. As the macro environment for oil corrects over the next 18 months, the focus will shift to the long-term future. The absence of capital for energy investment, as demonstrated by the sector's shrinking representation within the Standard & Poor's 500 Index, will become an overriding challenge. The shrinkage reflects the lousy returns generated by the companies. Until that record is corrected, the oil and gas industry will remain starved for capital. Starvation will force major changes on the industry.

## Could A Hurricane Create More Havoc For Energy In 2020?

**These forecasts are reminders of how this crazy year of 2020 may continue**

Virtually all attention is directed towards Covid-19 and the question of when this country's economy will re-open. Being overlooked is the upcoming hurricane season that starts June 1st and the havoc it could create. At the beginning of April, initial storm season forecasts are released. The Department of Atmospheric Science at Colorado State University (CSU) has released its first forecast for the upcoming season, as has AccuWeather. These forecasts are reminders of how this crazy year of 2020 may continue. Both forecasts call for the Atlantic basin hurricane season to be above normal. Moreover, CSU anticipates an above-average probability for major hurricanes making landfall along the U.S. East and Gulf Coasts and in the Caribbean.

**All of these conditions suggest a more active tropical storm season**

The climate forces driving the upcoming season include: the current warm neutral ENSO conditions likely transitioning to cool neutral ENSO or even potentially weak La Niña conditions by this summer/fall; sea-surface temperatures averaged across the tropical Atlantic basin are somewhat above normal; the Atlantic Multi-decadal Oscillation index being below its long-term average; and a warmer than normal tropical Atlantic Ocean. All of these conditions suggest a more active tropical storm season.

In light of these conditions, it is not surprising that the two forecasts are similar. CSU's predicted numbers for named storms and hurricanes are in the middle of AccuWeather's ranges. CSU is at the high end of AccuWeather's forecast for major hurricanes, however.

**Exhibit 10. 2020 Storm Forecasts**

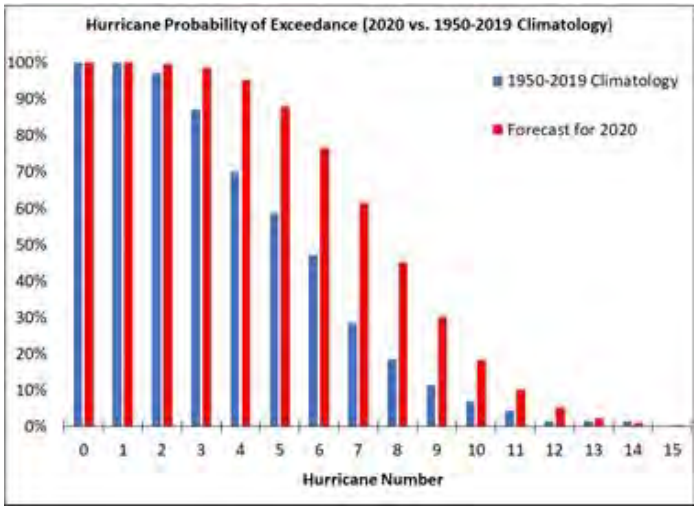
| | CSU | AccuWeather |
|---|---|---|
| Named Storms | 16 | 14-18 |
| Hurricanes | 8 | 7-9 |
| Major Hurricanes | 4 | 2-4 |

**Source: CSU, AccuWeather, PPHB**

**Its April forecasts, based on hindcasting, are the least reliable of all the forecasts it produces during the storm season**

This year, CSU introduced a discussion about the probability of its forecast being exceeded. This reflects the reality that its April forecasts, based on hindcasting, are the least reliable of all the forecasts it produces during the storm season. The June forecast is generally the most accurate, largely because the weather and climate patterns that drive storm formation and intensification are better defined.

**Exhibit 11. How 2020 Forecast Could Be Greater**




**Source: CSU**

**97% of Atlantic hurricane seasons during 1950-2019 experienced more than two hurricanes**

The way to interpret Exhibit 11 is to understand that the values along the x-axis indicate that the number of hurricanes exceeds that specific number. Thus, 97% of Atlantic hurricane seasons during 1950-2019 experienced more than two hurricanes. Visually, the blue columns (historical number) show a steady and fairly sharp decline as the number of storms increases. That is not the case for the red (forecast) columns, which don't show an accelerating decline until six storms.

An easier way to understand this risk is to examine Exhibit 12 (next page). It shows all the forecasted variables and their range of uncertainty. The forecasted variables are all at the upper end of their uncertainty range. The CSU forecasters noted that the range of the uncertainty is not symmetric around the mean value due to the historical distribution of tropical cyclone activity.

**Exhibit 12. The Range Of CSU Forecasts**

| Parameter | 2020 Forecast | Uncertainty Range (68% of Forecasts Likely to Fall in This Range) | 1981-2010 Average |
|---|---|---|---|
| Named Storms (NS) | 16 | 13 - 19 | 12.1 |
| Named Storm Days (NSD) | 80 | 60 - 100 | 59.4 |
| Hurricanes (H) | 8 | 6 - 10 | 6.40 |
| Hurricane Days (HD) | 35 | 23 - 48 | 24.2 |
| Major Hurricanes (MH) | 4 | 3 - 6 | 3 |
| Major Hurricane Days (MHD) | 9 | 6 - 13 | 6.20 |
| Accumulated Cyclone Energy (ACE) | 150 | 104 - 201 | 107 |
| Net Tropical Cyclone (NTC) Activity | 160 | 115 - 208 | 114 |

**Source: CSU, PPHB**

**The primary purpose of forecasting storms and their tracks is to alert people at risk**

While the effort to develop models predicting the probability of tropical storms making landfall, and even passing within 50 and 100 miles of the coast, was begun a number of years ago, the degree of forecasting accuracy remains a work in progress. The primary purpose of forecasting storms and their tracks is to alert people at risk. By identifying where a hurricane may make landfall, residents can better prepare or evacuate, saving lives. Creating accurate landfall forecasts has proven difficult.

The landfall predictions for 2020 show a higher than average probability across every region and category of storm. This is not unreasonable given a more active storm season. As Exhibit 13 shows, other than for all storms and all regions, the probabilities are noticeably above the historical averages.

**Exhibit 13. Where 2020 Storms Might Land**

| Region | Tropical Storms | Category 1-2 HUR | Category 3-4-5 HUR | All HUR | Named Storms |
|---|---|---|---|---|---|
| Entire U.S. | 92% (79%) | 84% (68%) | 69% (52%) | 95% (84%) | 99% (97%) |
| Gulf Coast | 76% (59%) | 59% (42%) | 44% (30%) | 77% (60%) | 94% (83%) |
| Florida plus East Coast | 67% (50%) | 60% (44%) | 45% (31%) | 78% (61%) | 93% (81%) |
| Caribbean | 94% (82%) | 74% (57%) | 58% (42%) | 89% (75%) | 99% (96%) |

**Source: CSU, PPHB**

**In several of these very active analog years, much of the storm activity was confined to the Atlantic Ocean or the Caribbean**

We always find it interesting to examine the analog storm seasons used by forecasters. CSU's are shown in Exhibit 14 (next page). In 1960, two major hurricanes (Ethel and Donna) landed in Louisiana and Florida, with Donna tracking the entire East Coast. In 1966, the only major hurricane (Alma) impacted Florida and South Carolina. A major hurricane (Allen) hit South Texas in August 1980. The two major hurricanes (Bertha and Fran) that year both landed in North Carolina. The 2008 storm season was very active, with four hurricanes landing on U.S. coasts, three of them in September. Major hurricanes Gustav and Ike hit Texas and Louisiana, while Dolly targeted South Texas and Hanna hit North Carolina. In several of these very active analog years, much of the storm activity was confined to the Atlantic Ocean or the Caribbean. Let us hope that is the case for 2020.

**Exhibit 14. Analog Hurricane Seasons For CSU**

| Year | NS | NSD | H | HD | MH | MHD | ACE | NTC |
|---|---|---|---|---|---|---|---|---|
| 1960 | 8 | 33.50 | 4 | 15.00 | 2 | 8.50 | 73 | 90 |
| 1966 | 11 | 64.00 | 7 | 41.75 | 3 | 8.75 | 145 | 140 |
| 1980 | 11 | 62.25 | 9 | 38.25 | 2 | 7.25 | 149 | 130 |
| 1996 | 13 | 79.00 | 9 | 45.00 | 6 | 13.00 | 166 | 192 |
| 2008 | 16 | 88.25 | 8 | 30.50 | 5 | 7.50 | 146 | 162 |
| Average | 12 | 65.40 | 7 | 34.10 | 4 | 9.00 | 136 | 143 |
| **2020 Forecast** | **16** | **80** | **8** | **35** | **4** | **9** | **150** | **160** |

**Source: CSU, PPHB**

**If you want to envision horror scenarios for energy, imagine a repeat of the hurricane season of 2005!**

It was interesting that AccuWeather only focused on two analog years – 1980 and 2005. We certainly hope 2020 is not a repeat of 2005 with its 28 storms, including major hurricanes Katrina, that devastated New Orleans, followed by Rita, hitting Texas, and Wilma, impacting South Florida. That was a year that also did extensive damage to the offshore and Gulf Coast oil, gas and petrochemical industries. Such a repeat would harm whatever industry recovery will be underway this summer and fall. If you want to envision horror scenarios for energy, imagine a repeat of the hurricane season of 2005!

## Lurking Demographic Issues Could Impact Energy's Future

**More people and workers are key to our growth, but there may be a lurking problem, carrying negative implications for our long-term energy growth rate**

Global energy consumption growth is intractably linked with expansion of the gross domestic product (GDP) of the world's economies. GDP growth is a function of population growth and rising living standards, which needs increased output from an expanding workforce. We have yet to get to an economy where machines replace workers, other than in limited situations. What is needed to grow GDP is more workers capitalizing on the nation's capital stock. How fast economies grow is tied closely to progress in employment growth, as well as employee productivity, and increasing our capital stock. More people and workers are key to our growth, but there may be a lurking problem, carrying negative implications for our long-term energy growth rate.

**We might actually only add 1.7 billion more people, reaching only 9.5 billion**

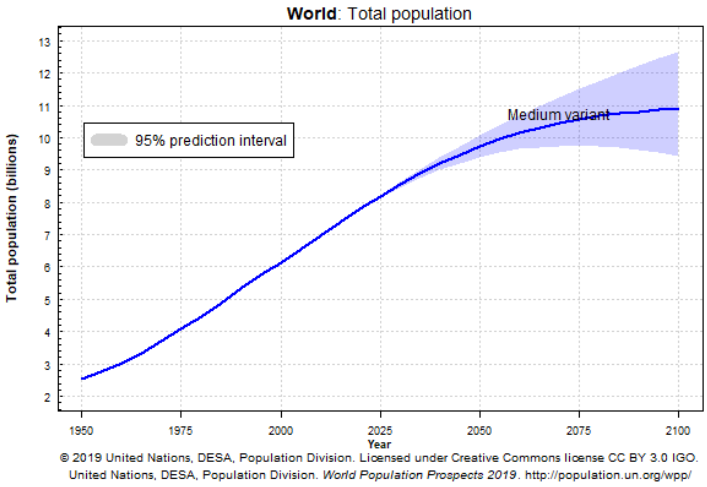
According to the Department of Economic and Social Affairs of the United Nations, there are 7.8 billion people living on this planet. Based on its latest projection, the world's population will increase through the balance of this century, reaching nearly 11 billion humans, an increase of over three billion people. As long-range forecasts traditionally do, the central projection is presented within a range covering 95% of the projections. By that measure, we might actually only add 1.7 billion more people, reaching only 9.5 billion. On the other end, if population growth trends fail to slow about 2050, the planet might have to find a home for an additional 4.5 billion people by 2100, bringing total population to 12.5 billion.

Environmentalists have been concerned for years about the world's population growing too fast. That will lead to an unsustainable

**They describe a world characterized by extreme human suffering**

situation with possible food and water shortages, significant pollution, and a degradation in living standards. They describe a world characterized by extreme human suffering. The question is whether these fears are similar to those expressed by British minister Thomas Malthus in the 1700s, and the forecasts of the Club of Rome in the 1970s? Both forecasts of deprivation proved wrong.

**Exhibit 15. How The Planet's Population May Grow**




**Source: U.N.**

**The older population's energy consumption declines as the group travels less, consumes less and often cohabitates with other family members, reducing housing-related energy use**

For the energy industry, the total population estimate is interesting, but of greater importance is its composition and geographic distribution. Energy consumption varies by age, as young people are limited to what they can do and where, while those in their 20s to 70s represent the labor force and have greater energy needs as work and travel consumes their daily lives. The older population's energy consumption declines as the group travels less, consumes less and often cohabitates with other family members, reducing housing-related energy use.

**The most economically developed economies (OECD) have been the driver of global energy consumption for decades**

The geographic distribution is largely a function of regional economic development. The most economically developed economies (OECD) have been the driver of global energy consumption for decades, but as these economies have matured and their populations age, energy consumption growth has slowed, especially relative to the rapidly developing economies of Asia, the Middle East, Africa and Latin America. The countries in these regions form the non-OECD group, and its energy use is rising quickly.

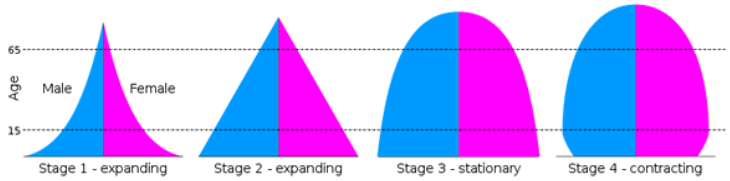
The *Worldometer* website discusses the population pyramid, while also presenting diagrams of the various stages every country's population goes through. The population pyramid is often called the age-sex pyramid, which is a graphical representation of the age and sex distribution of a population. There are three types of pyramid shapes defined as:

**Types:**

- **Expansive** - pyramid with a **wide base** (larger percentage of people in younger age groups, indicating high birth rates and high fertility rates) and narrow top (high death rate and lower life expectancies). It suggests a growing population. Example: Nigeria Population Pyramid.
- **Constrictive** - pyramid with a **narrow base** (lower percentage of younger people, indicating declining birth rates with each succeeding age group getting smaller than the previous one). Example: United States.
- **Stationary** - with a somewhat **equal proportion** of the population in each age group. The population is stable, neither increasing nor decreasing.

The stages of population growth are shown graphically below.

**Exhibit 16. How Country Populations Change**



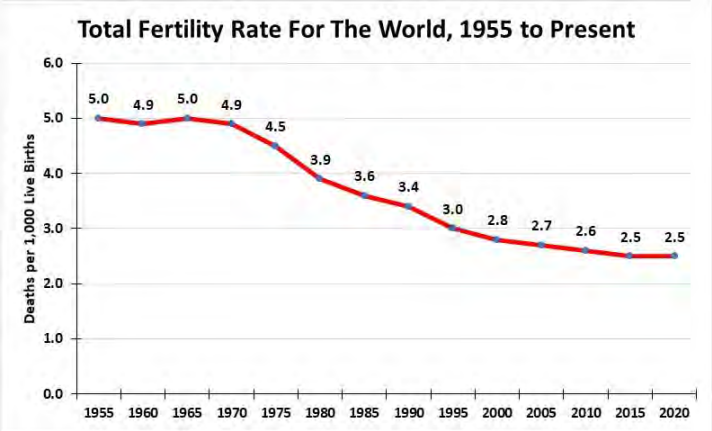

**Source:** ***Worldometer***

**The contracting stage is driven by declining birth rates that fall below 2.1, associated with a stable population**

The contracting stage is driven by declining birth rates that fall below 2.1, associated with a stable population. The current fertility rate globally is 2.5, which indicates the average number of children born to women during their lifetimes. The rate has been declining, which is consistent with the trend of steady improvement in medical, social and economic conditions. In the past, large families were needed due to high infant and young children mortality. Families needed more children to offset those early deaths, as they were the source of labor and income to support the family's existence, especially for those operating farms. Large families also provided support for parents as they aged and needed care in their final years.

In 1955-1970, the fertility rate fluctuated between 4.9 and 5.0. For 2015-2020, it has averaged 2.5. The question is whether the rate will remain stable at the 2.5 rate, or fall toward 2.1, or possibly lower.

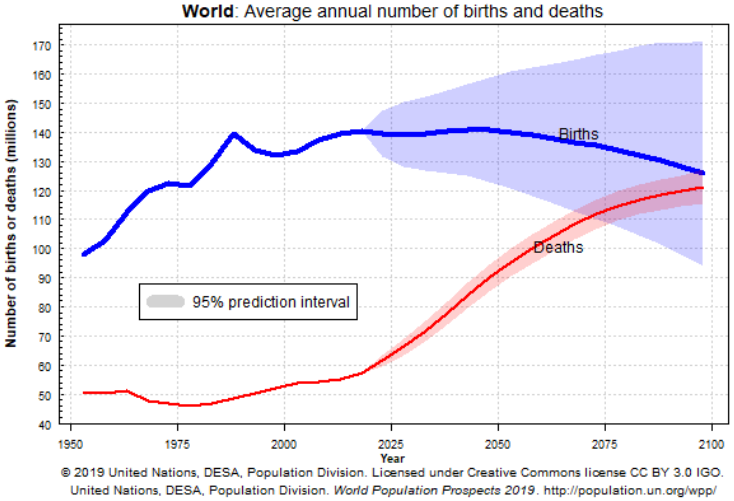
**Exhibit 17. The History of World Fertility**




**Source:** ***Worldometer***

The UN has modeled various fertility and death rates in projecting how the world's population may grow. Those projections are interesting in that the 95% projection interval surrounding births is huge when compared to deaths.

**Exhibit 18. Birth Projections More Uncertain Than Deaths**




**Source: U.N.**

**Hidden within the birth projections is a lurking disaster scenario that has only recently been highlighted by investment manager Jeremey Grantham**

Hidden within the birth projections is a lurking disaster scenario that has only recently been highlighted by investment manager Jeremey Grantham of Grantham, Mayo, & van Otterloo (GMO), the Boston investment management firm he co-founded in 1977. He started his career as an economist with Royal Dutch Shell in London. During his career, he championed index investing, but he is known more for having identified investment bubbles and avoiding them. GMO avoided Japanese stocks and real estate in the late 1980s, and technology stocks during the dot.com bubble. At one point he was an energy investment bull, before becoming an environmentalist.

He has introduced environmental, social and governance (ESG) investing at GMO. In addition, he and his wife created a U.K. foundation to conduct research into climate change and ways to limit carbon's damage to the planet.

**Deviation from historical averages provides possible opportunities to invest based on the expectation of a return to the mean**

*Wikipedia* describes GMO's investment philosophy as "reversion to the mean." That means it believes all asset classes and markets will revert to mean historical levels from highs and lows. Therefore, it seeks to understand historical changes in markets and predict results for seven years into the future. Deviation from historical averages provides possible opportunities to invest based on the expectation of a return to the mean.

Mr. Grantham is known for his colorful and insightful writing about investment markets. He also believes CEOs need to become more focused on the long-term and to think "outside of the box," when considering where they are directing their companies. In GMO's Fall 2008 client report, Mr. Grantham wrote of the shortcomings of managements during the financial crisis.

> "I ask myself, 'Why is it that several dozen people saw this crisis coming for years?' I described it as being like watching a train wreck in very slow motion. It seemed so inevitable and so merciless, and yet the bosses of Merrill Lynch and Citi and even U.S. Treasury Secretary Hank Paulson and Fed chairman Ben Bernanke – none of them seemed to see it coming.
>
> "I have a theory that people who find themselves running major-league companies are real organization-management types who focus on what they are doing this quarter or this annual budget. They are somewhat impatient, and focused on the present. Seeing these things requires more people with a historical perspective who are more thoughtful and more right-brained – but we end up with an army of left-brained immediate doers.
>
> "So it's more or less guaranteed that every time we get an outlying, obscure event that has never happened before in history, they are always going to miss it. And the three or four-dozen-odd characters screaming about it are always going to be ignored. . .
>
> "So we kept putting organization people – people who can influence and persuade and cajole – into top jobs that once-in-a-blue-moon take great creativity and historical insight. But they don't have those skills."

**"Seeing these things requires more people with a historical perspective who are more thoughtful and more right-brained – but we end up with an army of left-brained immediate doers"**

Mr. Grantham's latest cause is an outgrowth of his climate change focus. He is working to alert the public to the role the chemical industry has played, and continues playing, in destroying the world's

**The cause of this decline is attributable to the toxicity of chemicals**

fertility rate. In February, he authored a paper: "CHEMICAL TOXICITY AND THE BABY BUST - Unexpected threats to human fertility and, hence, chemical companies." The paper is based on research and an upcoming book highlighting the decline in sperm and its concentrations and the impact on the future of births. The cause of this decline is attributable to the toxicity of chemicals. They are also cited as a contributor to increased death rates, also.

The research data shows fertility rates in western economies and China below the 2.1 replacement rate. In Mr. Grantham's view, if these issues are not corrected within the next 10 years, he foresees a scenario where the world's population could eventually become extinct – like the dodo bird.

**The lower birth rate has been driven partly by choice**

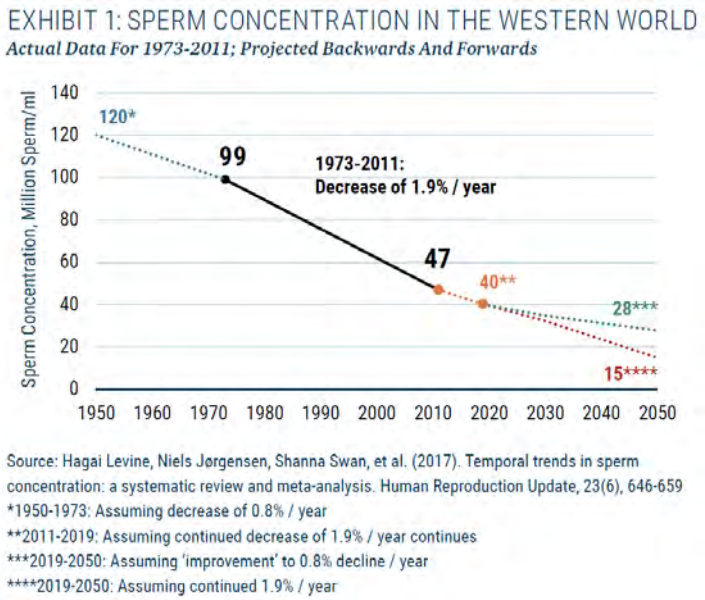
He pointed out the lower birth rate has been driven partly by choice – higher income and education, especially among women. The working environment has yet to fully embrace working women interrupting their careers to have children.

**A book published last year on the issue of the falling birth rate never mention toxicity**

A result of women deferring childbirth until they are established in their careers has pushed pregnancies into times when women are less fertile, thus reducing their success in getting pregnant and the overall birth rate. But, as he points out, a book published last year on the issue of the falling birth rate never mention toxicity and what it was doing to humans as an impediment to pregnancy.

The study Mr. Grantham referred to was based on an examination of all the sperm studies from 1973 to 2011. The study was conducted by a team of eight specialists, including a reproductive epidemiologist, an epidemiologist and an endocrinologist, from around the world. Mr. Grantham plotted the data and projected it backwards at a rate that put sperm concentration levels consistent with several earlier studies. He also extended the historical decline rate until 2020, followed by two projections – one based on the historical decline rate, and the other on the pre-1973 rate.

**Exhibit 19. A Bleak Future For Population Growth?**




**Source: GMO**

If these decline rates continue, Mr. Grantham believes future population growth is at risk. He wrote about future population growth:

> "Discussion with Swan [*the lead author of the study*] and others suggests that we homo sapiens are so overengineered that the reduction in sperm concentration from pre-chemical original levels of 120 or more to about 50 in 2010 left our effective fertility rate substantially unaffected. We had been given a biological pass as it were: with the normal distribution based around 50, only a small percentage of the public, around 5%, needed medical help in getting pregnant due to lack of sperm count. But in just the last 10 years, as we have dropped from 50 to 40, we now see up to 20% of young couples having trouble with becoming pregnant to the point where medical help or advice is needed. By 30 units, which at current rates of decline of 1.9% would be reached in a mere 15 years, it seems that the median couple will need help. And by 20 units, which at 1.9%, without allowance for any possible acceleration, would be reached in only 37 years, only 15% or 20% of couples will not need help. This decline is nearly certain to continue until action is taken to ban all or at least most of the chemicals that reduce our fertility."

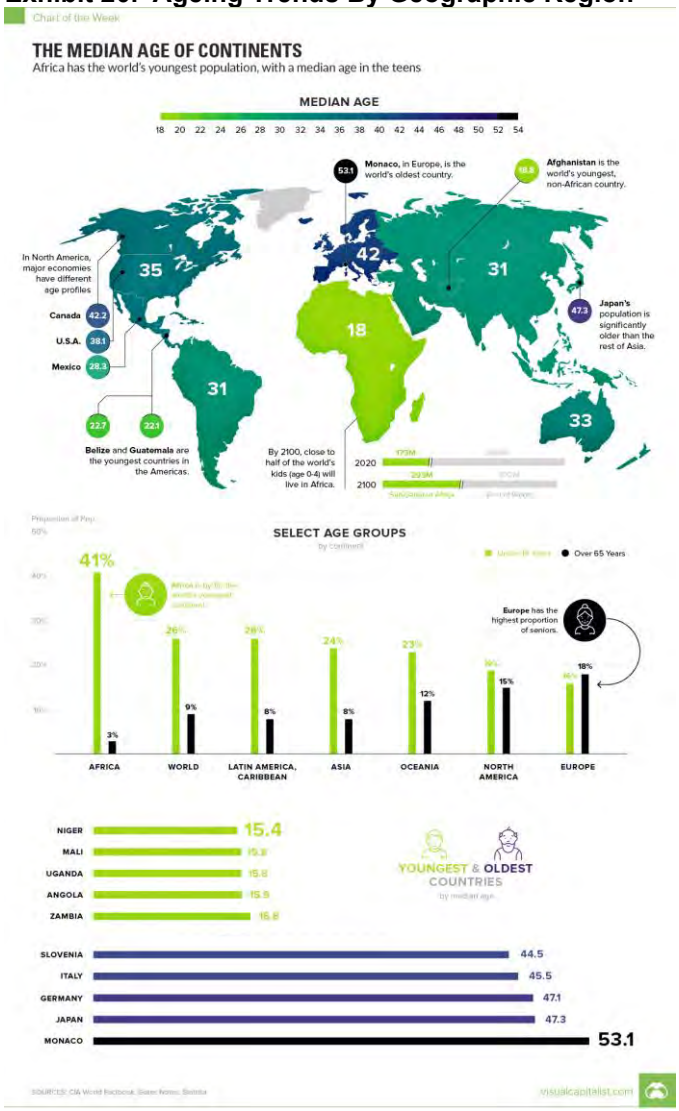
**"And by 20 units, which at 1.9%, without allowance for any possible acceleration, would be reached in only 37 years, only 15% or 20% of couples will not need help"**

As Mr. Grantham is now raising the issue of toxicity and a falling birth rate, which he envisions putting the future existence of humans at risk, his attack on chemicals is also an attack on the future of the energy industry. The declining birth rate's impact on the world's

**Europe and North America are the oldest continents**

ageing manifests itself differently by geographic region. When we examine which regions have the oldest and youngest populations, future economic activity and energy consumption issues appear in a different light. What we see from the charts in Exhibit 20 are that Europe and North America are the oldest continents. That is demonstrated in the bottom chart showing Germany and Italy as the third and fourth oldest countries. Importantly, Japan is the second oldest, behind Monaco, but it has the world's largest aged population.

**Exhibit 20. Ageing Trends By Geographic Region**

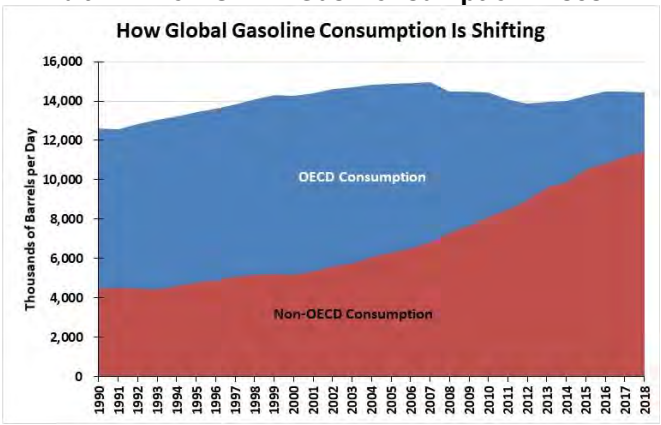



**Source: Visual Capitalist**

When we include Japan with the U.S. and Europe, we have most of the world's developed economies (OECD). We know the OECD's

consumption of gasoline has been in decline for many years, a shift that began about 2000. This shift has profound implications for energy markets, and may be related to ageing populations.

**Exhibit 21. Non-OECD Gas Consumption Rises**

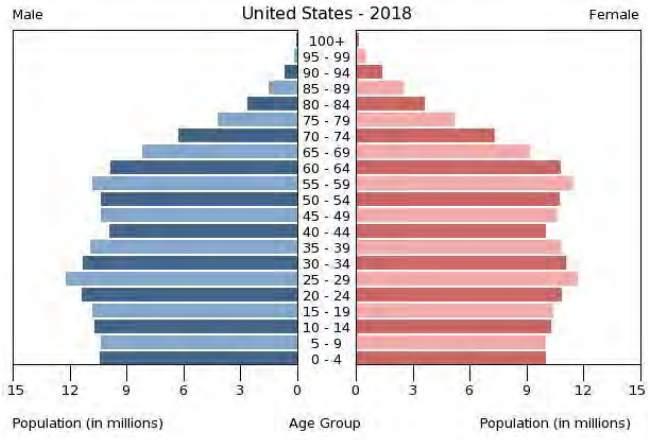



**Source: BP, PPHB**

**The U.S. consumes between 8-9 million barrels per day of gasoline, which represents about 9% of global oil output**

The significance of gasoline use and U.S. population growth is key to thinking about the current oil downturn. The U.S. consumes between 8-9 million barrels per day of gasoline, which represents about 9% of global oil output. It represents a key global market, and how it changes will have an impact on the oil industry.

**Exhibit 22. How U.S. Population Will Age**




**Source: U.S. Census Dept.**

**The U.S. Census bureau projects that in 2034, there will be more Americans 65+ in age than those 18 and under**

At the moment, the median age of the U.S. population is 38, but the population pyramid shows us ageing in the future. The U.S. Census bureau projects that in 2034, there will be more Americans 65+ in age than those 18 and under. That is a notable transition point, which has generated some interesting debates about how the social and political order in this country might change.

George Friedman, founder and chairman of Geopolitical Futures and earlier global intelligence firm Stratfor, in his new book The Storm Before The Calm, talks about the ageing of the American population and a possible change in our governing structure. He wrote:

> "Our current institutional system has a minimum age for voting but not a maximum age. As life expectancy increases and the birth rate stabilizes at a low level, the population will be skewed to the elderly, whose interests will be very different from those of the younger voters. The elderly will become a larger voting bloc, based on longer life span, than they are currently. In addition, the dynamism necessary to the cyclical nature of the United States may seep out of the system. The elderly will be productive, but there is a part of creativity that is found in the young. It is possible, one could guess, that at a certain point the question will become putting a cap on the upper age for voting, or the vote over a certain age counts less than others. The extension of old age will have many consequences, and this may be the one on which the twenty-first century pivots."

**"The extension of old age will have many consequences, and this may be the one on which the twenty-first century pivots"**

While Mr. Friedman sees the elderly remaining productive, he sees their contribution lagging that of the young. Since the elderly have higher voting participation rates than the younger segments, their disproportionate representation will exaggerate their political power. If it results in preventing the shift in governing policies in favor of those desired by the youth, it could result in a radical change in voting rights.

Dealing with an ageing population sparked a different and highly controversial solution proposed by Dr. Ezekiel Emanuel, the brother of Rahm Emanuel, the former chief of staff to President Bill Clinton and Mayor of Chicago, and an author of Obamacare. Dr. Emanuel is an oncologist and bioethicist, a senior fellow at the Center for American Progress, and the current Vice Provost for Global Initiatives at the University of Pennsylvania and chair of the Department of Medical Ethics and Health Policy. He advises Democrat presidential candidate Joseph Biden, who is 77 years old.

Dr. Emanuel is known for saying that he doesn't want to live past the age of 75, which he explained why in an article for *The Atlantic*:

> "[H]ere is a simple truth that many of us seem to resist: living too long... renders many of us, if not disabled, then faltering and declining, a state that may not be worse than death but is nonetheless deprived. It robs us of our creativity and ability to contribute to work, society, the world. It transforms how people experience us, relate to us, and, most important, remember us. We are no longer remembered as vibrant and engaged but as feeble, ineffectual, even pathetic."

**"Here is a simple truth that many of us seem to resist: living too long... renders many of us, if not disabled, then faltering and declining, a state that may not be worse than death but is nonetheless deprived"**

He later explained why he selected 75 as his desired termination age.

> "[T]he fact is that by 75, creativity, originality, and productivity are pretty much gone for the vast, vast majority of us... It is true, people can continue to be productive past 75—to write and publish, to draw, carve, and sculpt, to compose. But there is no getting around the data.
>
> "Even if we aren't demented, our mental functioning deteriorates as we grow older. Age-associated declines in mental-processing speed, working and long-term memory, and problem-solving are well established. Conversely, distractibility increases. We cannot focus and stay with a project as well as we could when we were young. As we move slower with age, we also think slower."

**"Like climate change, the aging of America demands a serious rethinking of the way we live."**

A December opinion article in *The New York Times* by Susan Jacoby, the author of Never Say Die: The Myth and Marketing of the New Old Age, titled "We're Getting Old, but We're Not Doing Anything About It," carried the tag line: "Like climate change, the aging of America demands a serious rethinking of the way we live." She was writing about the need to promote "doctor assisted suicide," as a solution for those entering the later stages of life, which in marked by extensive health issues. We doubt old age will become the same political movement climate change is. However, it is an issue energy companies need to consider when making long-term business decisions.

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