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ENERGY INVESTMENT BANKING

MUSINGS FROM THE OIL PATCH

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

Summary:

The Rhyme Of Oil History Should Be Heard And Studied – Part 4

We focus on how the world's oil market changed in the 1970s and 1980s due to high oil prices and disruptive supply events. These conditions spawned new supplies and choked off oil demand leading to a global oil glut. The glut caused oil markets to become unbalanced, forcing Saudi Arabia to end one era and start the next by crashing oil prices. We examine events that created this history and if it is being repeated today.

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Is There Trouble In The "Climate Emergency" World?

The climate emergency movement wants to decarbonize the world ASAP, which means electrifying the world's economies. For transportation, it means electric vehicles are our future. The problem is that for China and the U.S., the world's largest EV markets, sales are falling, with the prospect this trend will continue into 2020.

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More Onshore Wind To Help The World With Clean Energy

A new study claims wind's stilling (calming) across the mainland of North America, Europe and Asia has ended. If the currently observed increase in wind speeds continues, it is likely there will be a significant increase in wind power, helping the renewable energy market. However, it may only be cyclical with a finite future.

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The Rhyme Of Oil History Should Be Heard And Studied – Part 4

Saudi's 2014 Thanksgiving Day action was a repeat from its 1980s' playbook

When Saudi Arabia pulled the plug on supporting OPEC's oil price in late November 2014, the oil world was shocked. The most shocked were people counting on OPEC to act to stop the oil price slide from its June 2014 peak of over $100 a barrel to merely $80 by November. Anyone who anticipated Saudi Arabia shifting from defending oil prices to seeking to regain lost market share was either lucky or had a "gut" feel that history might repeat. Saudi's 2014 Thanksgiving Day action was a repeat from its 1980s' playbook. Then too, the kingdom had lost market share and income by playing the swing supplier role, while fellow organization members over-pumped their agreed-to-quotas to capture additional income.

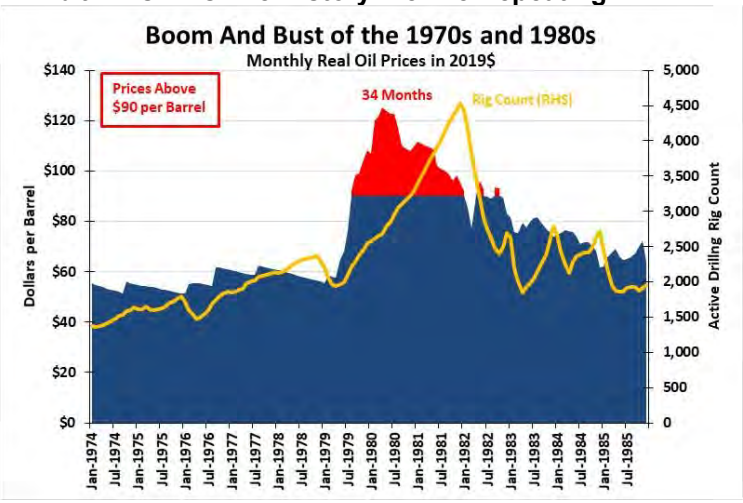
What took years to accomplish in the early 1980s was done in months in 2014

The primary difference between 2014 and the 1980s was the speed with which Saudi Arabia shifted from agonizing about a growing oil glut to abruptly abandoning its role of supporting unrealistic oil prices. What took years to accomplish in the early 1980s was done in months in 2014. The question is whether the time necessary for the oil industry to correct and re-establish a healthier trajectory this time will be less than the years it took in the 1980s and 1990s? The jury is still out on this question.

The U.S. oil price peaked in July 1980 at $39.50 per barrel

The U.S. oil price peaked in July 1980 at $39.50 per barrel. (In 2019 dollars, the price was $122.59.) While the price decline from that point forward was slow, the physical oil market had already shown signs of supply outstripping demand. As we highlighted in Part 3 of this series, the opening of the North Sea in the early 1970s and the high oil prices of that decade resulted in new and greater oil supplies arriving from non-OPEC sources. In the 1980s, "glut" had yet to become part of the industry's vocabulary, but it soon would.

Exhibit 1. Is This The History We Are Repeating?



Source: *WSJ*, EIA, PPHB

Oil service stocks had climbed 86% in price in 1980, but they were experiencing setbacks in the early months of 1981

The oil world was changing in 1981. A "Heard on the Street" column in *The Wall Street Journal* in February 1981 set forth the emerging divergence in the financial community's outlook for oil, and in particular, the outlook for oilfield service companies. As the column pointed out, oil service stocks had climbed 86% in price in 1980, but they were experiencing setbacks in the early months of 1981. According to Elizabeth Peak, oil service analyst at Wertheim & Co., the downturn in stock prices was "a reaction to increasing uncertainty about crude oil prices and caution toward the market in general. It represents a good buying opportunity." On the other side was Kenneth Miller of Smith Barney, Harris Upham & Co., who suggested that "the bull market in energy stocks has ended temporarily." He suggested these stocks might experience a "more erratic" trading pattern for the next few years.

Both analysts viewed the near-term fundamental outlook for the industry favorably. The difference in outlooks related to the intermediate term. While Ms. Peak thought that "instead of a slowdown in 1982, most industry observers currently expect that a pause in the uptrend could be postponed until 1983 or 1984." Mr. Miller said he was having a hard time making a convincing case for any material increase in "real" oil prices for the next several years. As a result, he expected "the oil industry's profit and cash-flow growth will slow down significantly. In turn, growth in oil industry capital and exploration spending also will slow significantly." That slowdown would impact oilfield activity at a time when the industry was rapidly adding capacity.

"We expect the service industries' profit growth to be around 25% a year into 1985, and many companies should grow at 30% a year"

Ms. Peak had embraced the optimism of the early 1980s espoused by Baker International's E.H. (Hubie) Clark in his August 1980 speech to the IADC/PESA Marketing Conference when he talked about why growth rates for oil service activity for 1980-1984 would be much higher than in the 1970s. Ms. Peak told the *WSJ* reporter that she expected well completions and footage drilled, that had grown at a compounded annual rate of 6.5% in the 1970s, would grow at least at 8% to 9% per year in the 1980s. The optimistic outlook fed into her projection that "We expect the service industries' profit growth to be around 25% a year into 1985, and many companies should grow at 30% a year."

In The President's Report in the July 1981 "ODECO Soundings," the employee newsletter for the offshore driller and explorer Ocean Drilling & Exploration Company, Hugh Kelly wrote:

> "The big event not in our crystal ball was the 'glut of oil', which has had an immediate impact on the stock market where energy stocks, including ours, have had a precipitous nose dive. This conclusion by the financial community is extreme because fundamental to that reaction is that oil and gas which is now plentiful will remain so way out into the future. Most thoughtful people do not believe this but there

are important lessons to be learned or, better, to be remembered. Oil prices had reached ridiculously high levels and the correction was inevitable."

By the end of 1981, Darnell Peacock, editor and publisher of *The Land Rig Newsletter,* wrote about indicators of a softening market. These included:

- "A sudden rash of rig order cancellations, becoming noticeable last month and continuing into December.
- "Soft spots in rig demand continue to show up in various geographical drilling areas.
- "Prepayments to drilling contractors from operators during the fourth quarter '81 have been virtually nil.
- "Seismic activity, typically a barometer of what's ahead for drilling, is down for the first time in 30 months, dropping three active crews in October from September and eight in November from October."

These developments did not signal a dramatic drilling downturn, but rather "a significant dip in the cyclical contract drilling business"

Mr. Peacock said that these developments did not signal a dramatic drilling downturn, but rather "a significant dip in the cyclical contract drilling business." He did suggest that market changes were prompting new business plans as established contractors were looking to buy slightly used rigs or acquiring companies. He also suggested that some enterprising people involved in rig management were going out on their own seeking rig management contracts from new entrant firms with minimal experience. He pointed out that rig rates, especially for shallow drilling rigs, were softening. In Oklahoma, the more competitive shallow rig market was leading producers to request a change in rig pricing from day rates to footage rates. In reality, an experienced driller in a basin often could earn more when pricing by footage-drilled than on a day rate basis. On the other hand, National Supply, a builder, servicer and repairer of rigs, forecasted that rig growth would eventually level off, but it saw a relatively stable rig population throughout the 1980's of well over 4,000 rigs, and "possibly 5,000, 6,000 or even 7,000 domestic rigs."

The economic shock of oil prices jumping from $3.67 per barrel in 1972 to $34.33 by 1981 was significant

The slowdown in oilfield activity was due to oil supply and demand dynamics being impacted by an extended period of very high oil prices. U.S. oil companies were embroiled in working with oil price controls that kept prices below global market levels, which were designed to shelter families from the full effect of the recent leap in oil prices. However, the economic shock of oil prices jumping from $3.67 per barrel in 1972 to $34.33 by 1981 was significant. The nearly tenfold oil price increase took a toll on consumer budgets because oil powered the nation's transportation system, a significant

Homeowners were rushing to add insulation to their houses to cut down on heating bills, and motorists clamored for more fuel-efficient vehicles

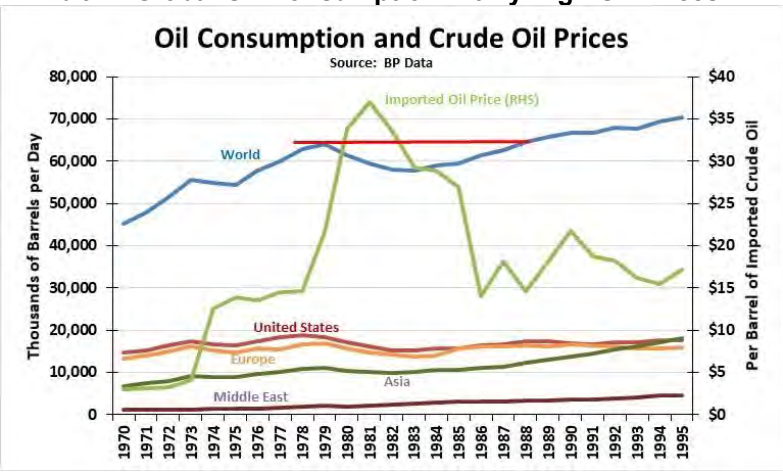
component of electric generating capacity, especially in the populous Northeast, Middle Atlantic and Midwest regions of the country, as well as home heating in those regions. While businesses and industries were working to adjust their fuel consumption, homeowners were rushing to add insulation to their houses to cut down on heating bills, and motorists clamored for more fuel-efficient vehicles. Utilities were also forced to readjust their fuel choices given the sharp rise in oil prices. The problem was that every one of these demand adjustments took time to implement – some much longer than others. Eventually they impacted the oil market, not only in the United States, but globally.

Exhibit 2 shows oil consumption for the world and select geographic regions versus crude oil prices from 1970 to 1995. We elected to use the cost of imported oil into the U.S. as representative of international oil prices. What we see is that world oil consumption rose from 1970 until 1973, when it fell. That decline was a function of both the Arab oil embargo that cut supplies to the United States and several other countries that supported Israel in the Yom Kippur War, and the recession created by the jump in oil prices from roughly $3 per barrel to $12.

It wasn't until 1988, some nine years later, that world oil use exceeded the volume consumed in 1979

The world recovered from the 1974 recession such that oil consumption was rising again in 1975, which continued until the Iranian revolution in 1979. The loss of Iran's production from the oil market for a brief period of time led to a doubling of global oil prices. The decline in oil consumption that began in 1979 bottomed in 1982-1983 and started to recover. As we have marked with the red horizontal line, it wasn't until 1988, some nine years later, that world oil use exceeded the volume consumed in 1979.

Exhibit 2. Global Oil Consumption Hit By High Oil Prices



Source: BP, EIA, PPHB

We have also shown oil consumption for the United States and three geographical regions: Europe, Asia and the Middle East. It is

Everyone felt the demand impact following the 1979 oil price jump

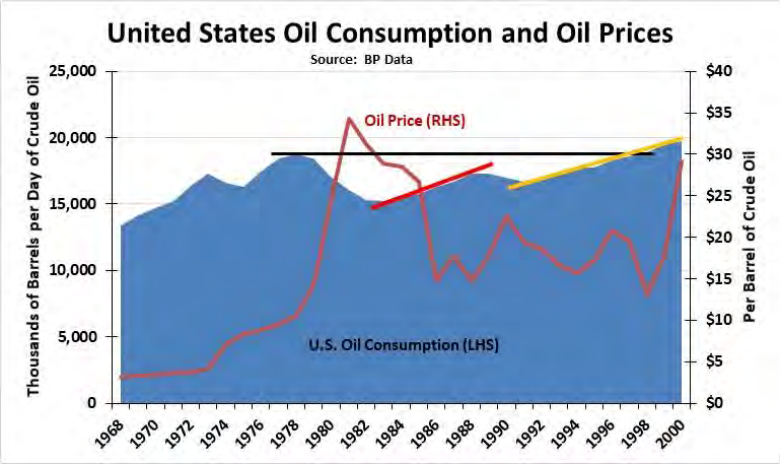
interesting to note that not all these regions showed a meaningful impact from the 1973 demand slump. However, everyone felt the demand impact following the 1979 oil price jump, although to differing degrees. The more developed economies – the U.S. and Europe – suffered much more noticeable consumption declines after 1979, than did the Middle East and rapidly growing Asia.

A closer look at U.S. oil consumption shows the sharp consumption drop in 1973-1974, but a very sharp recovery thereafter. The U.S. consumption peak occurred in 1978, a year ahead of the world's peak. What is surprising is that between 1968 and 1973, the domestic oil price only rose from $3.21 per barrel to $4.17. The following year, 1974, the oil price averaged $7.18, and it climbed further in 1975 to $8.39. Despite rising oil prices, the U.S. economy and homeowners began to adjust to higher energy costs and oil consumption grew until it reached a plateau during 1977-1979.

The "kiss of death" for oil use came when oil prices jumped from $10.61 a barrel in 1978 to $34.33 in 1981

The "kiss of death" for oil use came when oil prices jumped from $10.61 a barrel in 1978 to $34.33 in 1981. By then, U.S. oil consumption was falling as the accompanying recession reduced use, and efficiency gains in energy use began to have a greater impact on the economy. Cars went from averaging single-digit miles per gallon to mid-teens mileage. The impact of home improvements – increased insulation, better weather-stripping to seal off leaks, and more energy-efficient furnaces and appliances – decreased oil consumption. Manufacturers also worked to reduce their energy use, including figuring out ways to utilize waste heat from machines and other production processes. Utilities shifted oil burning electricity generators to coal and natural gas, in order to minimize the impact of escalating oil prices. Nuclear power was becoming a new source of electricity that eliminated oil and other fossil fuel-powered generators entirely. Importantly, people generally became more aware of their energy use.

Exhibit 3. U.S. Oil Use Needed Years To Recover



Source: BP, EIA, PPHB

It was 20 years between the first peak in U.S. oil consumption in 1978 at 18.756 million barrels per day (mmb/d), and 1998 when the U.S. surpassed that peak and consumed 18.917 mmb/d

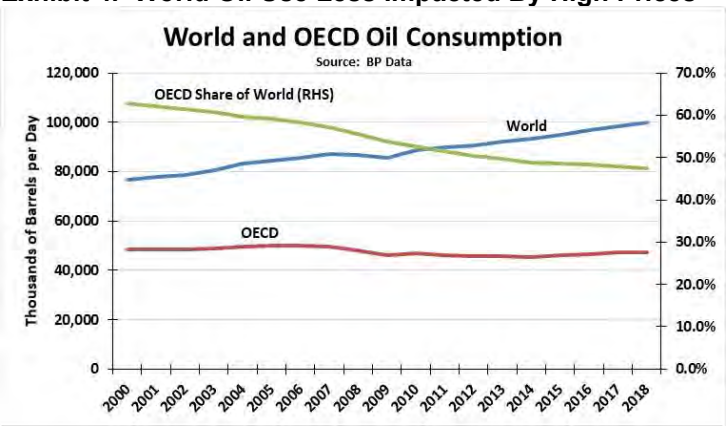
The U.S. oil consumption decline and recovery showed a markedly different pattern than that of the world. From 1978 to 1983, U.S. oil consumption declined. It rose slightly in 1984 but was flat in 1985, before staging a recovery that extended through 1989. In 1990 and 1991, oil use fell, but began to recover in 1992. As we show in Exhibit 3 (prior page), the slope of the recovery in oil consumption for those two periods was different, with the earlier one showing a faster pace than in the latter recovery. The key point is that it was 20 years between the first peak in U.S. oil consumption in 1978 at 18.756 million barrels per day (mmb/d), and 1998 when the U.S. surpassed that peak and consumed 18.917 mmb/d.

As we attempt to answer the question about how the current industry downturn compares to the one experienced in the 1980s, a critical issue is understanding the macro conditions impacting the oil market. In previous exhibits, we have shown how the jump in oil prices in 1973 and then again in 1979 contributed to a decline in oil use both globally and in the United States. What has happened to oil consumption in more recent years given high oil prices?

Since the peak in OECD oil consumption in 2005, these economies in 2018 collectively used 5.2% less crude oil

Exhibit 4 shows how world oil consumption has grown during 2000-2018, but oil use in the developed economies of the world, represented by those countries who are members of the Organization of Economic Co-operation and Development (OECD), has declined. Since the peak in OECD oil consumption in 2005, these economies in 2018 collectively used 5.2% less crude oil. At the same time, world oil consumption increased by 18.0%. These figures demonstrate how the global oil market has changed. Its growth is being driven by the emerging and developing economies of the world. We can see this clearly in the fact that in 2018, the OECD accounted for only 47.5% of total world oil consumption. Its share has declined steadily since 2000. In reality, the decline has occurred since it peaked in 1969 with OECD countries consuming 75.7% of the world's total oil use.

Exhibit 4. World Oil Use Less Impacted By High Prices

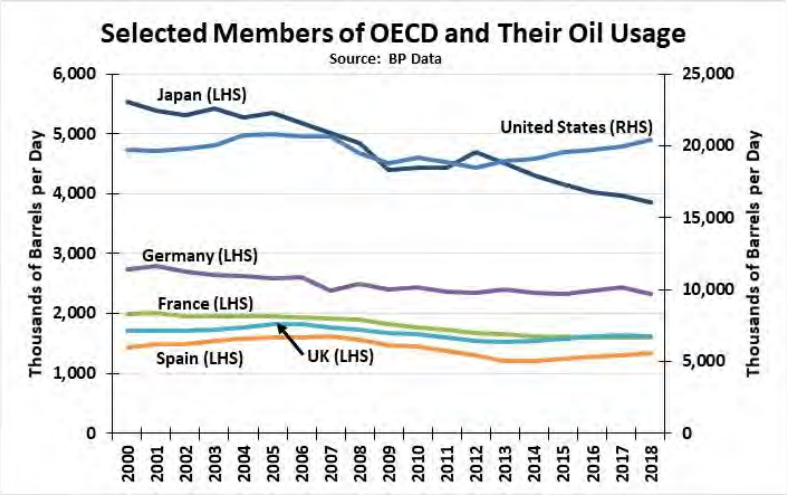


Source: BP, PPHB

The OECD total oil consumption declined 1.7% over this period from 48.311 mmb/d to 47.466 mmb/d

To better appreciate the shifting oil demand situation, we looked at the history of oil usage in a handful of leading OECD nations – the United States, Japan, Germany, France, Spain and the U.K. for 2000-2018. The OECD total oil consumption declined 1.7% over this period from 48.311 mmb/d to 47.466 mmb/d. Of the countries we looked at, the U.S. increased its oil use from 19.701 mmb/d in 2000 to 19.958 in 2018, a gain of 1.3%. All the other OECD nations we examined experienced declines in their oil use, with Japan showing the greatest at -30.5% followed by France at -19.4% and Germany at -15.5%. Both Spain and the U.K. had modest oil consumption declines of -6.2% and -5.5%, respectively. Other than Japan, all the other countries had years with lower oil consumption than in 2018, with most occurring within 2013-2016. Because there was a dispersion of years in which countries reached their most recent low oil usage, we cannot attribute any single economic event as the cause, other than to suggest that each country was ultimately impacted by the extended period of ultra-high oil prices and that it merely took longer in some cases to demonstrate the effects.

Exhibit 5. Where Oil Consumption Is Falling



Source: BP, PPHB

Collectively, these five countries have doubled their oil consumption over the past 18 years, and represent nearly 40% of world oil use

As high oil prices were destroying demand, at least in the developed economies of the world, they seemed to have little impact on most developing country economies. We have put together the oil consumption record for 2000-2018 for five significant developing countries: the two most populous ones, China and India; the leading economy in South America, Brazil; and two major Middle East countries, Iran and Saudi Arabia. Collectively, these five countries have doubled their oil consumption over the past 18 years, and represent nearly 40% of world oil use. These countries did not experience declines in oil consumption during this period, even during the 2008-2009 Financial Crisis and Recession that impacted overall oil use by the rest of the global economy.

We have an industrialized world, in which countries are suffering from the impact of high oil prices on their maturing economies and ageing populations

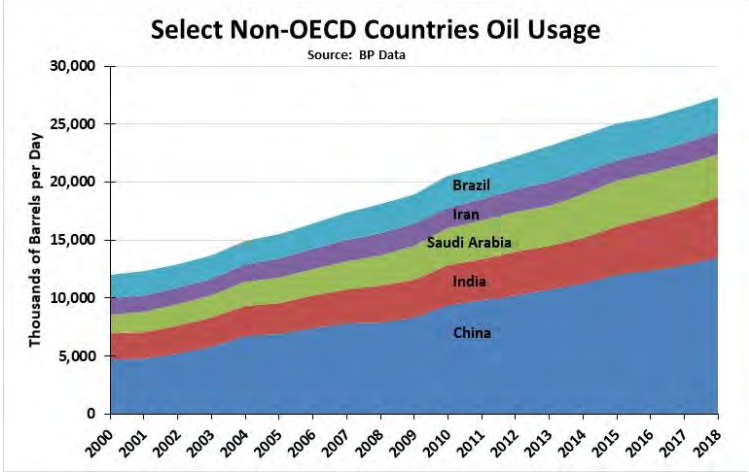
As we assess the oil consumption patterns of countries and the world in total during the 1970s-1990s compared to the 2000-2018 period, we see a distinct difference. World oil use in the earlier period was significantly impacted as a result of the 1979 high oil price. The impact was probably amplified by a delayed reaction to the jump in global oil prices during 1973. The fall in oil use reflected the impact of high oil prices on consumer spending and the forced transformation of economies to become more energy efficient. Today, we do not have such a single oil market dynamic. Instead, we have multiple dynamics. We have an industrialized world, in which countries are suffering from the impact of high oil prices on their maturing economies and ageing populations. These economies are also the current target of the strong anti-fossil fuel policies being enacted by climate emergency-embracing politicians.

On the other hand, we have a number of large, developing economies where increasing gross domestic product and rising living standards are driving increased energy consumption, including oil usage

On the other hand, we have a number of large, developing economies where increasing gross domestic product and rising living standards are driving increased energy consumption, including oil usage, albeit the rate of increase in oil use may be slower due to high oil prices. In some of these countries, fuel prices are subsidized, which further adds to the upward pressure on demand. These are countries where it is possible for government authorities to institute policies to radically alter their development trajectory, as well as countries that face inherent structural issues that can slow and even reverse growth at some point in the future. At the same time, some countries might potentially leapfrog the traditional energy development sequence and embrace an entirely new energy source.

We are not going to predict what will happen to future oil demand, other than to point out we have not experienced such a significant diversion in the forces driving the global oil business. This diversion between the oil demand profiles of the developed versus less-developed economies suggests a significant difference between the

Exhibit 6. Non-OECD Countries Are Growing Their Oil Use



Source: BP, PPHB

past major industry cycle of the 1970s-1990s and the current one. These dynamics may be about to change, however, as governments around the world are moving to reduce fuel subsidies due to their cost, and the public outrage has been dramatic. If governments hold firm on the subsidy reductions, we could begin to see significantly slower growth in oil use in many developing economies. This is something to watch out for.

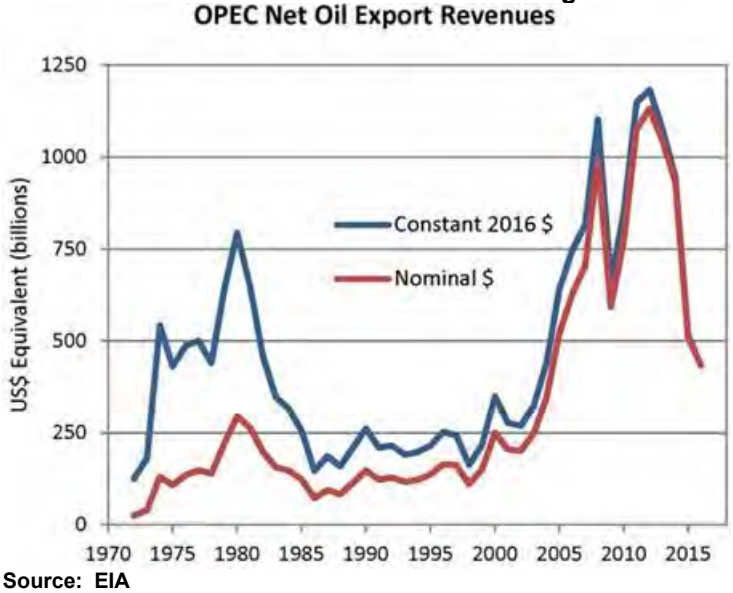
The 1970s and 1980s marked a period when significant new basins were discovered and began pumping substantial volumes of new oil into the market

The flipside of high oil prices and oil demand destruction is high oil prices and new supplies. The 1970s and 1980s marked a period when significant new basins were discovered and began pumping substantial volumes of new oil into the market. That new supply, most of which came outside of the OPEC community of nations, put pressure on OPEC members and ultimately led to the global oil price fall. A few charts help to explain what happened and why.

While world oil production grew by 50% during the interim, OPEC increased its output by only 30%

A 2016 chart from the Energy Information Administration (IEA) shows OPEC's net revenues in both current and constant dollars from 1972 to 2016. It highlights the significance of the high oil prices and the rapid oil consumption growth underway during the 1970s, helped by the 1973 oil price jump and the 1979 one, also. Much like the charts we have produced showing the significance of high oil prices in current dollars on the early years of the industry, the relative impact of the 1970s export revenues compared to recent high oil price years is impressive. It is especially so when one considers that in 1977, OPEC accounted for 30.3 mmb/d out of a world supply of 62.7 mmb/d. In 2016, OPEC's production growth had grown to 39.7 mmb/d, while world output was up to 91.8 mmb/d. While world oil production grew by 50% during the interim, OPEC increased its output by only 30%. In other words, OPEC's share of

Exhibit 7. OPEC Benefited In 1970s From High Oil Prices



Source: EIA

world supply shrank from roughly 50% to only 43%. But when you are half the world's market and oil prices are soaring, figuring how to sell a few more barrels to earn more income is easy to rationalize. The problem was that many OPEC members decided to cheat on their quotas and Saudi Arabia was forced to cut back its output to help support oil prices.

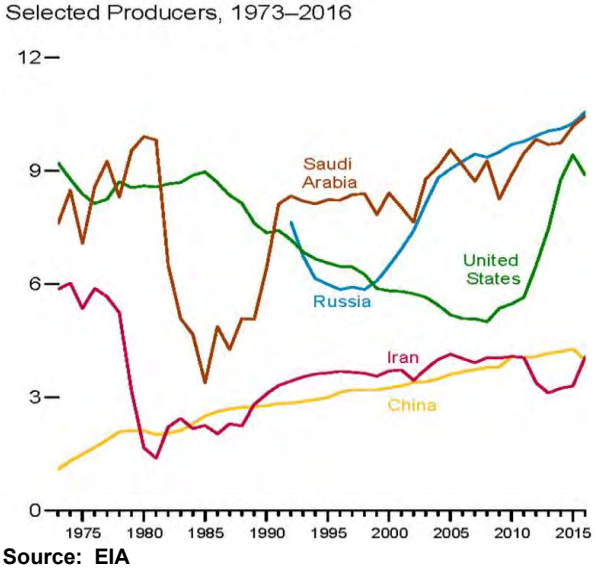
When the Iranian revolution led to the installation of a theocracy and the loss of a substantial share of its oil from the world market, there was a fly-up in oil prices

It should not be forgotten that when the Iranian revolution led to the installation of a theocracy and the loss of a substantial share of its oil from the world market, there was a fly-up in oil prices. Saudi Arabia opened its spigots in response and cushioned the financial pain that was being inflicted on the world's economies. This can be seen in the chart showing select oil producers' production when one examines the relationship between Iran's and Saudi Arabia's output at the end of the 1970s. Following the fall in production during the 1974 global recession, Saudi ramped up its output along with the rest of OPEC to satisfy the growing global need for oil. But it was what happened when Iran's leadership cut production that clearly demonstrated Saudi Arabia's policy of acting as a moderating force in world oil markets.

While Iranian production fell to 1.3 mmb/d in 1981, Saudi Arabia was adding 1.7 mmb/d to world supply to help cushion the loss

In 1977, Iran was producing 5.7 mmb/d, while Saudi was at 8.6 mmb/d. While Iranian production fell to 1.3 mmb/d in 1981, Saudi Arabia was adding 1.7 mmb/d to world supply to help cushion the loss. This was while the rest of OPEC was also adding barrels into the market. With Saudi Arabia producing at a 10.3 mmb/d rate in1981, a production volume supposedly at the nation's maximum capacity, oil prices were spiking. Demand destruction and additional non-OPEC supply blunted the price spike and set the oil business on its downward spiral.

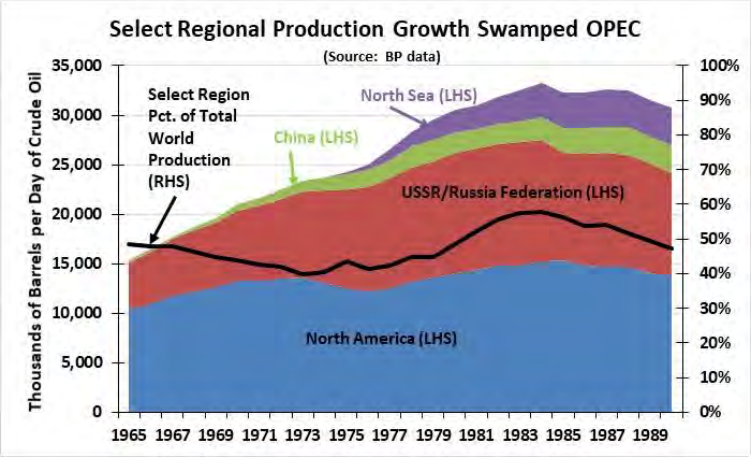
Exhibit 8. Selected Oil Producers History Of Output



Source: EIA

Exhibit 9 shows just how new oil supplies began arriving at the same time oil prices were spiking and Saudi Arabia opened its spigots.

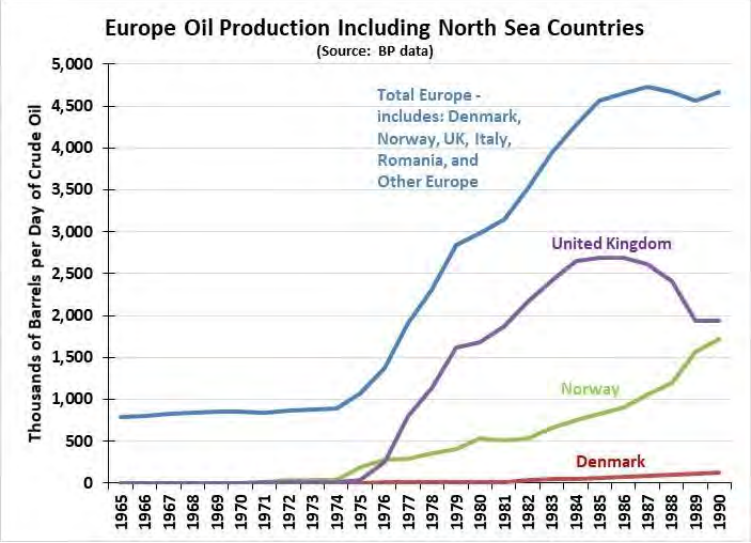
Exhibit 9. Sources Of World Oil Glut In 1980s



Source: BP, PPHB

Here is what was happening in Europe and the North Sea during that time period:

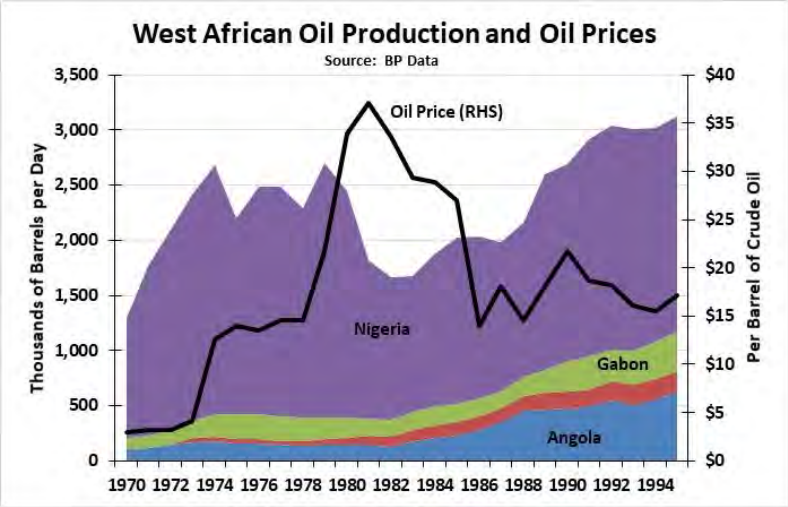
Exhibit 10. North Sea Oil Output Growth Altered Market



Source: BP, PPHB

And West Africa (next page) was chipping in extra oil in the 1970s, setting the stage for the emergence of significant new oil industry players.

Exhibit 11. West Africa Emerged As Major New Oil Supplier



Source: BP, *WSJ*, EIA, PPHB

As we wrap up the oil market overview of the tumultuous end of the 1970s and much of the 1980s, Exhibit 12 (next page) shows global oil production and consumption, oil prices and notable industry events. The production data is split between OPEC and non-OPEC to demonstrate how dramatically the world oil market changed in response to the 1970s' era of ultra-high oil prices.

To show some of the events of this history, we have also tapped into an *NPR Online* oil industry timeline originally published by the Department of Energy's Office of the Strategic Petroleum Reserve, Analysis Division. The full timeline begins in 1970 and ends in 2000, with the 1995-2000 portion provided by the EIA. We have focused on the 1978 to 1988 time period and have selected only those key events dealing with OPEC and oil pricing. This was an era highlighted with not only the overthrow of the Iranian government, but also the Iran-Iraq war. It was also a period when inter-organizational battles erupted within OPEC over the leadership roles of Saudi Arabia and Iran, which was often played up in battles such as whether oil should be priced in U.S. dollars or another currency. It was also a time when huge "petrodollar" flows pressured the global financial system. It was a period with demonstrations of significant excesses ranging from Saudi royal families flying 747 planes to London and Paris for unrestrained shopping trips to religious intolerance and battles waged against the "evil" United States, including the sacking of the U.S. Embassy in Tehran and the capturing and holding of 52 embassy employees as hostages for over a year. That episode led to a U.S. military rescue attempt that ended in a huge failure, including eight American military deaths, and the capture of military equipment and helicopters, and significant embarrassment on the world stage for the U.S. Ultimately, it may have cost President Jimmy Carter his presidency.

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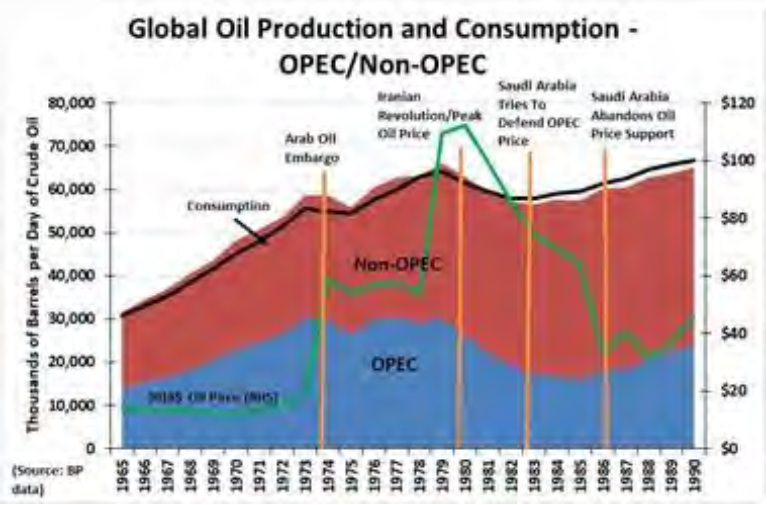
Exhibit 12. Oil Market Events In Difficult 1970s And 1980s



Source: BP, *WSJ*, EIA, PPHB

Despite the intermittent disruptions to Middle East oil supplies and the possibility of the war escalating into a more serious conflict, a serious oil glut emerged and OPEC was forced to deal with a rapidly deflating oil price

In selecting what to include in the timeline, we eliminated most details about U.S. oil pricing and regulatory changes. We also eliminated much of the details about the Iran-Iraq war. Readers should understand that this decade-long timeline had as a constant the backdrop of war, which involved significant destruction, attacks on oil industry infrastructure at times and large numbers of military and civilian deaths. At times, the war threatened to expand to neighboring Middle East countries. Despite the intermittent disruptions to Middle East oil supplies and the possibility of the war escalating into a more serious conflict, a significant oil glut emerged and OPEC was forced to deal with a rapidly deflating oil price. The world's oil market had entered an entirely different phase than any that had existed before. This new era represented a challenge.

Iran and Saudi Arabia block efforts of OPEC price hawks to fix the price of OPEC oil in a currency more stable than the U.S. dollar

1978

Jan - Student protests against government of Reza Pahlavi, Shah of Iran, begin, touching off a wave of political unrest and violent clashes between police and demonstrators. Throughout the year, increasing anti-Shah activities are led by Muslim fundamentalists seeking to establish a Muslim state.

June - Iran and Saudi Arabia block efforts of OPEC price hawks to fix the price of OPEC oil in a currency more stable than the U.S. dollar. Say world economy cannot support associated price increases. Are accused by hawks of being U.S. agents.

Sept - Shah puts Iran under military rule. Muslim leader Noori arrested in crackdown of opposition groups.

Oct - Iranian strikes; departure of foreign technicians.

Nov - Iranian oil production starts dropping.

Dec - Iranian production hits 1.5 mmb/d in mid-December; 500,000 on December 27, a 27-year low. OPEC production rises 1.6 mmb/d over two months due to increased Saudi production.

Dec 17 - OPEC decides on a 14.5 percent price increase for 1979, to be implemented quarterly.

1979

Jan 16 - Shah leaves Iran on vacation, never to return. Bakhtiar government established by the Shah to preside until unrest subsides.

Jan 20 - Saudi Arabia announces drastic cut in first-quarter production. 9.5 mmb/d ceiling imposed. Although actual cuts never reach announced levels, spot prices of Middle East light crudes rise 36 percent.

OPEC makes full 14.5 percent price increase for 1979 effective on April 1

Jan 20 - One million Iranians march in Tehran in a show of support for the exiled Ayatollah Komeini, fundamental Muslim leader.

Feb 12 - Bakhtiar resigns as prime minister of Iran after losing support of the military.

Mar 5 - Iran resumes petroleum exports.

Spring - Gasoline shortage/world oil glut.

Mar 26 - OPEC makes full 14.5 percent price increase for 1979 effective on April 1. Marker crude raised to $14.56 per barrel.

May - DOE announces $5 per barrel entitlement to importers of heating oil. Saudi Arabia announces intention to increase direct sales and to sell less through Aramco. Both announcements send prices higher.

Jun 1 - Phased oil price decontrol begins. Involves gradual 28 month increase of "old" oil price ceilings, and slower rate of increase of "new" oil price ceilings.

Jun 26-28 - OPEC raises prices average of 15 percent, effective July 1.

Oct - Canada eliminates light crude oil exports to U.S. refiners, except for those exports required by operational constraints of pipelines.

Nov 4 - Iran takes western hostages.

Nov 12 - Carter orders cessation of Iranian imports to U.S.

Nov 15 - Iran cancels all contracts with U.S. oil companies.

Dec 13 - Saudi Arabia raises marker crude price to $24 per barrel.

1980

Saudi Light raised to $28.00 per barrel, retroactive to April 1

Mar 1 - Windfall Profits Tax enacted.

May - Saudi Light raised to $28.00 per barrel, retroactive to April 1.

Sep 23 - Iraq invades Iran. Mutual bombing of installations.

Dec - Collapse of OPEC's pricing structure. Saudis use $32 per barrel marker, others use $36 per barrel benchmark.

1981

Saudis flood market with inexpensive oil in 1981

Saudis flood market with inexpensive oil in 1981, forcing unprecedented price cuts by OPEC members. In October, all 13 OPEC members align on a compromise $32 per barrel benchmark. Later, benchmark price is maintained, but differentials are adjusted.

Jan 28 - President Reagan lifts remaining domestic petroleum price and allocation controls originally scheduled to expire in September 1981.

OPEC reaches an agreement to unify crude price at $32 per barrel through 1982

Apr - After meetings in Baghdad and Teheran, attempts by nine Islamic Conference leaders to mediate peace between Iraq and Iran fail.
Aug - Windfall profits tax reduced.
Oct - OPEC reaches an agreement to unify crude price at $32 per barrel through 1982 and sets an ultimate price ceiling of $38 per barrel.

1982
Indications of a world oil glut lead to a rapid decline in world oil prices early in 1982. OPEC appears to lose control over world oil prices.
Jun 10 - Iraq declares unilateral cease-fire.
Jul 13 - Iran launches first attack into Iraq.

Oil glut takes hold

1983
Oil glut takes hold. Demand falls as a result of conservation, use of other fuels and recession. OPEC agrees to limit overall output to 17.5 mmb/d. OPEC agrees to individual output quotas and cuts prices by $5 to $29 per barrel.

Norway and Britain cut prices in response to falling spot market

1984
Mar 27 - Beginning of "tanker war." Over the next nine months, 44 ships, including Iranian, Iraqi, Saudi Arabian and Kuwaiti tankers, are attacked by Iraqi or Iranian warplanes or damaged by mines.
Oct - Norway and Britain cut prices in response to falling spot market. Nigeria follows, renewing pressure on OPEC price cuts.
Oct 17 - OPEC cuts production to 16 mmb/d, but agreement is negated by cheating and price-discounting.

OPEC output falls to 20-year low of 13.7 MMB/D

Saudi Arabia links prices to spot market

1985
Jan - Nine OPEC members adjust prices to cut gap between light and heavy crudes from $4 to $2.40 per barrel. Saudi light price cut one dollar to $28 per barrel.
Jun - OPEC output falls to 20-year low of 13.7 mmb/d.
Jul - OPEC loses customers to cheaper North Sea oil. More OPEC price cuts.
Aug - Saudi Arabia links prices to spot market. Output rises from 2 MMB/D in August to 5 mmb/d in early 1986.
Aug 15 - Dec - OPEC output hits 18 mmb/d boosting a glut and triggering a price war.

Average world oil prices fall by over 50 percent in 1986

1986
Average world oil prices fall by over 50 percent in 1986. There is wide use of netback pricing in 1986.
Feb 3-4 - OPEC fails to agree upon a production accord after a two-day meeting in Vienna.
Jun - OPEC production-cut talks fail, ending in a tentative majority pact on an average 1986 ceiling of 17.6 mmb/d.
Jul - Brent price dips under $9 per barrel. OPEC production rises to 20 mmb/d.

Aug 4 - Reports of probable OPEC agreement on output quotas sends oil prices higher.
Dec 19 - OPEC reaches an accord that would cut production by seven percent for the first six months of 1987 (from 17 mmb/d to 16 mmb/d) and would raise prices immediately toward a target world oil price of $18 per barrel.

OPEC price accord begins to deteriorate

1987
Jan - OPEC price accord begins to deteriorate.
Feb - OPEC majors stick to fixed prices.
Jun-Aug - Gulf war escalates.
Dec - OPEC meeting failure.

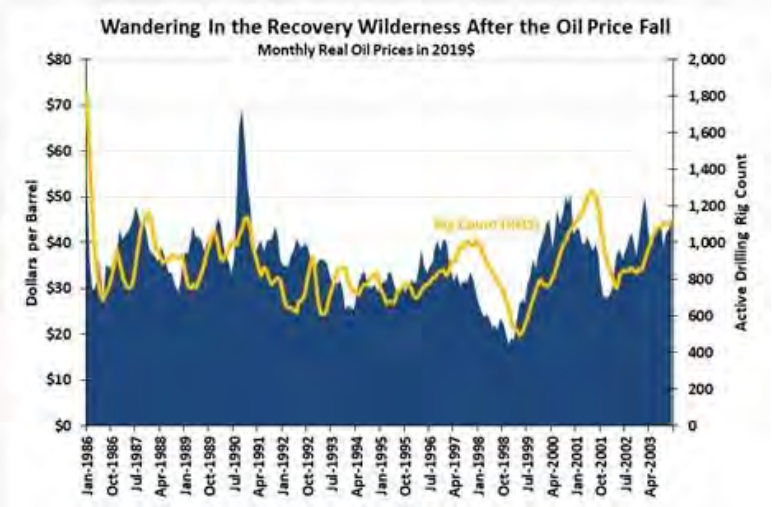
Crude oil prices jump in anticipation of possible production accord at Gulf Cooperation Council meeting set for October 16

1988
Wide use of crude formula pricing in 1988.
Feb - OPEC price meeting set.
Mar - OPEC/Non-OPEC meeting failure.
Jul - Iran accepts cease fire.
Oct 14 - Crude oil prices jump in anticipation of possible production accord at Gulf Cooperation Council meeting set for October 16.
Nov 28 - OPEC reaches production accord. Six-month agreement to set production at 18.5 mmb/d. Although the recent OPEC quota had been 19.0 mmb/d, actual OPEC production had been closer to 21.0 mmb/d.

Oil had gone from the heights to the depths in pricing in barely over 1,001 Arabian nights!

This timeline highlights the struggles the industry faced in figuring out how its business would perform in an era of oil price chaos. Oil had gone from the heights to the depths in pricing in barely over 1,001 Arabian nights! What was a barrel of oil going to be worth in the future? Until the answer to that question became clearer, people were in suspended animation, doing only what was needed to keep their businesses going, if that was even possible.

Exhibit 13. The Oil Industry Recovery Took A Long Time



Source: *WSJ*, BEA, Baker Hughes, PPHB

The oil and gas and oilfield service industries began to assess their future, which was viewed from a rubble-strewn landscape

As the dust settled in late 1988 following years of OPEC pricing turmoil, the oil and gas and oilfield service industries began to assess their future, which was viewed from a rubble-strewn landscape. Both industries were intimately intertwined, but predicting the future of either was challenging. The collapse in industry capital spending and activity due to oil pricing uncertainty was an overhang that shaped every corporate restructuring negotiation.

For people in the industry, the Valley of Death description was apropos for an industry full of companies on life-support

While Cambridge Energy Research Associates (CERA), in one of its infamous outlook scenarios during the 1980s oil industry turmoil, named its scenario for an oil price collapse the "Valley of Death," it had little vision for how a resolution of the oil glut would unfold. For people in the industry, the Valley of Death description was apropos for an industry full of companies on life-support. Finding a road to recovery involved pursuing courses of action that led to a total restructuring of the industry. Because this path was a winding one, we choose to refer to these years as "wandering through the wilderness." Crude oil and natural gas were still in demand, and the threat of them being displaced by other fuels was nowhere on the horizon. A growing world population and rising living standards necessitated that the oil and gas industry find and develop more fuel to meet these needs – now and for the future. There was an inherent skepticism of the stability of oil supplies from OPEC after the fiasco of the past 10-plus years. Non-OPEC oil producing countries saw their futures as bright, if they only could lure producers to their shores.

Its future would be far different from its past

On the other hand, the oilfield service industry was wallowing under the weight of huge equipment surpluses – and too many companies, most of which were "zombies," crippled by too much debt, inadequate revenue generating capacity and bloated workforces. The correction necessary to recreate a healthy, but always cyclical, service industry began in 1981. It wasn't until 1986, a year marked by the Arab oil price debacle, that industry participants began to confront the "reality" of how massive the changes would have to be in order for the global oil and gas business to return to a healthy state. Its future would be far different from its past. It was now time to begin cleaning up the mess and getting on with rebuilding the industry.

Is There Trouble In The "Climate Emergency" World?

The fury being unleashed against people supportive of, or promoting using fossil fuels under the guise of a "climate emergency" may be showing some cracks. That conclusion comes from the reaction of Harvard University to the disruption of the Harvard-Yale football game two Saturdays ago. In the statement, the university said:

> "Universities like Harvard have a crucial role to play in tackling climate change and Harvard is fully committed to leadership in this area through research education, community engagement, dramatically reducing its own carbon footprint, and using our campus as a test bed for piloting and proving solutions."

The main point of the demonstration against fossil fuels was to pressure the two universities to divest their investments in energy companies held in their respective huge endowment funds. Last year, Harvard President Lawrence Barcow told *The Harvard Crimson* that there were more effective ways to "bring about meaningful change" than divestment.

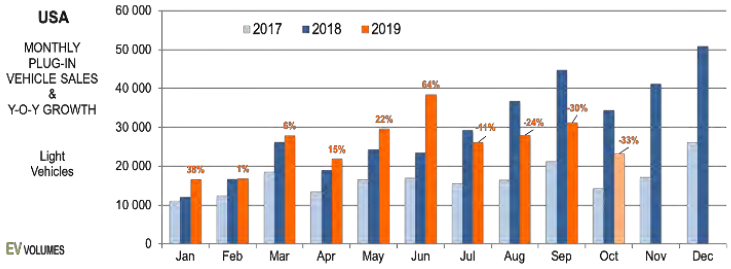
The strategy for dealing with this immediate fear of the environmental damage due to climate change is to rush to electrify the world

The strategy for dealing with this immediate fear of the environmental damage due to climate change is to rush to electrify the world. That would enable utilities to deploy wind and solar power to generate all our electricity in a "clean" manner, i.e., with no carbon emissions. This electricity will be necessary if the global transportation system is to switch to electric vehicles (EV). The problem is that the sales of EVs are declining in the United States as well as in China, the world's two largest EV markets. In fact, the decline in EV sales has even spilled over into the exotic metals market, where prices were projected to soar in response to the surge in demand for these minerals for batteries for the EV fleet.

Could it be that consumers still don't see the economic benefits of EVs?

In contrast to the rising EV sales projections from climate emergency proponents, the actual sales data is falling off those upward sales curves. That's not supposed to happen with dynamic (mandated) growth markets. Could it be that consumers still don't see the economic benefits of EVs? Maybe, especially in the U.S., we are running out of those "early-adopters" of new technologies. Today, many EV sales are represented by company and municipality fleet purchases, as buyers endeavor to demonstrate their alignment with the "green" lobby.

Exhibit 14. Electric Vehicle Sales In U.S. Are Down



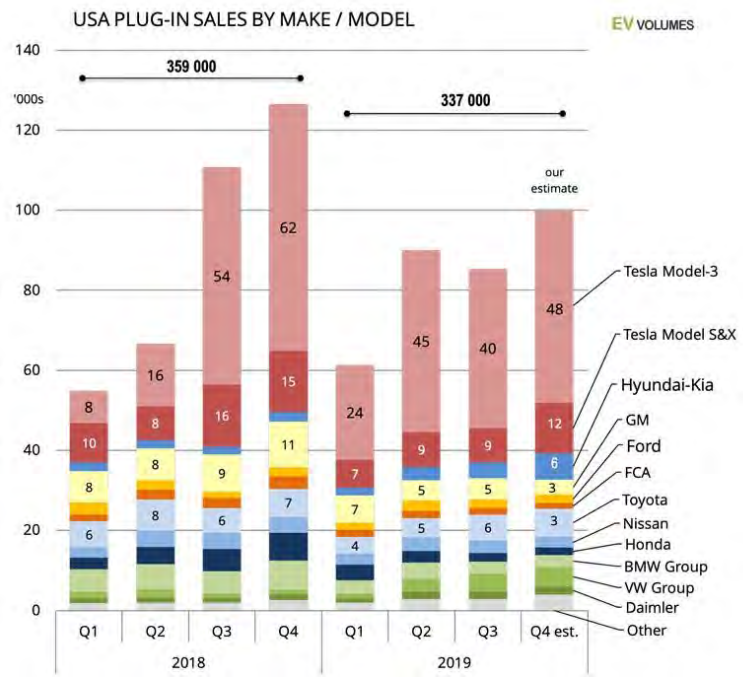
Source: ***evvolumes.com***

The EV monitor, *evvolumes.com*, reported recently that for the first three quarters of 2019 compared to the same period last year, EV sales increased 2%. However, with October's sales of only 23,200

2019 EV sales will only reach 337,000 units, down 6% from last year

EVs, down 33% from October 2018, year-to-date sales are now trailing 2018. This negative trend is expected to continue through the balance of the fourth quarter and extend through the first half of 2020. The EV monitor is projecting that 2019 EV sales will only reach 337,000 units, down 6% from last year.

Exhibit 15. EV Sales By Company For 2018-2019



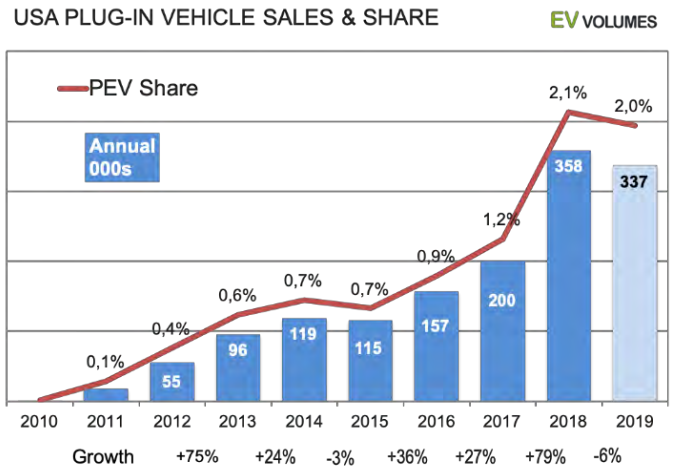
Source: ***evvolumes.com***

For 2019, Tesla's sales are projected to increase 9%, but that will not offset the sales decline of all other OEMs, which is expected to fall by 16%

The monitor claims the problem facing the EV industry is a lack of new models. They point out that Tesla's 2H19 sales will be down from 2H18 due to the fact that last year, all the Model 3 deliveries covered demand plus the backlog of prior orders. For 2019, Tesla's sales are projected to increase 9%, but that will not offset the sales decline of all other OEMs, which is expected to fall by 16%.

Looking at the history of domestic EV sales, there was a previous decline experienced in 2015, which was also due to a supply issue (lack of models). In that year, Toyota ended sales of its first Prius model, but did not have its replacement ready. And the same thing happened with GM's switch to the second generation of its Volt. Expectations are that EV sales will pick up in the second half of 2020 as some 20 new models will be arriving in showrooms next year. Ah, the latest toy and buyer brand loyalty will solve the EV industry's morass.

Exhibit 16. History Of U.S. Electric Vehicle Sales



Source: ***evvolumes.com***

While the 2015 sales decline was 3%, it only amounted to 4,000 units. This year's percentage decline will be twice as great at 6%, but it represents 21,000 units. What we thought interesting was *evvolumes.com's* discussion of the lackluster sales in 2019 lacked any mention of the ending of the tax subsidies for Tesla and GM.

The tax subsidy issue was pointed to in a recent Wall Street Journal article discussing the falling prices of EV battery minerals: cobalt and lithium

The tax subsidy issue was pointed to in a recent *Wall Street Journal* article discussing the falling prices of EV battery minerals: cobalt and lithium. The article discussed how the mining industry responded to the optimistic projections for EV sales and the expected shortage of these rare earth minerals by opening up new mines and stepping up production. An additional contributor to falling rare earth metal prices has been the drop in China's EV sales. Cobalt and lithium prices are now down more than 50% from their peaks in early 2018. George Heppel, an analyst at commodity research firm CRU, suggested that with the investments in new metal supply sources having been made now, he doesn't see prices returning to the very high levels of 2018.

"The change to subsidies was a lot more drastic than a lot of people expected in the market"

With China accounting for 60% of the global EV market last year, the shift in the government's attitude toward subsidies has inflicted a heavy toll on rare earth minerals prices. The government policy shift was designed to stimulate its auto industry's sales, in an effort to lift the Chinese economy. As Mr. Heppel commented, "The change to subsidies was a lot more drastic than a lot of people expected in the market." Few people expected such a radical change, given the congestion and air quality issues for Chinese cities. The announcement not only of the cuts in subsidies this year, but their elimination going forward, raises serious questions about how dynamic the EV market will be in the near future. The photo in

Exhibit 17. Unsold Electric Vehicles In China

Source: *WSJ*

Exhibit 17 had accompanied the *WSJ* article. It shows unsold EVs at an auto plant. Our count of all the EVs shown suggests there are at least 1,300 cars pictured. This is not a good sign for the EV business, and it is likely to cause some auto manufacturers to slow down their race to enter the market.

Given China's plans to abandon EV subsidies in 2020, it is possible that the EV sales shift onto a much slower growth curve than previously anticipated

Potentially one of the greater impacts will be on auto component suppliers. They have been wrestling with understanding the speed of the EV transition and what it means for their businesses. Given the rapid EV sales growth of the prior two years, some suppliers set in place plans to begin closing plants to lower their costs and keep a balance between demand for conventional auto parts and their ability to satisfy the demand. Now, they may be looking at a global automobile market that does not suffer from the expected penetration by EVs. In fact, given China's plans to abandon EV subsidies in 2020, it is possible that the EV sales shift onto a much slower growth curve than previously anticipated. If so, maybe there won't be as many auto parts plants shut down in the near future. That would be good for the workers at those plants, and possibly for various economies, assuming their unemployment rates don't increase dramatically. These are some of the less visible issues to be impacted by a change in the rate of growth of EVs. These are issues forecasters may need to reassess.

More Onshore Wind To Help The World With Clean Energy

A recent study published in *Nature Climate Change* suggests that the global wind stilling (calming) phenomenon for onshore wind, which has for years stymied scientists' understanding of why, has

The study shows that since 2010, average wind speeds across the North American, European and Asian continents have increased

come to an end. The study shows that since 2010, average wind speeds across the North American, European and Asian continents have increased. This is an important development assuming that the trend continues. If the observed declining wind speed trend evident for 1980-2010 of -8% were to continue to the end of the century, it is estimated average wind speed would fall by 21%, leading to a halving of the world's potential wind power output.

If the wind speed increase were to continue to 2024, there could be as much as a 37% increase in wind power output

According to the study, the global average wind speed has increased from 7.0 miles per hour to 7.4, a gain of 5.7% since 2010. Due to the interaction with wind turbines, this hike in average wind speed can mean as much as a 17% increase in potential wind energy. If the wind speed increase were to continue to 2024, there could be as much as a 37% increase in wind power output. The study's authors suggest that the wind speed improvement could last for another decade, but more importantly, they believe the increased wind speed will have a much greater impact on wind energy's output than technological improvements in wind turbines.

Determining wind power is done via a formula. The formula states:

P = c x d x (D^2) x (v^3)
P: Power produced (mechanical) (Watts [W])
c: constant
d: density of wind (kilograms per cubic meter [kg/m^3])
D: turbine blade diameter (meter [m])
v: velocity of wind (meters per second [m/s^2])

Ideally, the faster the wind and the larger the blades, the more power is produced

The key to the formula is that when the wind speed doubles, wind power increases by a factor of eight! Alternatively, if the wind turbine blades' diameter is doubled, wind power increases by a factor of four! So, ideally, the faster the wind and the larger the blades, the more power is produced. This helps explain why wind turbines have been growing in size over time. It also highlights why the study's conclusion of a reversal of the decline of wind stilling could have a significant impact on wind energy's contribution to our power supply. The conclusion, however, still ignores the issue of wind's variability. In fact, the prospect of more wind power may actually create greater challenges for utilities in managing their grids, and for wind farm owners in what they get paid, if more surplus wind energy is produced. We could experience longer periods of negative wind power prices when too much wind energy is available relative to demand.

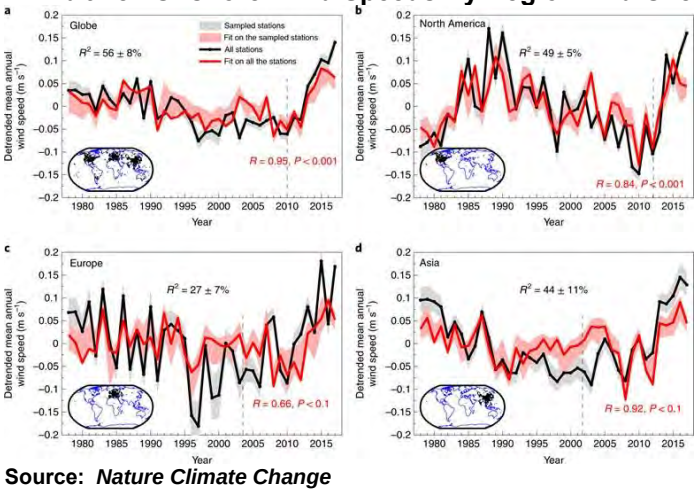
The decline in wind speed over global land masses from 1980 to 2010 has been observed and scientists have worked to understand why it has happened. They have examined a number of factors including large weather circulation forces. The problem the scientists have had with all the various factors considered is the inability of replicating the data in the various analyses conducted.

This has led to the general conclusion that the slower wind speed is related to either the greening of land masses that have increased friction for surface winds, or the impact from increased urbanization.

To appreciate what the scientists did in their study, we have reproduced the "Analysis" section from the abstract of the article.

> "We integrate direct in-situ observations of wind speed from ground weather stations from 1978 to 2017 with statistical models for detection of trends. The stations, mainly distributed in the northern mid-latitude countries, were carefully selected from the Global Summary of Day (GSOD) database following strict quality control procedures. To test for a continuation of the terrestrial stilling after 2010 (refs. 1–4), we use a piecewise linear regression model to examine the potential trend change."

Exhibit 18. Onshore Wind Speeds By Region And Overall



Source: ***Nature Climate Change***

We found the four charts very interesting. The statistical analysis as shown by the R value (coefficient of correlation, or the degree of relationship between two variables) and the R^2 value (coefficient of determination, or the percentage of variation in y explained by all the x variables together) appears significant. As often happens, the combined analysis of the North America, Europe and Asia data shows higher values than each of the regions individually.

Is it possible that this pattern is merely a reflection of a natural climate cycle of roughly 20 years?

We noticed the very clear pattern of wind speed in North America over time. It was rising from 1978 to about 1989, at which point it began declining. The fall in average wind speed stopped at 2010 and then reversed. Since we don't know what the wind speed was doing before 1978, we don't know how long it had been rising. Is it possible that this pattern is merely a reflection of a natural climate cycle of roughly 20 years? If so, then about 2030, North America's wind speeds will begin to slow.

Given that amount of time, one wonders whether we might be looking at Europe's wind speed currently approaching a peak?

When we examined the Europe chart, it appears average wind speed reached a low about 1996. Again, without knowing what was happening before 1978, we see about an 18-year decline. Given that amount of time, one wonders whether we might be looking at Europe's wind speed currently approaching a peak? We draw that conclusion from observing the red line turning down in 2017. The Asia data, which is primarily China, shows a steady decline from 1978 to 2002 and then an increase, but driven by higher wind speeds during the most recent years, as 2008's red line is below, and 2012's is barely above, the 2002 low for the black line.

To the extent that this study is accurate and the cycle time can be pinpointed, it could help the energy industry to better allocate capital in the onshore wind business. With the life of wind turbines well defined, knowing when more turbines are needed to offset the next phase of global wind speed declines could help the timing of upgrades to existing turbines, as well as investment in new turbines, given their typical permitting and construction times. It may, in the end, help utilities in managing the wind power component of their renewable energy portfolios.

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