3rd Quarter Commentary

October 2020

Two Assessments of Energy: 'The Market' and Contrarian (fact-based) Investing

Introduction

Today we're talking about energy. Not exclusively, but mostly. Specifically because many of you have been asking about how the fossil fuel divestment movement and green energy initiatives will impact the energy sector – more frequent questions, and more alarmed. If we don't address this, there might not be the mind space to hear anything else. The fear is that there will be such a drastic collapse of oil and gas use, or that, as some have suggested, fossil fuel use will be non-existent by the year 2035, that it will create a permanent failure among energy stocks; stranded assets, and all of that.

We see the investment reality entirely differently; entirely. The imminent danger is not the collapse of fossil fuel use; the imminent danger is an oil supply shortage and oil price shock. However peculiar this might at first sound, energy, right now, is one of the few 'once-in-a-lifetime' investment opportunities that one can be fortunate enough to actually come across in a lifetime.

To be clear, this is not about one's stance on the validity or rightness of reducing carbon emissions, or about the place of renewable energy in addressing that challenge. I, for one, fully support such measures and will readily exchange lifestyle conveniences for the bettering of our environment. This is about making informed decisions. Even casting aside investment considerations, if your sole goal were to reduce global carbon emissions, you would still want to make informed decisions. Were I, instead, addressing an audience of environmental activists, they would hear the same fact. The narrative would arc in a different direction, because they might be interested to learn that they could more effectively advance, say, the growth of wind power if they were to advocate for more funding to modernize the aging and increasingly strained U.S. electric grid. But the facts wouldn't change.

As an advance apologia, this might be a lot more detailed presentation than many of you want to hear (though some people do want it). You want me to just get to the meat of it. The problem is – as I hope you will see – I can't give it to you with a set of short answers, it just won't do the trick. One has to have enough detail to get to the 'a-hah' moments that are properly informing, that let you take away some real understanding, your own understanding. However, you asked for it, and it might be a bit of a haul. And, it would be even longer, but I ran out of time to cover some important topics.

Contrarian (Fact-Based) Investing

The converging elements that have created this investment circumstance hasn't happened before; one of so many recent firsts. One of those elements is the fossil fuel divestment movement's severe impact upon energy company production expenditures, reserves, and supply capacity. Another element is investors' misunderstanding about the degree to which renewable energy technologies can replace fossil fuels and whether this will even happen within a practical investment planning time horizon.

This has resulted in a massive dislocation between the pricing of energy companies and demonstrable asset and business values. That's a very good thing, for an investor, not bad. The game can change very quickly. We think we're properly positioned for the coming period. There will be a few examples later – old names, new information.

During the 1999 Internet Bubble period, our opportunity was a relatively passive one – simply avoiding the inflated part of the market, although there was the chance to purchase the highest quality blue-chips of the time without paying a valuation premium, since investors were selling them to raise money to buy technology stocks. Today is far better. We're not limited to the bubble-sector avoidance tactic. There are now strategic pathways to benefit directly from the aforementioned dislocations and also from the emergence of a number of possible shocks to the economy and financial markets.

The fear about energy is understandable; I get it. When people don't have access to a sufficiency of facts or information, they default to what little is available to them. It's called availability error. In the financial markets, in the absence of better information, the default is price. It's always available. And if price is all you have to go on, energy stock prices look scary. If it's price, there are only two judgments: something's up or it's down, and that defines good or bad.

Another classic judgment error is confirmation bias: when a certain sector keeps going up, it rewards the buy decision, and when one keeps going down, it confirms the negative presumption., Or the social anchoring effect, which is about what other people say and do.

Another judgment error stems from false choices, like: "there will be less demand for oil and gas." This qualitative statement, correct or not, stands in isolation, with no quantitative reference points. It says nothing specific about time frame or about the mechanisms by which renewable power sources work or don't work. It says nothing about the supply position of critical commodities necessary to actually manufacture these alternatives, or about the supply of oil and gas itself. Because the balance between supply and demand ultimately tells you almost everything you need to know about the direction in which the price of just about anything that human beings use is headed. Without adequate information, there is no basis to understand a different outcome than simply a continuation of what's already occurred.

We believe we have plenty of facts, that we've assessed them carefully, and that we integrate new information into our understanding of the circumstances and valuations. This is how we learn about what expected returns should or could be. We're very confident about it with respect to the energy sector.

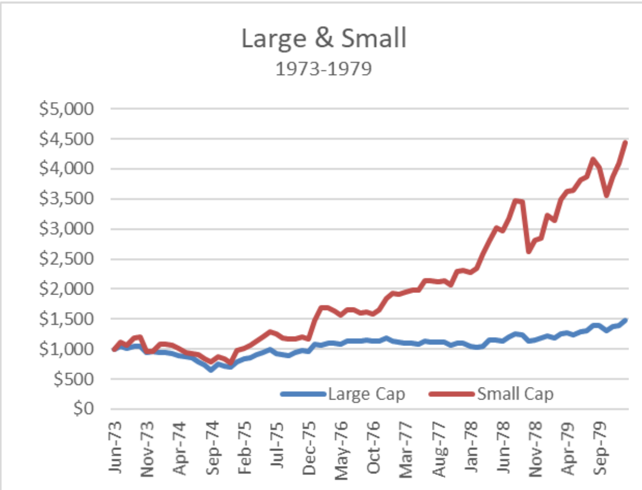
If it's not plain by now, we're contrarians. It is how we practice investing. *The Contrarian Research Report* is the title of our first subscription research series, published since 1995. Not as a matter of style choice or posturing, as most people understand the term, but because we practice fact-based investing. And it is a fact that very much of the time, particularly when the preponderance of investors moves toward an extreme, fact-based investing looks very much like the opposite of the market. It might look as if it's contrarian by *intent*, but that's only an *outcome* – an outcome of investing on the basis of information, as opposed to momentum or arbitrary index weightings or unqualified growth presumptions and other crowd-based investing approaches.

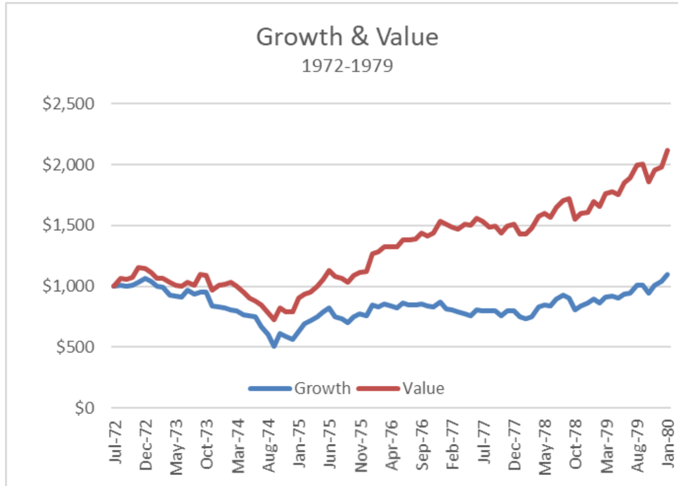
'The Market' – A Preparatory Reality Check – Where Are We in the Scheme of Things?

I hear, and I know, that many people can't stop looking at the downward trajectory of energy stocks or the upward trajectory of the Information Technology sector. So, let's get some price-focused discussion out of the way before the energy discussion, which is forward looking. Let's start with the clarity of a backward-looking lens. Here are 5-year historical charts of the performance of large-cap vs. small cap companies, and of growth vs. value stocks[1]. The red lines represent small-cap and value stocks. It is a very familiar pattern at this point. It is exceedingly difficult – near impossible – for most people to look with equanimity at five years of very sub-par or even *negative* returns while at the same time the rest of the market is experiencing superlative returns. Ccertainly, if you don't have any fact-based understanding other than stock price. How could one react in any other way without other reference points?

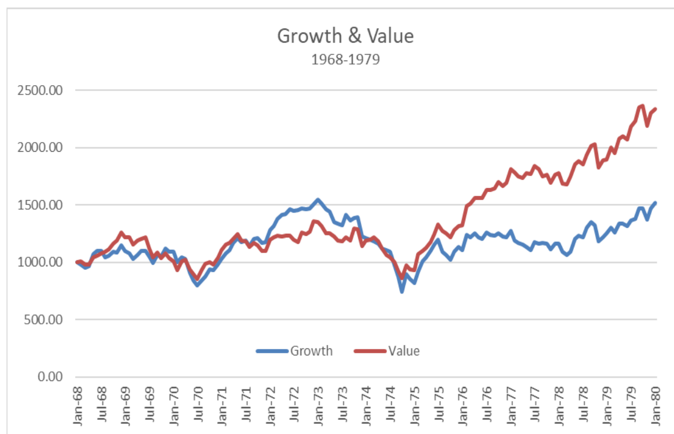
But these charts are not from today. They're for the period 1968 to 1973. That was the first half of a decade-long equity cycle, one of three primary equity cycles of the past 50 years: the 1970s 'Nifty Fifty' bubble and aftermath, followed by the 1990s Technology/Internet era, and now, the index-based Information Technology/ Internet era. The next two charts show the other half of the 1970's cycle, the succeeding six years from 1973 to 1979. These show just the opposite, only more so.

[1] *Source: Factset, Ibbotson*



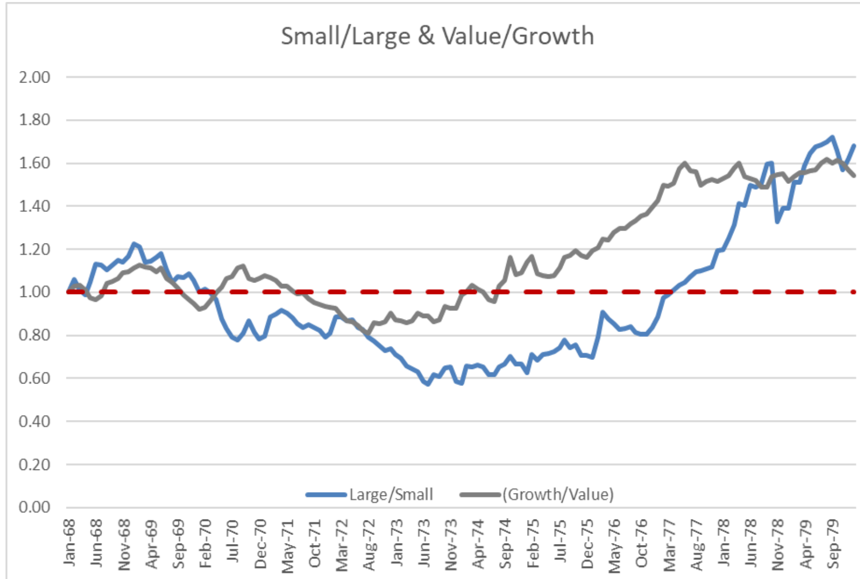


Here is the entire one-decade result[2], including a ratio chart of the relative returns of small vs large and growth vs. value.



[2] *Source for all charts on page: Factset, Ibbotson*

It was actually possible, despite five or six years of superlative returns in the Nifty Fifty bubble stocks, to suffer an overall loss. There was plenty of data in the early '70s to identify the extreme valuations and the consequence of reverting to a reasonable valuation. At the peak, the most popular of the Nifty Fifty growth companies, such as Polaroid, McDonalds and Disney, traded at over 80x earnings, while others, like Avon, Black & Decker and Xerox, had P/E ratios above 50x. Some shares declined 90%.

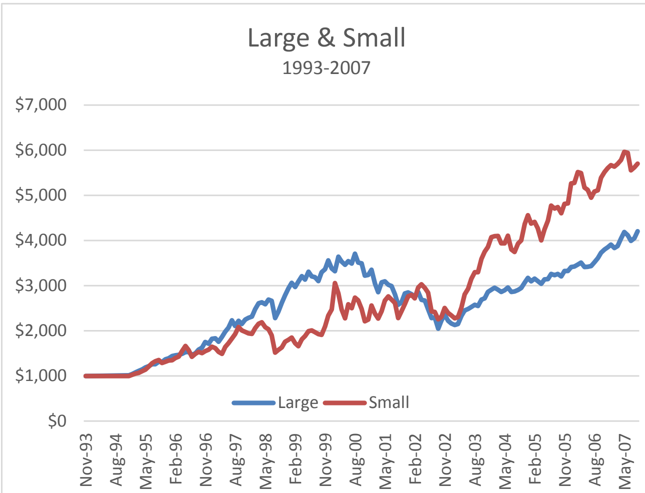


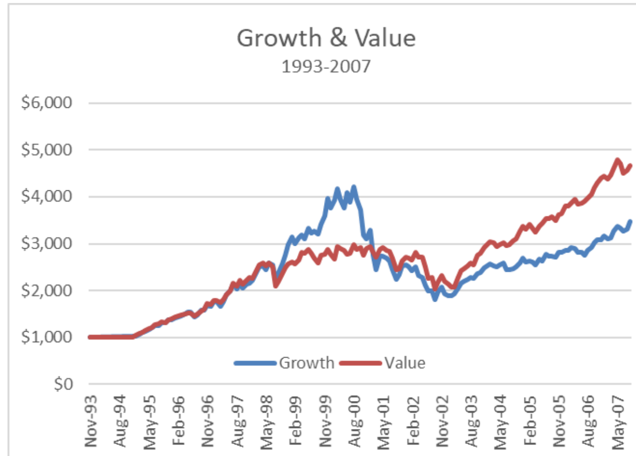
Source: Ibbotson, Factset

And when the unpopular small-cap and value stocks reached extreme low valuations mid-way through that cycle, there was likewise plenty of data to identify that likely outcome. Over the decade-long cycle, value and small stocks outperformed by 54% and 68%.

At the same time, the abandoning of the gold standard in 1971, the enactment of Medicare and Medicaid legislation, and the funding of the Vietnam War were factors in an extended inflationary period. Aside from the collapse of the Nifty Fifty stock prices, inflation averaged close to 7% for the decade 1968-1978. That reduced the S&P 500 return, in after-inflation terms, from a 3.2% annual rate to a negative figure.

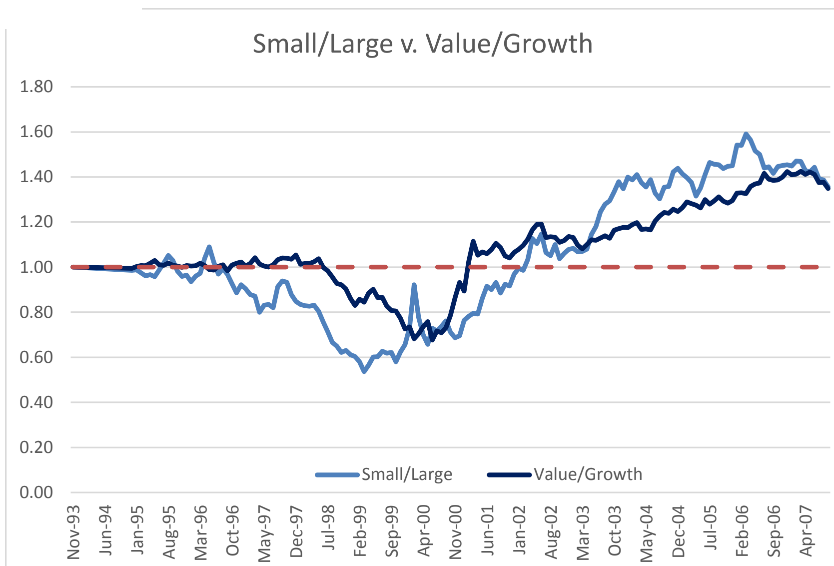
The same pattern can be seen in the next major bubble market about a decade later, as the U.S. led a global growth cycle in technology and connectivity. By year-end 1999, Microsoft had the largest market value in the S&P 500, trading at about 70x earnings. Again, a half-decade-plus of small-cap and value underperformance, on the order of 50%. If price was the only benchmark by which to guide satisfaction, it would have seemed a miserable experience that would never end. Nevertheless, the ultimate price destruction – the entire Nasdaq Composite fell 75% – was little different than among the Nifty Fifty.





Source: Ibbotson, Factset

There is no end of examples of bubbles, from smaller ones like biotech in the '90s and again in 2000 and again in 2015, to larger ones like technology and internet stocks in the late '90s. Every time, at every peak, the preponderance of investors find the extreme valuations – even extreme lows – to be entirely justifiable. Eventually expectations reconcile to financial fundamentals and prices revert to the general vicinity of fair value (at least for a bit).



How to Go About Researching Renewable Energy/Fossil Fuel Consumption Questions

Let me just say that if anyone would like to do their own research on how renewable energy and fossil fuels might play out over the next 20 years, you will find it engaging and highly educational. I recommend it, if you are troubled or intrigued by any of these issues. There is a world of difference between being a passive recipient of information and actively developing it for yourself.

Look up a comprehensive sort of brief, like this year's 30-year *International Energy Outlook* from the U.S. Energy Information Administration (an 81-page report), or a narrower explanation of how a wind turbine works or how a solar panel is constructed, and you can hardly spend 10 minutes reading before wanting to look up another bit of information or citation. And that leads to something else, and to something else.

Read enough and you might begin to see that many reports and articles and websites that have the same message, a seemingly powerful set of independent source confirmations, are simply repeating the very same statistic that was first published on one government website. You'll know that only because you read it yourself on that government website. And that, right there, puts you way ahead of the crowd.

After you read a variety of fact sheets on, say, the SEIA.org website, about the growth rates of solar panel installations, and you notice a scarcity of any complexity or challenges to the positive projections, you might be prompted to look more closely at the source.; In which case you'll discover that SEIA.org, which sounds like it might be an independent research organization, is actually the Solar Energy Industries Association. This is not bad; in fact, much of the information is helpful – but this is the way vested interests work. The only bad is if, as someone who wants to make informed decisions, you are not aware of the bias, or of the reliability and completeness of the information.

Part of what you'll learn, separate from the information itself, is how utterly enormous in scale, how multi-disciplinary, complex and interdependent the entire set of topics about renewable energy is. Even if it were all objective and reliable, there is an ocean of information, and you can't swim or sail across it in a day or a week or a month. There are hundreds, maybe thousands of study areas related to global warming, carbon emissions, new sources of energy production, carbon sequestration technologies, battery technology, etc. There must be thousands of development and research efforts, in public companies and private, in universities and government agencies. There are probably millions of documents among which to search and select. There are regulatory efforts, competing local, national and geopolitical and economic parties, and the self-interest of commercial players, certainly and perhaps especially oil and gas producers, but also those involved in 'green' energy ventures, many of which are simply industrial manufacturers or sales organizations pursuing opportunity. There are even environmental organizations that track the polluting behavior of many green energy manufacturers.

You'll also learn that not all facts are actually facts; some are only assertions. Some facts are correct in isolation, but don't take account of other countervailing facts. Not all facts are of equal importance. Some might be unimportant in the short term, but critical in the long term. Some facts are valid in one state or part of the world, but invalid in another. And then there are the important facts that you don't even know about.

It's a lot more complex than the simple answers we want. It's difficult to get a sense of that unless you swim in those waters for a bit.

The Reference Case?

Now, who wants to do that? For the shortest initially satisfactory answer to the question about how rapid the decline in demand for fossil fuels will be, one might start with an authoritative source, an organization that already has an extensive breadth of information, that uses original source material, and is comprehensive in its methodology. We'll give you three, for their second-opinion value. One is the U.S. Energy Information Administration (EIA). Before showing you its latest projections for global energy consumption over the next 30 years, it's informative to view the variety of factors they incorporate into their models, many of which someone not schooled in this area wouldn't even think of. It will give a sense of the thoroughness of the analysis. The idea is, would you tend to give more weight, or less, to a study such as this over other projections you might hear?

This year's annual *International Energy Outlook* by the EIA was published in January 2020, but an update this month includes the covid-19 pandemic's influence on market transitions. All of the various projections the study puts forth include three scenarios for each important input: a reference or base case, a low case and a high case, and they pointedly include renewable energy.

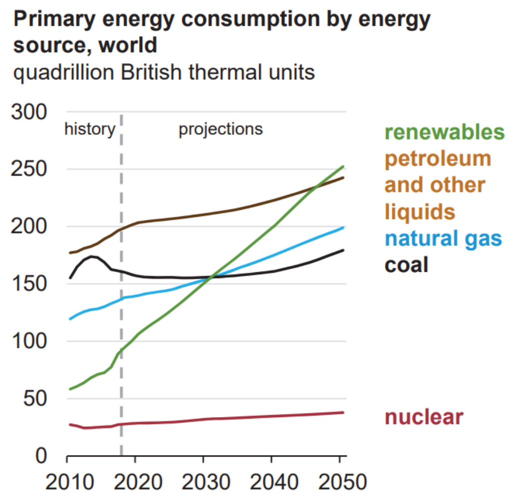
- For oil, for instance, using North Sea Brent Crude prices, the reference case trends from $60 per barrel (which would be West Texas Intermediate in the $50s) to a 2050 price of $100; a low oil price scenario has Brent trending from below $40 and heading to $45; and the high case has oil ultimately over $180.
- For renewable energy, too, there is a trio of cost curves, a reference case, and low and high scenarios.

Here is a mere partial list of the projection inputs, which all include reference, low and high scenarios:

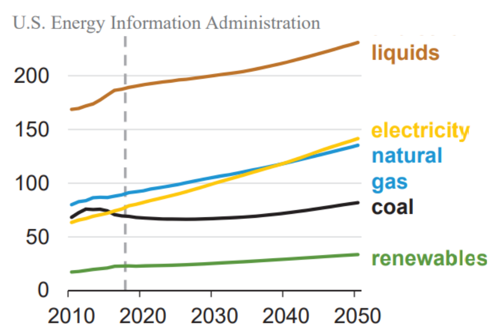
- World energy consumption, separated by OECD and non-OECD nations
- Sources of both production and consumption under each oil price case, also by OECD/non-OECD nations.
- GDP projections, likewise broken out by developed and developing economies
- Per-capita GDP projections, both OECD and non-OECD
- Energy consumption by sector: industrial, transportation, commercial, and residential
- End-use consumption by fuel: petroleum, electricity, natural gas, coal, renewables, including by services vs. manufacturing sectors (and further broken down by both energy intensive and non-energy intensive manufacturing)
- The shifts in manufacturing, over time, from 'rest of world' toward India and China, which impacts industrial energy consumption growth, particularly in non-OECD countries
- The impact of buildings: estimated gains in energy efficiency, in building materials as well as appliances and equipment. Underlying estimates include growth in commercial floorspace by type (such as warehouse, healthcare, lodging, education, etc.).
- Transportation energy consumption, broken down by passenger vs. freight, and by type of vehicle (buses, rail, air, light-duty trucks, international marine, etc.). This includes electric vehicles.
- Electricity demand growth. This includes:
  - Net generation projections and use projections by sector (industrial, residential, plug-in electric vehicles, and so forth). This includes projections for both retirements of, and additions to, generating capacity, and by type of fuel.
  - Estimates for utility-scale battery storage, commercial rooftop solar distributed generation capacity, and residential solar adoption rates.
  - Market share of renewables in net electricity generation. This includes a reference case of a 50% renewables market share by 2050, and accounting for over 70% of generating capacity additions by 2050. Broken down, of course, by source (hydroelectric, wind, solar, geothermal, other).

OK, so whatever ultimate weight one gives to a projection constructed in this manner, whatever methodological flaw or whatever factors one feels it might have left out, it would be challenging to say this is not a very serious effort. Here are some of the primary findings.

This first chart is of primary energy consumption, which is the use of energy at the natural resource end, before conversion or transformation. It shows renewables exceeding all others by the year 2050. Yet, it also shows rising production of oil and natural gas. This is where many people have difficulty reconciling the two concurrent trends. You'll find very little discussion of the reason for this, but those reasons are central to understanding the outcomes of these studies.

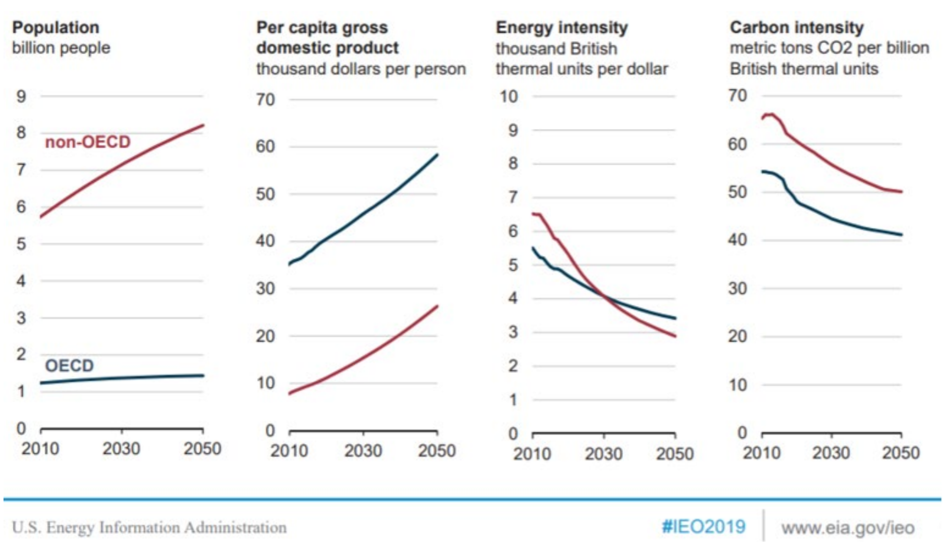


The second chart shows global end-use energy consumption, which is energy that has been transformed from its primary, at-the-source form, and directly consumed by the user, such as gasoline (as opposed to unrefined petroleum). In this case, oil remains the dominant energy source. Coal, surprisingly, continues to exceed renewables consumption. How is this possible?



One factor is population growth, though it's a modest factor. The larger factor is the increase in per-capita GDP in the poorer non-OECD nations. As that happens, total energy consumption rises, offsetting the substantial efficiency improvements in energy and CO_2 consumption. The 4-chart set below illustrates these offsetting patterns. Irrespective of the gains in renewable energy production, global energy consumption is modeled to rise nearly 50% between now and 2050, with almost all of the increase occurring in non-OECD countries, and most of that from India and China. That is a very significant factor.

That's only one set of factors in why oil and gas and coal don't disappear in these projections. There are reasons, embedded in these projections but which are not identified that we'll discuss later. But in the interest of assessing the reliability of sources of information, one might question whether any political pressure might have impinged upon the creation

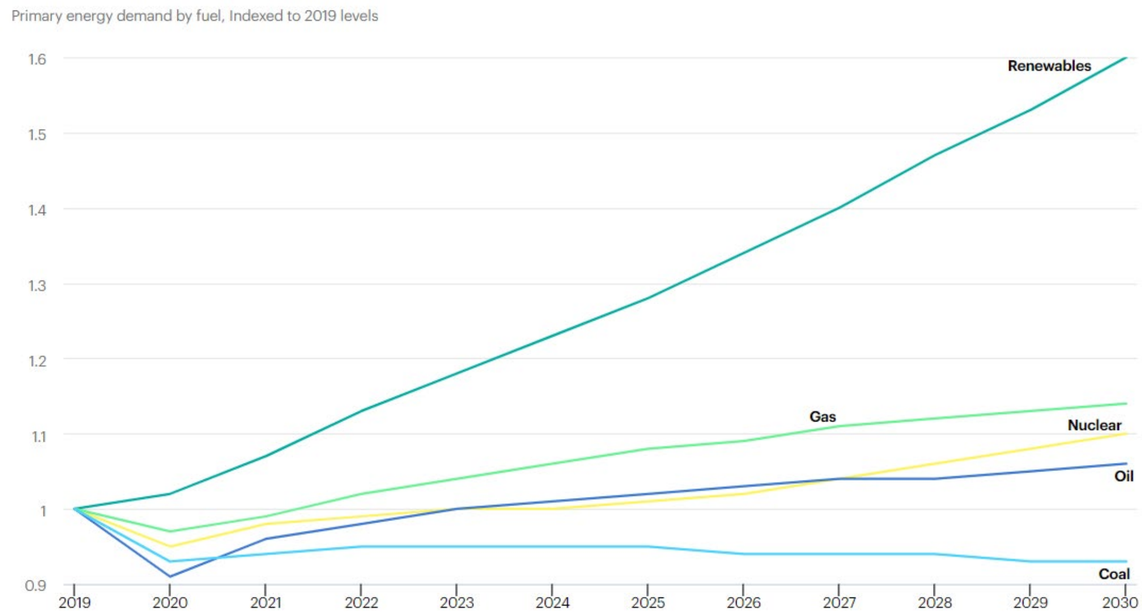


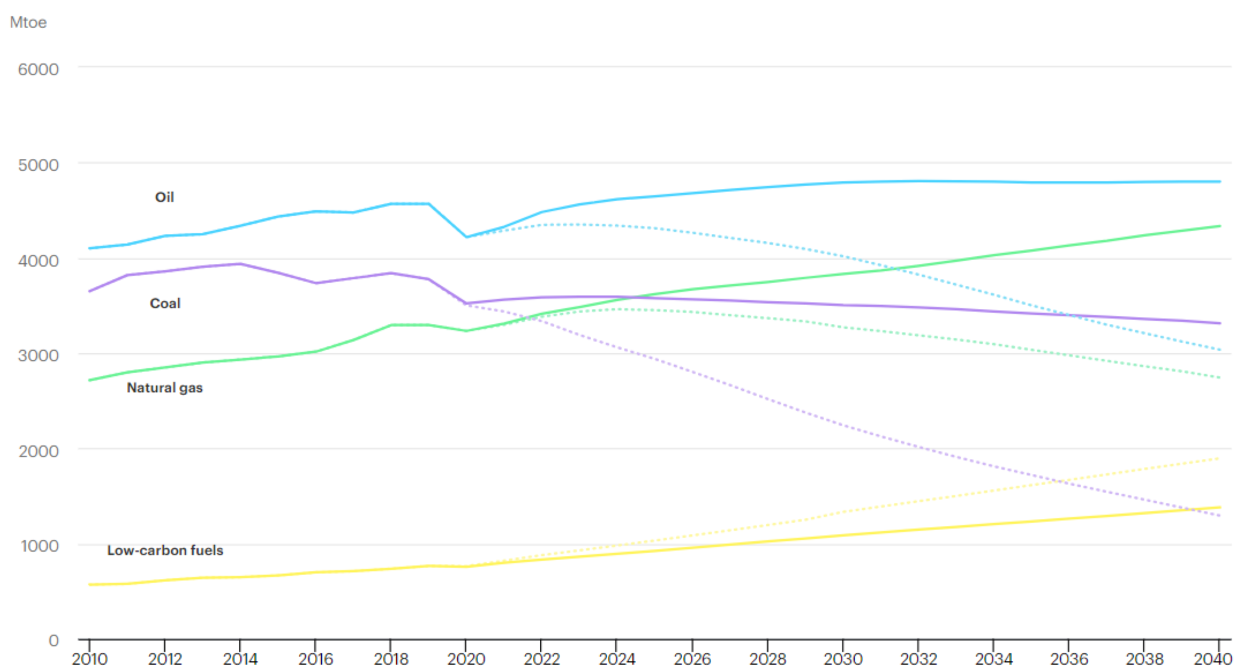
of these models at the EIA. Perhaps that's not the case. I hope it isn't, but it would be easy to effect. Anyone who has ever worked with the annual compounding of multi-decade projections knows that the slightest alterations in one or two factors can totally skew the result; you can make the final answer big or small, as you like.

For a second opinion of the same authoritative ilk, there is the *World Energy Outlook 2020* by the International Energy Agency, published this month, which models energy consumption over the next 20 years through 2040. The IEA was a joint creation, in 1974, of 17 developed nations, now 30, in response to the 1973-1974 oil shock that was imposed by the OPEC cartel. It was organized to respond to potential disruptions in global oil supply, and has worked to help stabilize markets during crises since then. In recent years, it has broadened its goals with respect to global energy policy. Beyond energy security for oil, gas and electricity, it now engages with major emerging economies, and also focuses on clean energy technology, including energy efficiency.

To understand this report's orientation, the models incorporate three alternative global energy policies: one set of iterations assumes a "stated policies scenario", reflecting all of today's announced policy intentions and targets; another is a "sustainable development scenario" which sees a surge in clean energy policies and investments, including the Paris Agreement; and there is a "net zero emissions by 2050 case". The models also include scenarios with greater or lesser use of carbon capture technologies, and they incorporate differing impacts of the Covid-19 pandemic.

These next two charts are: the projections for the ascendance of renewables-sourced primary energy over the next 20 years; and another for the future profile of the global fuel supply. The latter includes both the stated policies scenario and the sustainable development scenario. Neither is very different than the U.S. EIA projections. Oil and natural gas remain the largest sources of energy.





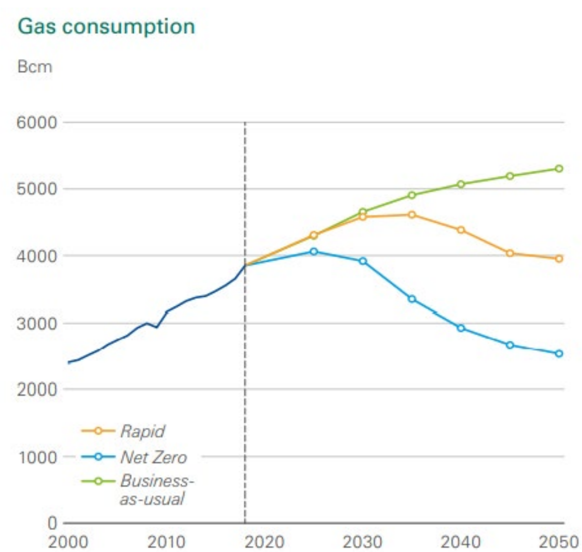
IEA, Global fuel supply by scenario, 2010-2040, IEA, Paris https://www.iea.org/data-and-statistics/charts/global-fuel-supply-by-scenario-2010-2040

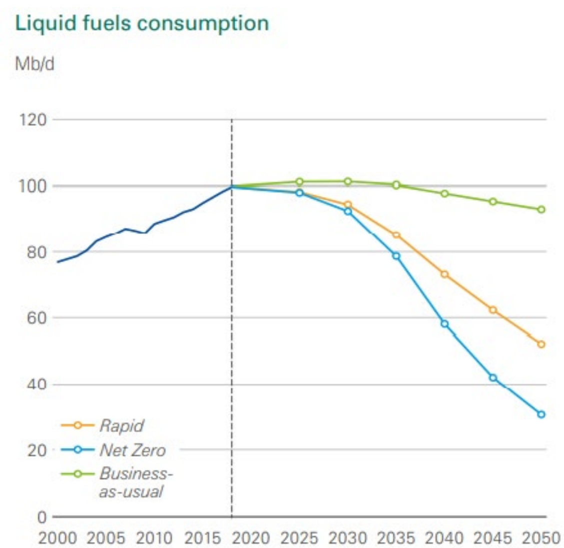
Mtoe: Megatoe, or one million tonne of oil equivalent (toe)

And third in the realm of comprehensive reports, there is the 157-page *Energy Outlook*, an annual report by BP (British Petroleum). Now, BP is an oil company, so that certainly informs us of its vested interests.

Nevertheless, the *Energy Outlook* is a very informative data source. In the opening pages of this 2020 edition, BP announced its ambition to be a net-zero carbon emissions company by 2050 or sooner, and to help the world get to net zero. It has stated, for what it is worth in one's assessment of the report, that it intends to build scale in renewables, hydrogen power, and carbon capture, utilization and storage, and increase its investment spending in these areas by 10x over the next decade, to $5 billion annually.

With that framing, the BP analysis is every bit as comprehensive as the other two, although it favors some different factors, such as the differences in the carbon intensity of oil production in different countries, and it incorporates the impact of climate change on global economic growth. But, really, the same underlying fact sets are being used. Their results are not much different either.





Source: https://www.bp.com/en/global/corporate/energy-economics/energy-outlook.html

Some Factual Observations: Renewables, Interruptibles, Fossil-Free

Whether you judge the above reports to be compelling or not, they are summary findings; they show statistical inputs and outputs, but are not explanatory. They do not really explain why it could take 20-plus years for oil and gas consumption to moderate or decline even as renewable energy production accelerates. We're not going to explain either, as we have no special qualifications in this area. We can, though, provide some additional facts. Not all the facts, just some.

Interruptibility

A principal feature of renewable energy production, primarily wind power and solar power, is that they are interruptible. Therefore, they cannot operate alone without being accompanied by on-demand, fossil-fuel based energy (or effective energy storage). And they cannot be manufactured without fossil-fuel as part of their content and without fossil-fuel-based energy. These are simply facts.

For wind turbines:

- Onshore wind turbines typically operate only 25% of the time, offshore turbines about 40%. Obviously, there are periods of no wind, but at low wind speeds, power generation drops, and when wind speed is too high, the turbine must stop to avoid damage.
- A 'shadow' fossil fuel plant must therefore accompany each set of wind turbines, in order to provide in-feed power to the electric grid when the turbines aren't producing.
- That fossil fuel power plant has to be an always-on base-load plant, so it constantly burns fuel. Utilities can make use of peaking plants, which take time to fire up, because their activation can be timed in advance for known periods of higher demand, but peakers can't serve the intermittent power pattern of a windmill.
- Because of the 25% expected load factor, for any given expected output from a wind farm, the total generating capacity, by number of turbines, has to be about 4x larger to compensate.

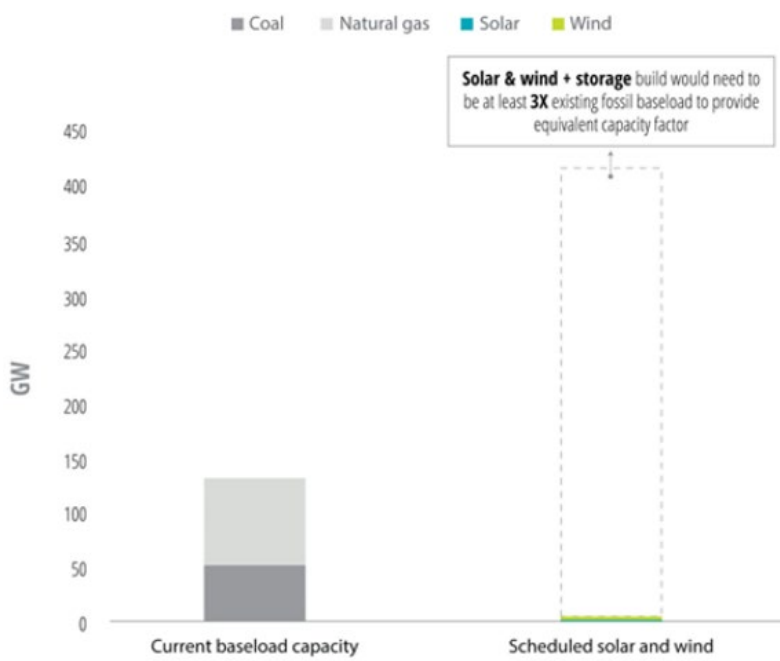
For solar power plants:

- Utility-scale solar in the U.S. also operates, on average, at about 25% of rated capacity. The intermittency is not only a function of the day/night cycle and cloudy days. There is also the sharp drop-off in generation when the sun is not directly overhead; it falls significantly in late afternoon and early evening, just as electricity demand begins to climb.
- Intermittency also occurs when clouds pass overhead, which has an impact on the ability of the electric grid to handle 'rolling waves' of power decline and resurgence.
- The periods of power deficit to the electric grid must be supplied by alternate power sources.

Base-load power, which is the amount that is always required, cannot be intermittent. Rightly or wrongly, the public requires, or at least desires, power on demand, whether for street lamps or internet use. This power-on-demand function is accomplished with fossil fuels, even when using wind and solar power. That is what partially explains the following seemingly conflicting facts:

1. Over 75% of new U.S. electric generating capacity this year will be provided by wind and solar power. It is clearly growing very rapidly.
2. U.S. natural gas consumption reached all-time monthly highs in the most recent two months for which information is available (June and July), in the depth of the pandemic and economic recession. That is rather extraordinary, if you think about it.

A Deloitte study suggests that solar and wind installation would need to be 3x to 8x global peak energy demand to ensure sufficient electric power available when sun and wind availability is lowest. To meet a zero-percent emissions target, total solar and wind, plus storage, would need to be at least 3x the existing fossil fuel *baseload* capacity. If one goes by the accompanying chart alone, that is an astounding – perhaps impossible – scale.



Sources: S&P Global Market Intelligence; Deloitte analysis.

<u>*Wind, Solar and Fossil Fuel Consumption*</u>

On an operating basis, wind and solar power release very little carbon. But manufacturing them requires huge quantities of fossil fuels. Entirely separate from the energy consumption, the manufacturing process also requires pure carbon as an input or itself releases substantial amounts of CO_2.

Solar:

- Solar panels are basically silicon semiconductor wafers that must, without exaggeration, be at least 99.99999% pure.
  - Silicon dioxide, in the form of quartz, which is mined, is first heated to its 4,000°F melting point, which requires fossil fuel power.
  - Moreover, it must be heated in the presence of carbon (in the form of coal) to free an oxygen atom from the silicon dioxide ($SiO_2 + 2\,C \rightarrow Si + 2\,CO$). 550 pounds of coal are required for every 1,000 pounds of quartz.
  - That product is then intensely heated, again, with fossil fuel, to achieve the necessary purity and produce the wafers.
  - The wafers are then heated again, to near the melting point of silicon, 2,570°F, in order to dope the silicon with various rare earth metals to enhance its conductivity.
- China produces about 50% of the world's solar panels. It has been calculated that because of fewer environmental standards and more coal-fired power plants, the carbon footprint of a solar panel from China is twice that of one from Europe.

- A typical solar panel weighs about 40 pounds, much of which is not only the silicon, but plastics: to laminate the silicon wafer array, the backplate (mylar) and the plastic cover (plexiglass). Petroleum is the unrefined feedstock for plastics.
- While direct solar radiation is free, the land upon which a utility-scale solar facility is placed is not free. How much land would be needed to power a city of 100,000 homes (with no allowance for businesses, schools, hospitals, street lamps, etc.)?
  - A 1-megawatt solar farm, sufficient for roughly 100 homes, requires at least 70,000 square feet[3]. A football field is 57,600 square feet.
  - For 100,000 homes, a 100MW plant would be needed, and the area required would be 70.2 million square feet (1,200 football fields or about 2.5 square miles).
  - Even on a sunny day, this configuration only produces at capacity when the sun is at its optimal position. The EIA reports that the capacity factor for utility scale solar energy in the U.S. in the last 12 months was 25%. Allowing for that, 4x that area, or 10 square miles of land would be required to power 100,000 homes.
  - For comparison, the town of Santa Clara, California, with 43,000 households, is supported by a 147MW natural-gas-fired electric power plant, which is 50% greater capacity than required in the above example. The Santa Clara plant occupies 2.86 acres.

Wind:

- Each blade on a 2 MW turbine can be 160 feet long, and the tower height can be 400 feet. A 50MW wind power farm[4] would use 6,820 kilograms of steel and iron, and 21,230 kg of concrete. A deep and wide foundation is required because of the forces generated so high atop an otherwise slender pole.
- The steel for the tower as well as the rebar in the concrete is produced by heating iron ore in a blast furnace at 3000° F, and the fuel used is coke, which is coal that has already been combusted in a high-temperature kiln.
- Concrete, made with cement, is not only particularly energy intensive but also accounts for about 8% of global CO_2 emissions. Global agriculture (including animal husbandry) accounts for 9.9% of greenhouse emissions. Alternatively, Industry accounts for 22% of global emissions, so cement production is about one-third of that.
  - The high energy consumption is because cement manufacture requires heating limestone to 2,600°F, which requires fossil fuel, to produce calcium oxide.
  - During the heating process, the lime is also combined with coal in order to convert the limestone, which is calcium carbonate, to calcium oxide and carbon dioxide ($CaCO_3 \rightarrow CaO + CO_2$). This produces direct CO_2 emissions.
  - One cubic meter of concrete requires about 350 kilograms of cement, and it takes about 70 kg of coal to produce that much cement.

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[3] A typical 250-watt solar panel is 5.4' x 3.25', or 17.55 square feet. A one-megawatt solar farm would require 4,000 solar panels which, if placed end to end with no allowance for physical access for servicing and repair, would require 70,200 sq. ft.

[4] Using Vestas V110 2MW wind turbines.

- o One scientific study exploring less carbon intensive methods of cement production reviewed the chemistry and process engineering of dozens of fuel alternatives[5]. It could only identify some marginal reductions in the use of coal in the lower-heat portion of the multi-stage combustion process. Nevertheless, those reductions entailed burning other sources of carbon, ranging from refinery waste gas to oil sludge to domestic refuse and plastics residues.

– The blades on a turbine are generally made of fiberglass, which is glass-fiber reinforced plastic. Glass fiber production is highly energy intensive. Silicon dioxide must be melted in a furnace, which requires high heat, and coal is the fuel. The plastic, like all plastics, is produced from petroleum.
  - o A 155-foot blade weighs about 27,000 lbs. Hundreds of thousands of tons of blades are produced each year, and the volume is rising rapidly.

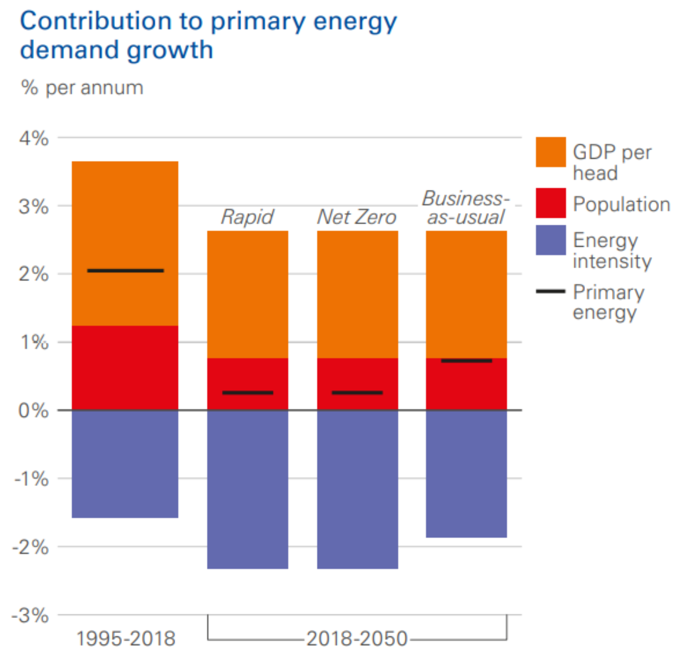
Takeaway:

We've covered only a few elements of this enormous topic; there are other significant areas, and limiting factors such as electric vehicles and the metals mining and supply implications for solar panel manufacture. But so far, we have this:

– Accompanying all the progress being made in renewables technologies, population growth and per-capita GDP growth in developing nations offsets global energy efficiency gains[6].

– That because wind and solar power are interruptible power, that intrinsically limits their ability to act as baseload, on-demand capacity, which is most of electricity consumption.

– Interruptible power requires pairing with an always-on fossil fuel plant (or sufficient battery storage).



Source: BP Energy Outlook 2020 Edition

– Interruptibility also requires roughly 4x or more the installed capacity to meet planned output, which entails construction of a large physical asset base.

– Renewables' low energy intensity can mean order-of-magnitude increases to the volume of physical asset construction and land use. Land use, in cost or availability, can be a limiting factor.

– Constructing solar and wind plants requires carbon-based fuels; they cannot be made without them. Substantially all the materials that make up solar panels and wind turbines require:
  - o Intense fossil fuel-based energy for heating the various materials to their melting points;
  - o Chemical reactions that specifically require the use of coal;
  - o Separately, the chemical-process-based release of CO_2; and,

[5] https://www.intechopen.com/books/alternative-fuel/alternative-fuels-in-cement-manufacturing
[6] Another visualization, in the accompanying chart, is from the BP *Energy Outlook 2020 Edition.*

- In the case of plastics and resins, they are comprised of refined petroleum products.

The same energy intensity described above applies not only to manufacturing solar panels and wind turbines, but to manufacturing other key global-scale intermediate materials across the world, from semi-conductor chips to construction cement and steel.

This discussion is not an argument against renewables; renewable energy is critical. It is part of a necessary understanding about the replaceability or non-replaceability of aspects of fossil fuels, and about implementable time frames within the complex, developing global energy economy. Knowing more puts one at an advantage.

More Factual Observations: Other Factors in the Equation

<u>*Raw Materials: Supply Limitations and Environmental Impact*</u>

<u>Solar Panels and Silver Supply</u>
Solar panels require silver as a conductor, silver being the most conductive metal, superior to copper, aluminum and gold. Merely to replace today's U.S. electric power production capacity with solar panels would require at least 4.25x the today's global annual silver mining production.

– One megawatt of electricity requires roughly 5,000 solar panels (based on a typical 200-watt solar panel), without allowance for the average 25% capacity factor for utility-scale solar power in the U.S.
– The U.S. produces 1,100,546 megawatts of electricity[7].
– A 200-watt solar panel presently uses 20 grams, or 0.643 troy ounces, of silver.
– To meet the electricity needs of the United States would therefore require 5,000 x 1,100,546 panels, or 5.503 billion panels.
– This would require 3.538 billion ounces of silver (5.503 billion panels x 0.643 ounces of silver).
– Global annual silver production is about 836 million ounces[8]

Real-life circumstances are more complex than such a simple exercise suggests.

– Manufacturers efficiencies have been improving, and it is estimated that perhaps half as much silver per panel might be required within about 10 years.
– On the other hand, because solar panels in the U.S. only produce about 25% of their optimum capacity, about 4x the above-calculated amounts would be needed. And that was just the U.S.
– Of course, this ignores any contribution from wind. But wind poses its own needs (more of which below).

As an alternative exercise, solar panel demand used 11.8% of global silver mine production in 2019, about double the 2015 figure of 6.1%. Solar power production is anticipated to roughly triple by 2050.

– Extending from this figure, solar panels will require the equivalent of 35% of today's silver mining output.

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[7] U.S. Energy Information Administration
[8] https://www.silverinstitute.org/wp-content/uploads/2020/04/World-Silver-Survey-2020.pdf

- Meanwhile, silver production has declined every year in the past four years and in 2020 is expected to be 10% below the 2015 level.
- Much of silver production is a byproduct of mining other metals, such as gold. Gold mining activity has been declining for some number of years.

Solar Panels and Water Supply

The world's largest collection of solar power arrays, with an aggregate capacity of 2 GW, is in the arid area of Pavagada north of Bangalore, India. It occupies 53 square kilometers. Two primary challenges for the project are[9]:

- The need to keep the panels dust-free. One of the operators, with 400,000 panels, which is a small fraction of the millions of panels in the whole project, requires at least 2 liters of water to clean each panel, and this is done twice a month. That's 1.6 million liters per month for that portion of the project. That places an additional strain on a region that already overuses its groundwater supplies.
- Power surges and drops created by clouds passing over the region are an increasing challenge for the electric grid operators, which must counter the variations with coal-fired and hydropower plants (more of which below).

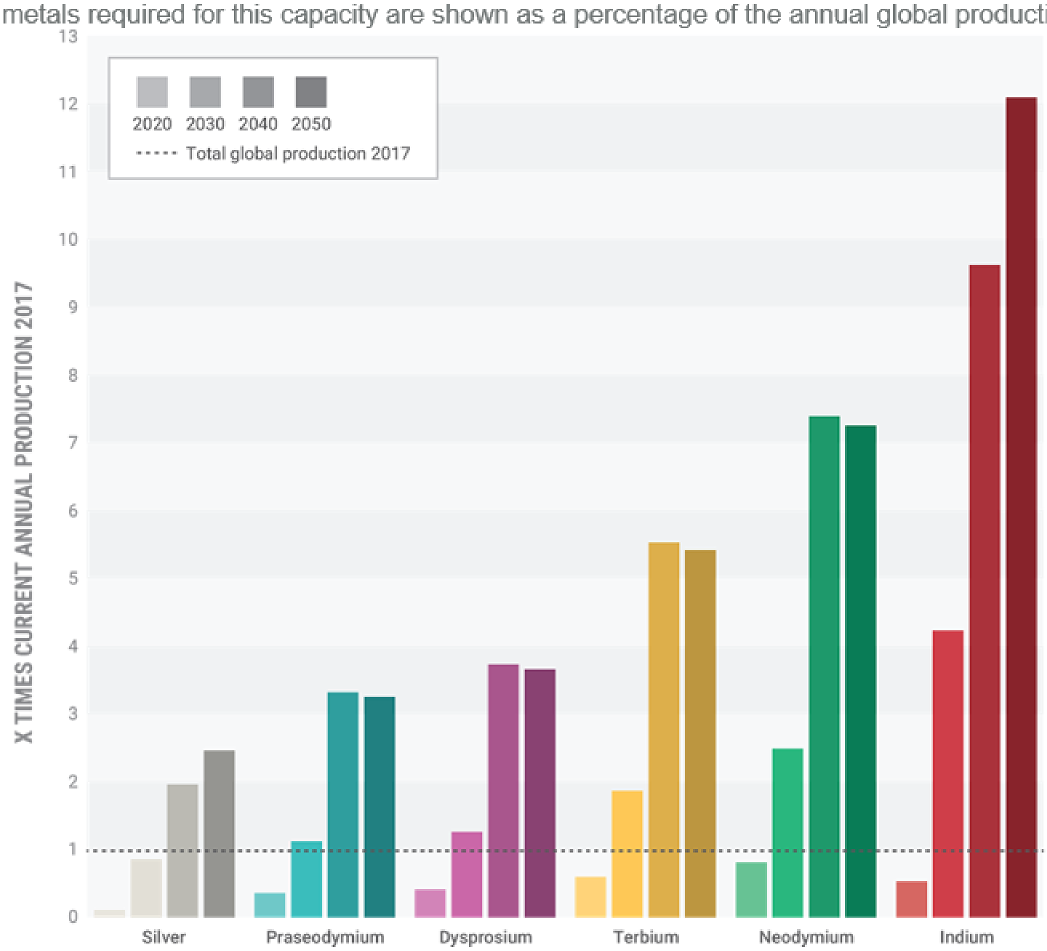
Solar Panels & Wind Turbines and Critical Metals Supply

The Netherlands, one of the leading nations in the transition to renewable energy, commissioned a study through the Dutch Ministry of Infrastructure and Water Management to assess the future availability of critical raw materials required in solar and wind power with respect to *Dutch* needs[10]. This does not include critical-metal demand for electric vehicles and batteries, which is addressed in a follow-on study.

- Six critical metals were identified for which Dutch demand by the year 2050 would exceed current global production, and by some multiples.
- Many such metals are important in making strong permanent magnets used in devices like turbines, and in improving the conductivity of solar panels.
- Dutch demand alone, for silver, is expected to be 2 ½ times today's global production of silver. For metals such as Neodymium and Indium (used in creating strong permanent magnets and improving solar panel conductivity), Dutch demand is projected to be 7x to 12x current global production levels.

[9] Institute of Electrical and Electronics Engineers: https://spectrum.ieee.org/energy/renewables/the-pros-and-cons-of-the-worlds-biggest-solar-park
[10] https://www.metabolic.nl/publication/metal-demand-for-renewable-electricity-generation-in-the-netherlands/

The renewable electricity targets [for the Netherlands] for 2030 serve as the starting point for the calculations. Based on these targets, the annual installed capacity is calculated. The metals required for this capacity are shown as a percentage of the annual global production.



Annual global critical metal demand for wind and PV, between 2020 and 2050, compared with the annual metal production index (2017 = 1).

Source: https://www.metabolic.nl/publications/metal-demand-for-renewable-electricity-generation-in-the-netherlands-pdf/

<u>CO_2 Capture Technologies</u>

There are many efforts in CO_2 capture, utilization and storage technologies. Should any of these be truly successful on a large scale, that alone could meaningfully alter those demand curves for fossil fuel use and net CO_2 emissions that were produced by the Energy Information Administration and other agencies. For example:

– Last month, Norway announced that it would majority finance a €2.1 billion carbon capture and storage project involving Equinor, Shell and Total. Carbon captured at a cement factory in southern Norway will be transported to and buried in geological formations in the North Sea, presumably from expended oil deposits. The initial goal is 1.5 million tonnes/year.

– More impressive, if it is scalable, scientists have very recently discovered how to turn CO_2 captured from power plants into rock, believe it or not, for permanent storage. A pilot project in Iceland mixed power-plant-captured CO_2 with water and hydrogen sulfide and injected it into underground porous basaltic rock, which reacts naturally to form solid carbonate minerals. Within 2 years, 95% of the CO_2 has mineralized, vs. an expected 8-10 years.

  Reykjavik Energy expects to increase its CO_2 injections to 10,000 tonnes/year this year and to increase volumes thereafter. There are large basaltic rock formations off the coasts of South Carolina, NY, NJ, and Massachusetts.

Electric Grid Insufficiency: Impact of Interruptible and Distributed Power Growth

The American Society of Civil Engineers recently described the state of the U.S. electric grid. Its 'report card' scores the U.S. electric infrastructure a D+, most of the transmission and distributions lines having reached or exceeded their 50-year life expectancy[11].

– The proportion of power outages attributable to transmission disruption (as opposed to severe weather) rose to 46% in 2019, from an average 32% in the 5 years prior.
– Despite a surge in investments in recent years to improve grid reliability and accommodate renewables access, it said the U.S. still faces a spending gap between current levels and the amount needed: $208 billion in the next 10 years and $338 billion by 2039. Meeting that shortfall would require doubling the current spending level.
– The growth in renewables' power is a major factor in the grid's degraded performance.

A grid infrastructure challenge is handling the unplanned-for complexities and strains of renewable energy.

– One reason is that the entire U.S. electric grid, with an estimated depreciated value of perhaps $2 trillion, and a far higher replacement value, was designed to transmit power from centralized generation points (large fossil fuel plants) in one direction outward toward the areas of consumption. It must balance supply and demand shifts on a second-by-second basis.
– Renewables-based power, though, is widely distributed, often along the edges of the network, and travels in many directions.
– That, and the momentary power changes from interruptible sources, is a challenge to maintaining voltage and frequency within acceptable limits and to prevent transformers from overheating during reverse power flow.
– The more of the grid capacity that is represented by renewables, the greater the strain and instability.

A Real-World Example of Transmission Grid Strains

Integrating renewables and new technologies will help create a 'smart grid' that can ameliorate the power-imbalance problem. California, the policy leader in the green energy movement and energy efficiency, is perhaps the best window into the near future. Smart meters are in place in most California homes, and

[11] https://www.asce.org/uploadedFiles/Issues_and_Advocacy/Infrastructure/Content_Pieces/Failure-to-Act-Energy2020-Final.pdf

other technologies, like smart charging of the growing electric vehicle fleet, will also reduce grid instability. Nevertheless, California accounts for 33% of the national grid spending gap.

- In August, for the first time since the 2001 energy crisis two decades ago, the grid system operator had to shut off power to certain groups of customers – blackouts, basically – to avoid a system-wide collapse.
- Part of the problem was the simultaneous increase in renewables power production and the retirement of 5,000 MW gas-fired power capacity in the past 5 years.
- The grid operator, providing one among many opposing explanations, faulted the Public Utilities Commission for failing to ensure adequate power capacity on hot summer evenings when electricity from the state-wide fleet of rooftop solar panels dropped to zero while air conditioning demand remained high.
- Not only is there less gas-fired capacity to make up the deficit, but importing out-of-state power is constrained because neighboring states have also been retiring base-load fossil-fuel plants.

Power Storage

An important element in the ultimate success of renewables is battery storage. Although California required that 1,300 MW of storage capacity be built by the end of 2024, only 500 MW are currently available. The only nuclear plant in the state, another 250 MW, will be retired at about the same time, in 2024 and 2025. Battery storage is an entirely different topic area. The requirements, just to replace the country's peaking power plants, are immense. The carbon intensity of battery production, environmental impacts, production considerations, and so forth – just as for solar or wind – are not obvious without studying the fact-set, which encompasses a large body of knowledge.

Permitting Issues: The Electric Grid

The geographically dispersed nature of renewables power sourcing requires more electricity transmission lines. Merely obtaining the regulatory permitting for a new transmission line project can mightily delay or even prevent a project, because there are so many interested parties. The transmission systems are regulated at the federal level, but approvals are required by state governments; crossing multiple states requires multiple approvals.

- Last year, seven years after applying to build a $1.6 billion, 192-mile transmission line to bring 1,092 MW of Canadian hydroelectric power to Massachusetts, Eversource, the New England utility, abandoned the project. It spent over $300 million on the process.
- Approval was required from the DOE to import the power, and from the Dept. of Interior, since a proposed route crossed national forests in New Hampshire. Law suits were brought by local residents and conservation groups with respect the degradation of State park lands, and there was political opposition at the State government level. Eminent domain conflicts arose where the lines would have crossed private land.

The rate of growth of distributed power growth is partly dependent upon these types of real-world practical impediments. It would be interesting to know whether the 20- and 30-year energy outlook studies cited earlier include this factor.

Environmental concerns other than carbon dioxide:

Silicon Valley Toxics Coalition (SVTC), a non-profit organization that advocates for environmental sustainability, has been scoring solar panel manufacturers on a range of such measures for the past 10 years[12]. Its scorecard covers items such as emissions, chemical toxicity, water use and recycling. Companies on the scorecard represent about 75% of the solar panel industry.

– The latest annual scorecard shows less, not more, reporting transparency among the participants.
– One concern is the recycling challenge. Solar panels contain an array of toxic metals. However, the market value per panel of these otherwise valuable metals is quite small relative to the cost of recovery. In any case, there is an insufficient volume of discarded panels to warrant commercial recycling projects, although substantial damage occurs during storms, which entails soil pollution and remediation. Those concerned with such issues believe the disposal/recycling challenge will ultimately be of serious proportion.
– A particularly toxic waste product of solar panel-grade silicon manufacture is silicon tetrachloride. About four tons is produced for every ton of silicon. This can be recycled, but the equipment is expensive and is a factor in the price of the finished product. Chinese companies have been found to dump the chemical in open fields, with serious environmental and human health consequences.
– Though not covered in the SVTC scorecard, wind power industry participants are likewise concerned about the end-of-life disposition of wind turbines. As with solar panels, the technical solutions for some of these complex materials are challenging, but there is no current pressure to address what they acknowledge will be a large-magnitude problem.

Energy: Demand and Supply, and The Universal Field Theory of Securities Prices

This portion of the discussion is about supply with respect to demand. Is anyone here willing to say that energy prices today are higher than at year-end?

[12] http://www.solarscorecard.com/2016-17/2016-17-SVTC-Solar-Scorecard.pdf

This startling chart is of natural gas prices. Gas is now exactly 100% higher, at $3.01/mcf than its June low of $1.50. It is 40% higher than at year-end 2019, and 20% higher than 12 months ago. During a 1-week period in August, it rose 25%.

How is this possible during an oil oversupply crisis and global pandemic? Supply and demand. On one side, demand keeps growing.

Natural Gas (Henry Hub), 1-Year Price History to 10/23/20

Source: EIA.gov

Natural gas demand set an all-time record in July, the most recent data.

– The annualized 15-year increase in U.S. demand for natural gas has been 2.6%.
– This year's increase, as of July, was 3.5%.
– U.S. 15-year GDP growth was only 1.1%/year.

U.S. Natural Gas Consumption (mill. cubic feet)	
July 2005	1,686,609
July 2010	1,825,828
July 2015	2,067,714
July 2019	2,409,508
July 2020	2,494,702

https://www.eia.gov/dnav/ng/hist/n9140us2m.htm

Why has natural gas demand grown faster than the population and faster than GDP, and why did it accelerate this year? A start is to identify gas-consuming industry sectors that grow faster than the rest of the economy.

– Data centers have been growing by at least 25% a year[13]. Data centers support the 'cloud', which includes the burgeoning video streaming, AI and Internet-of-Things markets. They are very energy intensive and probably account for over 4% of all U.S. electric power consumption. If it continues growing at the same rate, it will be 8% of national consumption in 3 years.
– The semi-conductor and alternative energy industries' growth rates have far exceeded GDP growth. Their manufacturing energy intensity, which both include silicon wafers, is very high.
– As well, alternative energy production requires paired fossil fuel generation, typically natural gas.

But that doesn't explain a 40% surge in price on a 3.5% demand increase. Why was that?

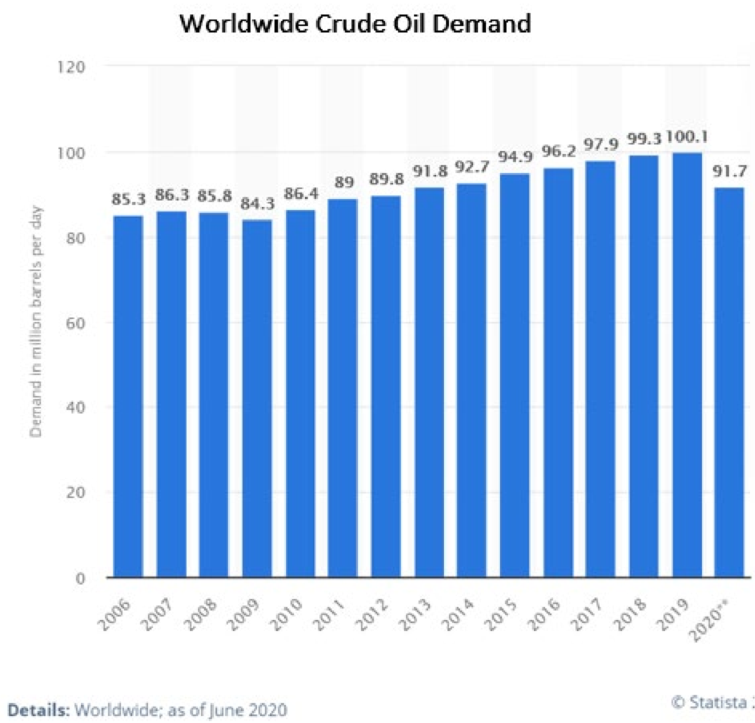
– A large portion of natural gas production is a byproduct of oil drilling. Oil drilling activity has collapsed, so natural gas production is lower.

[13] https://www.forbes.com/sites/forbestechcouncil/2017/12/15/why-energy-is-a-big-and-rapidly-growing-problem-for-data-centers/#2868bace5a30, Dr. Radoslav Danila

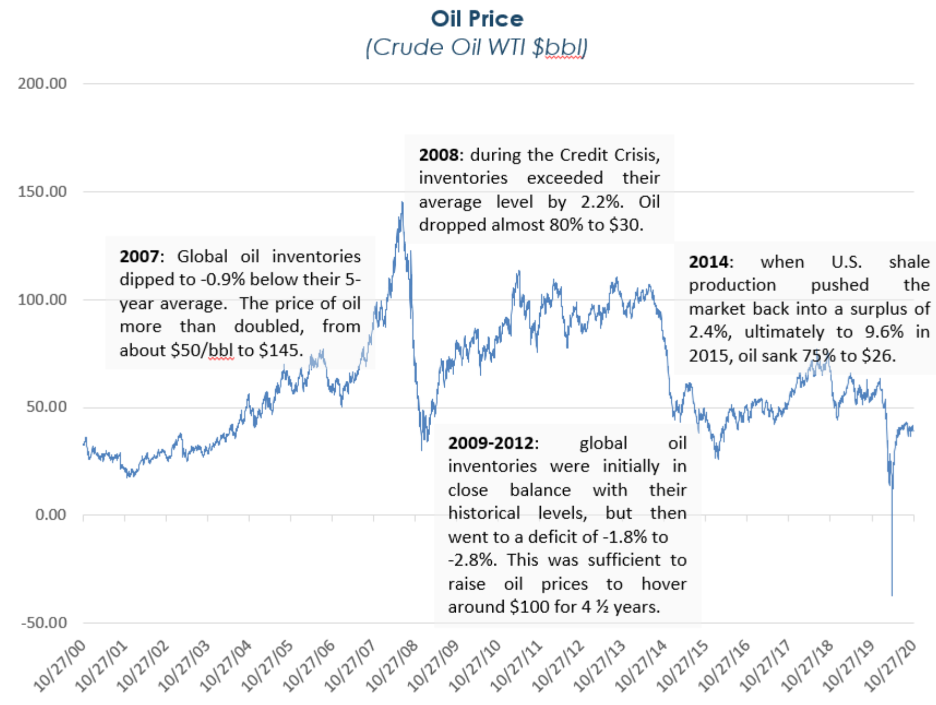
- There is less storage capacity for gas than for oil, because gas occupies so much greater volume, so inventory supply is lower, too.
- It is during the summer that utilities secure supply for the winter heating season. That's firm demand.

A 25% increase in a key commodity in 1 week, a doubling in 4 months is pretty breathtaking. But not really that unusual when there is a supply shortage of a required commodity.

Such a shortage does not need to be extreme to create extreme price changes in a demand-inelastic commodity. A surprisingly modest imbalance will do. Below is a comparison of oil price changes with the deviation in global oil inventories from their 5-year average. Actual consumption is remarkably stable:



- In 2007, global oil inventories dipped to 0.9% below their 5-year average. The price of oil more than doubled, from about \$50/barrel to \$145.
- In 2008, during the Credit Crisis, inventories exceeded their average level by 2.2%. Oil dropped almost 80% to \$30.
- Between 2009 and 2012 as the world exited the Credit Crisis, global oil inventories were initially in close balance with their historical levels, but then went to a deficit of 1.8% to 2.8%. This was sufficient to raise oil prices to hover around \$100 /barrel for four and a half years.
- In late 2014, when U.S. shale production pushed the market back into a surplus of 2.4%, ultimately to 9.6% in 2015, oil sank 75% to \$26.



Crude Oil WTI /Global Spot NYMEX ($/bbl) Source: Factset

OECD Crude Oil Inventory Surplus/Deficit Vs. 5-Yr Avg	
2007	-0.93%
2008	2.25%
2009	0.29%
2010	0.41%
2011	-1.87%
2012	-0.21%
2013	-2.83%
2014	2.41%
2015	9.62%
2016	7.56%
2017	1.33%
2018	-0.45%
2019	-1.06%
2020	1.94%

Source: U.S. Energy Info Admin

Most of these 50% and 100% swings were associated with inventory variations of just 1% to 3%.

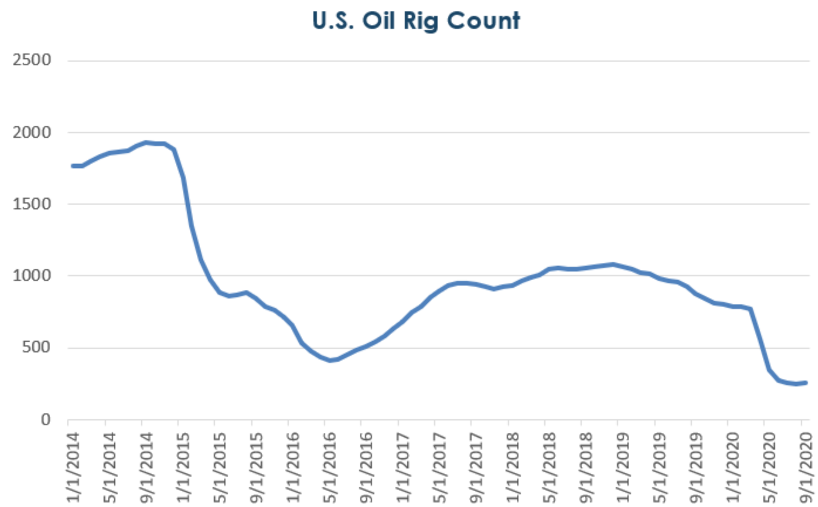
Oil Supply: This Year and Thereafter

Since the 2014 decline in oil to below about $60/barrel, oil companies began reducing their exploration and production expenditures. That price was too low to provide a suitable return on investment.

- ExxonMobil's oil development expenditures last year were 28% lower than in 2014. As of June, spending was another 43% lower than last year. At this level, Exxon is spending 60% less than in 2014.
- Chevron's capital expenditures last year were 52% lower than in 2014. As of June, spending is another 48% lower than last year. At this latest level, the company is spending 75% less than in 2014.
- Last year Chevron replaced just 44% of its output. Royal Dutch Shell replaced just 65% of its output.

In light of the above information, one can understand that the U.S. rig count in recent years was clearly not enough to sustain reserves.

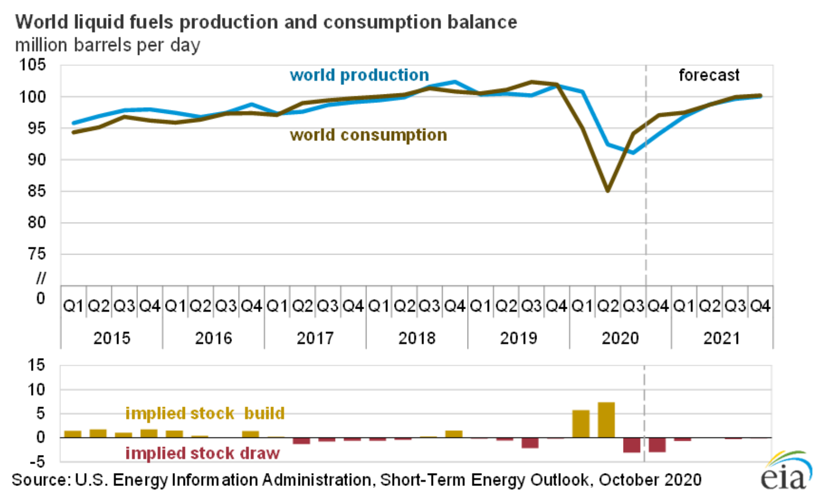
- The U.S. rig count was 1,083 at Dec 2018, and in Dec 2019, it was 805.
- As of October 23rd, the rig count was 287, which is almost 75% lower than in 2018.
- This year's pandemic-induced drop in demand was unprecedented. But, the decline in drilling activity this year, which takes more time to react, has also been unprecedented.



Source: https://rigcount.bakerhughes.com/

- When demand does recover, it can do so relatively quickly. In April, global oil and gas consumption was 21% lower than year-end; it is currently 'only' 7% lower.
- In the meantime, excess inventories are being slowly drawn down. U.S. crude oil stocks amounted to 27 days of supply 12 months ago. In May of this year, it was 42 days. Last week it was 36 days.
- Energy demand – which is always a firm need – will meet the available supply level at some point in the relatively near future. When it increases very slightly more, there will not be sufficient supply.
- Moreover, supply will continue to decline, because capital expenditures are continuing to decline. Even if capital expenditures remain stable, supply will still decline, because production volumes from existing wells decline, as much as 50% in the first year, in the absence of additional spending.

Recall the modest variances of only a percentage point or two in supply and demand vs. large-scale changes in the price of oil. What if a future supply shortage were as great as the recent supply excess has been? That is certainly not reflected in the accompanying EIA chart.



The risk is that the current declines in supply are creating a structural deficit. That cannot be reversed in a month, a year or even a few years. It could be decades.

- Even existing closed wells can take substantial time to reopen, and there are supply consequences:
  - Permitting might not be secured, even for a well that was previously active; political and regulatory factors are often involved, more so in today's environment.

   - The well might never return to the previous production rate. The costs are so great that operators often find it uneconomic to reopen at all.
     - Wells and drilling equipment are designed to operate at full capacity or not at all.
     - To re-open, pumping equipment must be repaired or replaced. This is quite expensive.
     - Closing a well can seriously damage the reservoir, which might never return to prior production levels.
     - This is happening even on sovereign-nation levels, as in Venezuela (more of which below).

- New supply could take many years to develop, a decade or longer. That makes it a structural supply deficit issue.
   - Public market and private market financing for drilling is effectively unavailable, and the companies must rely on their own cash flow.
   - Some supply might be permanently or near-permanently lost. Venezuela exemplifies this.
     - Venezuela, with some of the world's largest reserves, produced about 2.6% of the world's oil in 2016. Due to U.S. sanctions, this year, it's less than 1%; production has dropped 65% since then, so it might now be less than 0.5%
     - Aside from severe damage expected to its reservoirs and oil field equipment, it has been reported that former workers have been dismantling facilities to sell as scrap metal.

Banning Fracking

'Fracking', like many terms we've reviewed here, is convenient, but it so oversimplifies a complex topic that people can entirely misunderstand what they hear or read. That prevents the ability to make informed decisions. As with the recent electric power blackouts, California provides a case study:

- In October 2020, Gov. Newsom announced the intention to work with the state legislature to phase out new hydraulic fracking by 2024. Many people are apt to hear this as a complete ban on fracking.
   - There are many methods of injection drilling, including water flooding, steam flooding, cyclic-steam drilling, gas injection and air injection. Statistics on all of these activities are maintained by California's Geologic Energy Management Division (CalGEM).
   - The announcement referred only to hydraulic drilling, not the other methods.
   - It applied only to new permits, not to existing activity.
- In April 2020, the governor ended a moratorium on fracking that he had put in place the prior November; on the day the moratorium ended, 24 new permits were approved. Each permit allows an operator to frack the same well up to 100 times or more. Each permit typically covers multiple wells.
- In Nov 2019, state regulators imposed a moratorium on high-pressure steam extraction, which the governor described as "necessary steps to strengthen oversight of oil and gas extraction as we phase out our dependence on fossil fuels and focus on clean energy sources."
   - The moratorium applied only to new applications, not existing wells that use the technique.
- In July 2019, Gov. Newsom fired the state's oil and gas supervisor after a newspaper report that the number of fracking permits issued in his first six months in office was double that of the same prior-year period under Gov. Brown's tenure. It was reported that senior managers were invested in the oil companies they were charged with regulating.

- o In 2019, California issued more drill permits than in 2018.
- o In the first half of 2020, the number of new drill permits was higher than in the first half of 2019.

There are practical and economic as well as political realities that influence governing decisions.

- CalGEM was concerned that halting ongoing steam injection drilling – as opposed to not accepting new applications – could not only damage the reservoir but could also lead to well failures and, in turn, to "surface expressions," which is a term for oil breaking through the rock to the surface, which could be catastrophic.
- If California were a nation, it would be 5th largest by GDP. Computer and electronics products is twice as large as the next largest manufacturing segment of the California economy. Fossil fuels are critical to California's manufacturers of silicon wafers and semi-conductor computer chips.

OK to all that, but what if the U.S. bans fracking anyway?

Two short responses first, not intended to be glib; related factual observations will follow:

1. That's not going to happen.
2. If it does happen, it would be great for the best energy companies, including Texas Pacific Land Trust.

More generally, the negative consequences are too great. Any efforts in this direction will be shaped by the classic integration of political and economic pressures, expediency and misdirection. The preceding California case study was selected because it was a field test of this proposition. Even California, the U.S.'s standard setter of progressive action and legislation around climate change, has to make calculated decisions along the path toward its goals.

On the geopolitical front:

- In February 2020, the U.S. finally transitioned from being a net importer of oil to a significant exporter. That is a strategic shift in U.S. geopolitical power, including the power to influence and advance climate change policies.
- As of June 2020, the U.S. reverted to being a net importer again, since domestic production declined by far more than the rest of the globe.
- ***Most*** oil and gas wells employ some form or degree of fracking. There are virtually no onshore vertical drilling opportunities left, outside of OPEC. This may be why BP and other global integrated oil companies appear to be 'divesting' fossil fuels and drastically reducing their exploration expenditures – *new* growth investments are too expensive, speculative and long-term. This does not mean they intend to relinquish their most valuable existing properties.
- Therefore, near-term restrictions on fracking and its large portion of supply would intersect with a post-pandemic resumption in economic activity, and would remove the U.S. from that recently attained geopolitical pivot point advantage. The supply deficit would be made up by Russia and Saudi Arabia,

(000 bbl/day)	**U.S. Net Imports**	From OPEC	From Non-OPEC
Jun 2020	675	1,574	(899)
Feb 2020	(1,526)	902	(2,428)
2019	670	1,434	(765)
2018	2,341	2,580	(239)
2017	3,768	3,174	594
2016	4,795	3,221	1,574
2015	4,711	2,654	2,057
2014	5,065	2,996	2,070
Feb '20 to June '20 swing	2,201		
Annual value @ $40/bbl, $ bill	$ 32.1		

Source: EIA, Horizon Kinetics Research and to their great advantage: higher market share, energy prices and state revenue. A long-term power shift, the consequences of which can be contemplated.

On the domestic front, if the U.S. banned all new leases on federal lands, then within a 2-year window (new leases have 2 years to begin drilling), the U.S. would:

– Lose over $10 billion in annual federal revenue[14], much of which funds the U.S. National Park system.
– Lose over 300,000 jobs for offshore workers in Texas, Louisiana, Mississippi and Alabama.
– Lose possibly twice this amount across onshore, midstream and service jobs in N. Dakota, Montana, Wyoming and Colorado, for a total approaching 1 million jobs.
– Remove close to 4% of global oil supply, and a far higher ratio of gas. All else equal, this sends energy prices sharply higher, exacerbating an oil price shock that is, by our assessment, already pending.
– Redound to the benefit of the largest, most profitable oil companies. They have the financial flexibility and the reserve portfolio flexibility to make the best use of any such changes.

As to Texas Pacific Land Trust (TPL), in this context, the federal government can only ban fracking on federal land. TPL owns its properties, and would be about the 10th largest private landowner in the U.S. Private land is state controlled, and that would be Texas. The state needs the money. Texas is a petro-state. One can think about the industries that are important to California, and about the types of decisions California has made in trying to reconcile its environmental policy goals with its economic exigencies around energy security.

Are All Investors Leaving Oil?

– There is never "all" investors. There is the general movement of the preponderance of investors. And there are always investors who, because of expertise, information access or other faculty, have better information.
  - The largest energy ETFs, which represent substantially all of the energy ETF sector, are down nearly 50% this year.
  - Each one of them had net investment inflows this year.
  - Those inflows amounted to almost 40% of their collective AUM.

($ mill.)	AUM at 10/9/20	YTD Return to 9/30/20	Net Inflows	Inflows % AUM	Price/ B.V.
Energy Select SPDR Fund (XLE)	$ 8,907	-47.6%	$ 3,396	38%	1.02
Vanguard Energy ETF (VDE)	3,100	-48.5%	878	28%	1.10
SPDR Oil & Gas Exploration (XOP)	1,813	-54.5%	734	40%	0.69
iShares Global Energy ETF (IXC)	852	-45.8%	648	76%	0.77
VanEck Vectors Oil Svcs ETF (OIH)	401	-63.1%	40	10%	0.56
	$ 15,072		$ 5,696	38%	

Source: Company reports, Horizon Kinetics Research

Perhaps it can't be determined whether the investors responsible for that $5.7 billion of inflows are better informed or more expert than the ones who sold the shares of those companies down 50%. We can only know that they are moving differently than the preponderance of investors.

[14] Dept. of the Interior

- There is a presumption that strategic buyers within the same industry have the greatest information advantage, that they are the most informed.
  - Two weeks ago, ConocoPhillips announced it would acquire Concho Resources for $13.3 billion. The result will be the largest so-called independent oil and gas producer in the world.
    - Speaking of shale oil and fracking, the entirety of Concho's reserves is in the Permian Basin, as are those of Texas Pacific Land Trust.
    - The merged company will have access to 23 billion barrels of oil that can be supplied at a cost of less than $30/barrel.
    - ConocoPhillips and Concho have complementary acreage positions in the Permian Basin, which can be value enhancing on many levels.
  - In July of this year, Chevron announced it would acquire Noble Energy for $5 billion. Noble's asset portfolio is far more varied than Concho's, but it does have 92,000 acres in the Permian Basin that are adjacent to or contiguous with Chevron's.

It could be that these acquisitions turn out to be ill-informed. However, it is not unusual in any industry going through a severe downturn that the best capitalized and most profitable companies acquire competitors, and at prices that can only be that favorable during such periods. In the energy industry it's known as buying reserves on the stock exchange. Ultimately, reserves and production concentrate in the best companies, and those companies, with the flexibility afforded by diverse portfolios, can focus development on the lowest-cost, most productive reservoirs.

Daniel Yergin, founder of the energy research consultancy Cambridge Energy Associates, and author of the Pulitzer Prize -winning: *The Prize: The Epic Quest for Oil, Money and Power,* commented recently on the ConocoPhillips transaction: "If you're hunkering down for the long term, you want to hunker down in the Permian." His new book, *The New Map: Energy, Climate, and the Clash of Nations,* was published last month.

Texas Pacific Land Trust

There's not much we haven't written about TPL in the past, exhaustingly, no doubt, if not exhaustively. Paradoxically, there is far less to say about it than about 99% of the companies in existence, save for other royalty companies, because it is, well, a royalty company. Therefore, other than to briefly frame the business model, which is the essence of its extraordinary value, this portion will be only be comments about recent results and valuation.

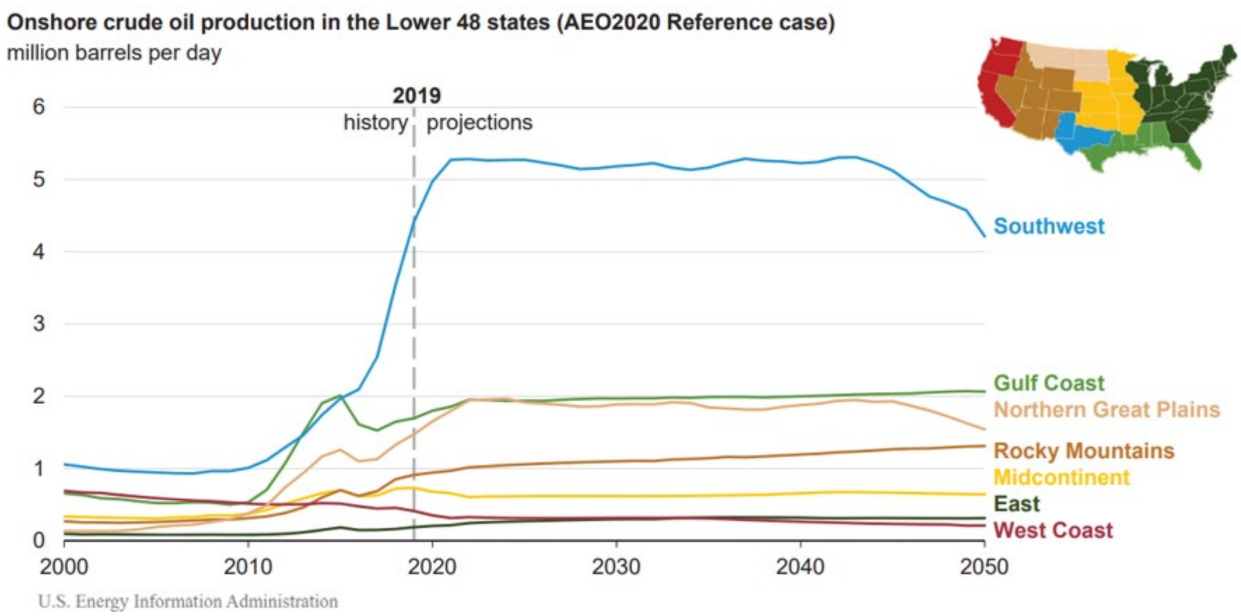
Because TPL is a royalty company, other than the portion of its water operations involved in recycling, it is essentially a pass-through vehicle for:

- Royalties on the oil and gas output of other companies that take it upon themselves to commit billions of dollars of capital, take great operating risks, and are operationally intensive.
- Lease revenues on its 900,000 surface acres that are interspersed throughout portions of the Permian Basin, most importantly the Delaware Trend within the Permian. These form a blocking position for operating companies that pay multi-year fees to cross or otherwise use TPL's land.
- Revenues from the sale of the non-potable water to which TPL's surface acreage grants it rights.

The company's royalty and land positions in the Delaware Trend are legitimately described as crown jewel properties in the crown jewel of the U.S. energy reserves.

– TPL requires no capital and has no debt, because it does not need to acquire land or more royalty interests, these having been granted to it over 130 years ago.
– These pass-through activities incur negligible operating expense, since they require perhaps a couple of dozen personnel for the $490 million of revenue they generate.
– Only a very small fraction of the royalty land has ever been drilled on. Plus, within that small fraction, most of it was done with old technology, so probably only a small fraction of those particular reserves has been extracted. It is a resource that should be productive for many, many decades.

In the EIA's own projections of U.S. oil production over the next 20 and 30 years, it is the Southwest, which primarily means the Permian Basin (the blue line in the graph below), that remains the dominant source.



For all these structural reasons:

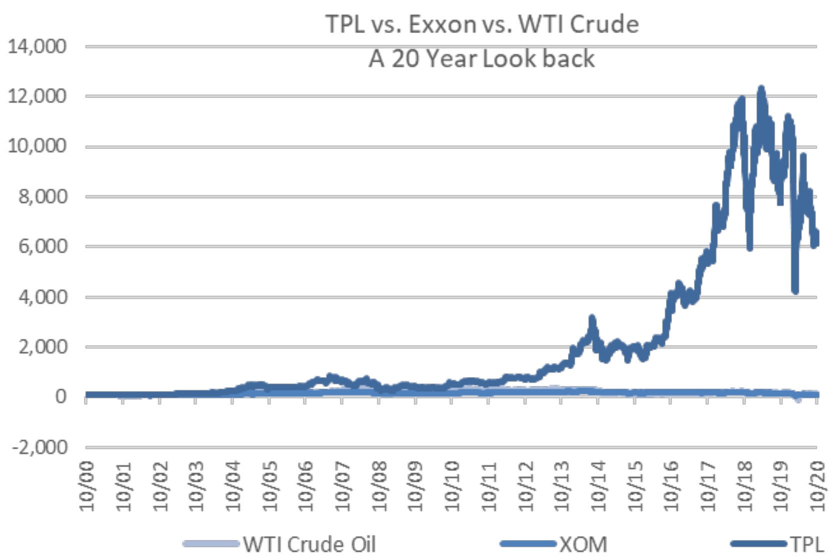
– TPL's free cash flow margins exceed those of the most profitable S&P 500 company.
– It is the single highest quality, highest profitability asset that it is possible to identify in energy – we, at least, have located no other – and therefore a singularly

	Market Cap, $ billion (10/27/20)	2019 Revenue ($ billion)	FCF Margin
Texas Pacific Land Trust	$3.59	$0.490	70%
Alphabet	$1,089.42	$161.857	19%
Visa	$418.70	$22.977	52%
Johnson & Johnson	$376.85	$82.059	24%
Microsoft*	$1,612.28	$143.015	32%

Source: Company reports, Bloomberg

important inflation hedge that can pay off mightily at a contingent moment that might be greatly damaging to most other equity valuations.

– Like any insurance, the cost of not having it, should the need arise, could be extreme. One wants to have *some* insurance. Yet, the business model does not require an inflationary oil environment in order to provide a superior financial return, as will be reviewed below.



Source: Bloomberg

On the business value side, TPL is actually doing remarkably well, which is an expression of its royalty business model and unique mineral rights position. The following are some relevant figures from the June quarter earnings statements. They will be out of date in several days, when TPL announces its third quarter results. Whatever the quarterly results might be, and as all of the preceding discussion to this point should make clear, near-term changes in oil production or prices – the short-term changes that draw short-term attention – are irrelevant or, worse, misleading relative to the long-term case and intrinsic value.

As a basis of comparison, I'll use ConocoPhillips, which is the 3rd largest U.S. oil company behind ExxonMobil and Chevron. I use Conoco, because roughly one-half of the Exxon and Chevron businesses are chemicals and refining, although their results would look surprisingly similar to Conoco's.

– West Texas Intermediate oil is down over 25% from its average 2019 price
– Conoco's 1st Half 2020 revenue was down 48% vs. H1 2019
– Pre-tax loss (excluding gains, impairments and non-operating losses): $(632) million vs. $3,774 million income in the 2019 period.

That is what is going on even among the largest, best-capitalized energy companies.
As for TPL's 1st six months of 2020, excluding land sales:
– Operating revenues were down 12%
– Operating income: $103.6 million vs. $129.2 million

As to TPL's production-level experience in the 1st half, vs. 2019:

- Oil revenue was down only 11%, because underlying production volume was up 10.9%
- Gas revenue was down only 24% (gas price was down 34%), because production volume rose 30.1%

For TPL's June quarter, vs Q2 2019:

- Oil revenue down 49.3%. The average realized price was down 54.0%, while production volume rose 10.6%
- TPL's Q2 pre-tax operating margin: 63% vs. 70%
- Cash: $258 million; total liabilities $80 million

As of June 30th, the Trust's share of production volumes, in barrels of oil equivalent per day, was 15.7 thousand vs. 13.7 thousand at 12/31/19. Because of the increased drilling volumes on properties where TPL has mineral rights, what would its revenues look like on a run-rate basis?

- At 15,700 boe/day and recent $41 average spot pricing for oil (equating, by our estimate, $30/net barrel to TPL based on its mix of oil/gas/natural gas liquids), its royalty revenue is $180 million/year, separate from its other revenue sources. Calendar 2019 oil revenue was $155 million
- For a modest sense of earnings sensitivity, the same June 30th production level, but using $55 avg oil price ($40 net to TPL), revenue would be $230 million of annual royalty revenues ($30/share), which would be 50% higher than last year.

Other Valuation Observations

- Drilled-Uncompleted-Wells

  Among other aspects of TPL's valuation that are not known in the general public realm (TPL itself being virtually invisible to the public) are drilled-but-uncompleted wells (DUCs) in which the Trust has a royalty interest. These are wells for which substantially most/all of the drilling and expenditure has been done, but for which the operator (say, Chevron or Apache) has temporarily delayed completion. In the past, this might have been in response to limited pipeline takeaway capacity, or perhaps undesirable near-term oil/gas pricing. It's a timing issue. However, these DUCs require limited expense to complete, and in some cases, the well can be forfeit under lease terms if not completed by a certain expiration date. DUCs numbered 583 at 6/30/20.

  - The DUCs, therefore, have a sort of inventory value for TPL. Viewed that way, by very rough estimation, that could be worth $1.8 billion of future 'inventory' revenue to the Trust. TPL has a market cap of $3.5 billion. The calculation, for whatever weight one gives it, is as follows, with the assumptions included:

    583 DUCs x 1.250 million boe/well x $40 net barrel pricing x 1/16th avg. royalty = $1.8 billion

– <u>Concho Resources Valuation</u>
  We've been asked about the $13 billion enterprise value that ConocoPhillips paid for Concho earlier this month and what that implies for the TPL valuation. A direct comparison cannot be made, at least not with any valid accuracy:
  - First, there is the stark difference we've been discussing between a royalty business model and a capital-intensive operating company – they are opposite sides of the moon. The return on sales or capital of a developer is a small fraction of that of a royalty company, and the business risk is exceedingly greater. Accordingly, the price paid per equivalent acre for an operating company would be far lower than for TPL's royalty acres.
  - Second, not all acreage is equal. The Concho acreage lacks surface or water rights, which figure very large in TPL's revenue and business value.
  - Also, much of Concho's Delaware Basin acreage is in New Mexico. That acreage is at risk of federal political policy (federal land) and has higher operating expenses (N.M. permits less infrastructure).

  Nevertheless, with that prior proviso, which should dominate the degree of credibility one attaches to these figures, here is a very generalized assessment:
  - The $13 billion, for 550,000 net acres (on 800,000 gross acres) comes to $24,000 per net acre.
  - In recent years, transaction prices for royalty acreage has been roughly 5x that of 'operating acres'.
  - One still has to differentiate, for each company, between those positions that are in prime locations that are now being operated and producing cash flow today, and those that are less well situated and which might not be operated for many years and which will require large capital investments.
  - Not to ignore the obvious, but this pricing occurs during the deepest energy sector crisis on record.
  - Making the various detailed and abstruse adjustments that our analyst does, and figured off the Concho acquisition price, we believe the TPL mineral rights alone, separate from the land and water earnings, far exceed the company's entire market value.

– <u>A Final Word or Two</u>
  - All of the TPL discussion takes place in an environment in which the price of oil has declined by 16% in the past 3 years, and 28% in the past 5 years, yet the company's oil and gas royalties in 2019, 2018, and 2017 were, respectively, $155 million, $124 million, $58 million. And, as calculated above, even at the current severely depressed oil price of $41, the run-rate production level is $180 million. The share price is up 45% in those 3 years and 255% in the 5 years.

    One must wonder why you would ever bother with the complexities of a conventional oil company.

    One must wonder what the result would be if oil were $100/barrel again, or $200, which it hasn't been.

  - Exxon Mobil has a reserve life of 17 years. Its trades at 0.745x book value. That is a quantitative measure of investors judging (knowingly or not) that only 74.5% of the Exxon Mobil reserves will be consumed, so that the reserves will be produced for only 12.7 years (17 years x .745). Applying the same calculation to Chevron, which has a 10-year reserve life and trades at 0.983x book value, the expectation is that it will stop producing in just under 10 years. Using these two largest U.S.

energy companies as benchmarks, the share prices seem to discount the near total elimination of fossil fuel usage in 10 to 12 years.

If one judges, based on this review, that this will not be the case, that is to understand, hopefully, what is meant by 'extreme dislocation' and colorful phrases like 'once in a lifetime opportunity.'

Cryptocurrency

Not so long ago, we said that for Bitcoin (and fixed-issuance cryptocurrency in general) to gain broad acceptance, one first required the entry and acceptance of some institution of sufficient reputational and brand value – call it gravitas – that others would follow. That has happened, and acceptance among institutions of this class has been expanding geometrically. While barriers to its adoption remain, the pace of the progress toward meeting the infrastructure and other requirements is only accelerating. Below is a handful of recent, noteworthy developments from just the last several weeks.

- On October 21st, PayPal announced the launch of a service allowing clients to buy, hold, and sell cryptocurrency in their PayPal account. The company also noted that, beginning in early 2021, it will allow customers to use their cryptocurrency holdings to fund purchases[15].
- In August, Fidelity announced the launch of its first Bitcoin Fund, Wise Origin Bitcoin Index Fund I through a new business unit: Fidelity Digital Funds[16]. It will be custodied at Fidelity Digital Assets, which was established in October 2018.
- On October 9, 2020, the Bank for International Settlements (BIS), along with seven central banks[17], published a central bank digital currency (CBDC) report[18] outlining what they view as the feasibility and required features for a CBDC to help central banks accomplish their public policy objectives. The report does not provide an opinion on whether such currencies should be issued, but lays the groundwork for the future development of such currencies, which it indicated would coexist with cash and other types of money. The core features identified in report, which would be required of any CBDC system are:
    - *Resilient and secure to maintain operational integrity*
    - *Convenient and available at very low or no cost to end users*
    - *Underpinned by appropriate standards and a clear legal framework*
    - *Have an appropriate role for the private sector, as well as promoting competition and innovation*[19]

The continued development and eventual launch of such CBDCs would surely remove any questions about the legitimacy of cryptocurrency. To do so, the central banks would need to address core features listed

[15] https://newsroom.paypal-corp.com/2020-10-21-PayPal-Launches-New-Service-Enabling-Users-to-Buy-Hold-and-Sell-Cryptocurrency
[16] https://www.bloomberg.com/news/articles/2020-08-26/fidelity-launches-inaugural-bitcoin-fund-for-wealthy-investors
[17] Bank of Canada, the Bank of England, the Bank of Japan, the European Central Bank, the Federal Reserve, Sveriges Riksbank, and the Swiss National Bank
[18] https://www.bis.org/publ/othp33.htm
[19] https://www.bis.org/press/p201009.htm

above, which represent some of the current barriers to broader acceptance of cryptocurrencies. They seem to be doing that.

If people have, by default, a FedDollars app or wallet on their phones, how much different or exotic would it be to have a Bitcoin wallet?

If people wonder whether a FedDollar wallet is a prelude to the elimination of cash and to the inability to save, store or transact money outside of the banking system and Fed oversight, particularly at a time of rising currency debasement via rapid money creation, how might they judge the FedDollar wallet versus a Bitcoin wallet?

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