Shifting Oil Industry Structure and Energy Security Under Investment Phase-Outs

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ABOUT THIS PAPER

In May of this year, Fatih Birol, speaking as head of the International Energy Agency, stated publicly that "*The pathway to net zero is narrow but still achievable. If we want to reach net zero by 2050 we do not need any more investments in new oil, gas, and coal projects.*" Mr. Birol's comments notwithstanding, large parts of the world continue to rely upon a wide range of petroleum products to sustain and improve their living standards. If such a strategy is pursued without a commensurate reduction in demand, it would inevitably lead to rapidly rising prices for fossil fuels, diminished living standards, and even potential shortages. It would also lead to serious concerns about the energy security of the member states of the IEA, which Mr. Birol heads. Oddly enough, the central mission of his organization is to promote the energy security of the developed world.

This paper by Michael Lynch examines the emerging policy and structural developments in U.S. crude oil production that are likely to cause larger volumes of world oil production to shift to two producing centers, the Middle East and Russia. Policy initiatives to address concerns over U.S. energy security have their roots in the 1973-74 Arab oil embargo. The resulting gasoline lines and shortages of the so-called Arab oil embargo commanded enormous public fear and political upheaval (shortages were clearly exacerbated by national wage and price controls in place at the time) and U.S. policy makers subsequently undertook a broad range of responses to address growing concerns over energy security for decades after the embargo.

Energy security was not only tied to the level of U.S. import dependence, but also from a concentration of low-cost oil reserves in unstable regions of the world. This concentration of resources presented two important cost and security risks to the U.S. economy; (i) a few producers could restrain output resulting in oil prices becoming higher than would prevail in a more competitive environment, causing large wealth transfers from U.S. consumers to foreign oil producers, and (ii) the growing potential of a damaging "price shock" to the U.S. economy from supply disruptions in major producing centers, either as an instrument of national policy or from war and terrorism. These economic and security risks were addressed through a broad range of policy responses, including development of strategic petroleum stocks in the U.S. and among its allies, energy efficiency programs, greater fuel diversification, and the promotion of new supplies outside legacy production centers. More recently, the development of technological advances such as hydraulic fracturing saw the U.S. emerge as a major new world oil producer. Over the last ten years, the U.S. crude and related liquids production provided over 80 percent of the growth in world oil supply as the U.S. emerged as one of the world's largest oil and gas producers.

As Lynch points out, public concern that rising worldwide emissions of carbon dioxide in the atmosphere is harmful to the climate has encouraged government policy initiatives to encourage (and sometimes mandate) reductions in carbon emissions. Public and private initiatives are underway to limit carbon emissions, including processes to capture carbon and subsidies and mandates for both alternative fuels and new energy production technologies. In an attempt to accelerate reductions in carbon emissions, many governments in the developed world (OECD) also are attempting to reduce fossil fuel use by limiting supplies through indigenous production cuts. As the paper makes clear, these initiatives offer considerable potential to take us "Back to the Future." Before we embark on this journey, we should at least have a clear understanding of the consequences.

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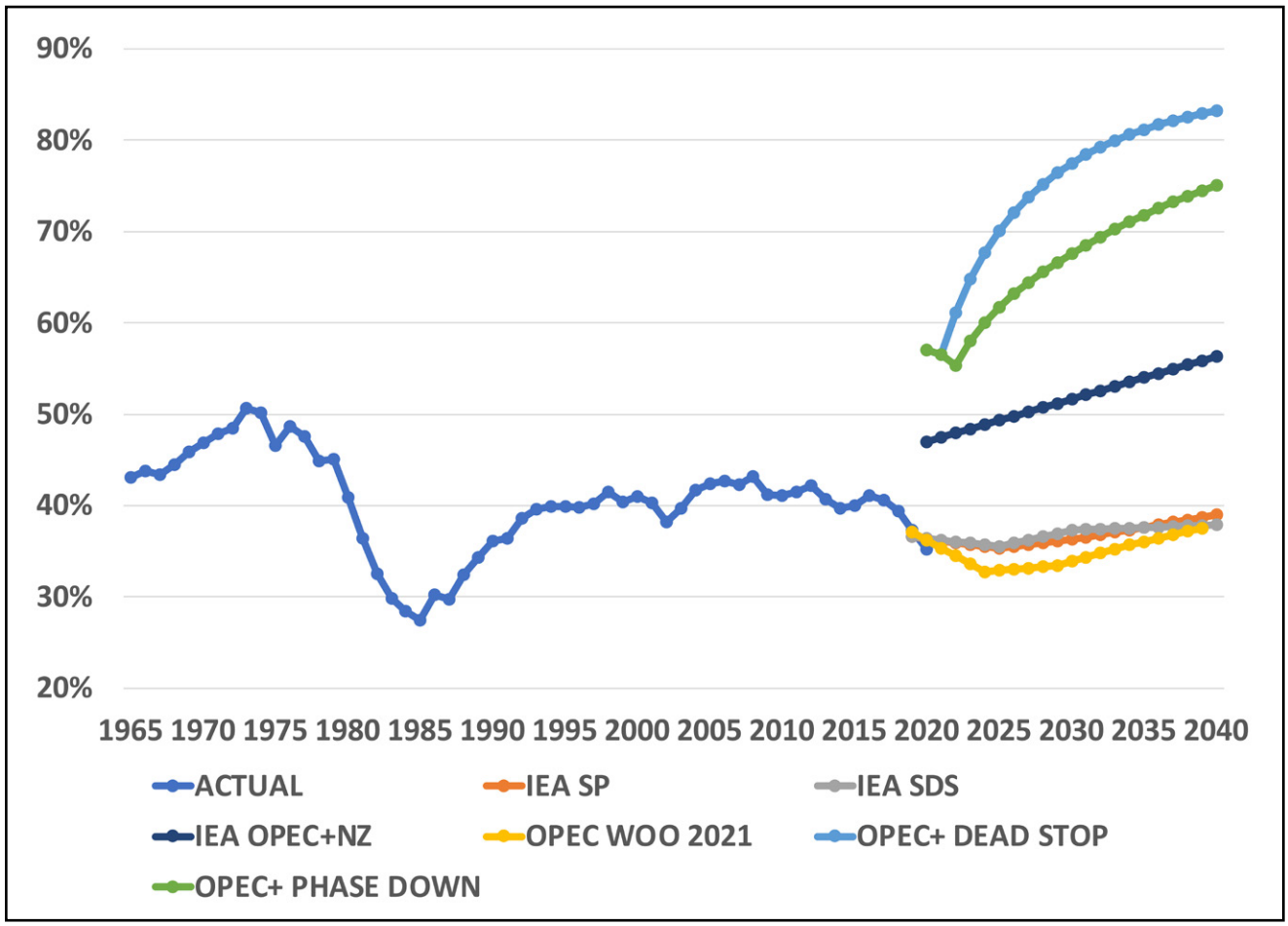
SUMMARY

A variety of factors could cause oil production to shift increasingly to the Middle East and Russia, and from private to national oil companies: official government policies in the U.S. and throughout the developed world limiting local production, ESG (Environmental, Social, and Corporate Governance) pressure, investors' call for financial discipline, and low oil prices due to climate change policies. This could have serious negative consequences for energy security, including an increased impact from political unrest in a producing country, less cooperation with emergency sharing programs from national oil companies, and a smaller spot market, meaning less fluidity during a 'shortage.'

Figure ES-1 shows an estimate of market share for OPEC+ under the assumptions and calculations undertaken by the author. The conclusion is that even with a slow phaseout of upstream investment by the private oil sector, OPEC+ market share will grow from 55% to 75% in 2040. Aside from the oil price implications, market behavior in another major oil supply disruption could be substantially different from seen in the past.

Figure ES-1
OPEC Market Share Actual and WEO 2021 Forecasts

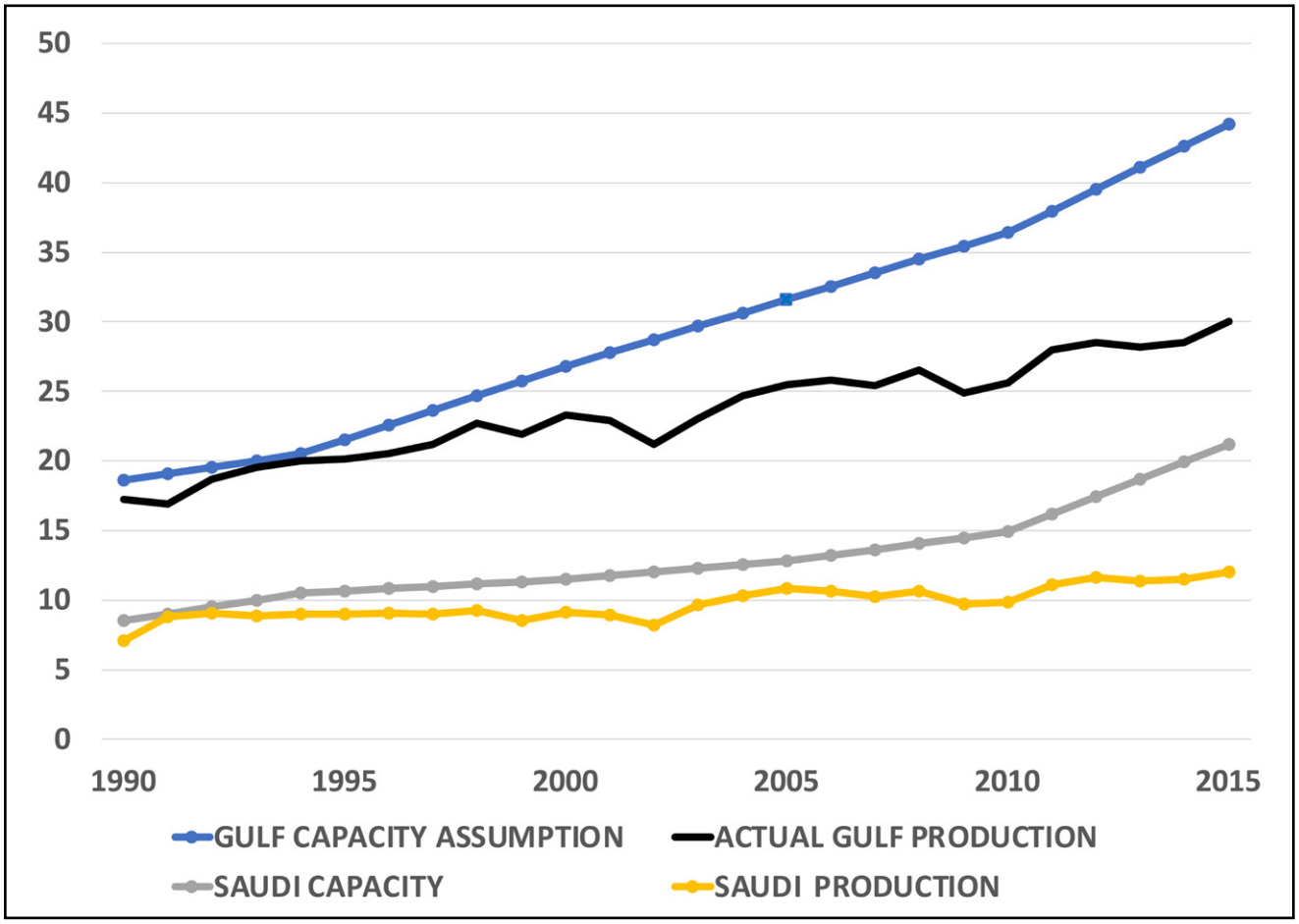


Sources: International Energy Agency, World Energy Outlook 2021, OPEC World Oil Outlook 2021, and the author.

INTRODUCTION

In the aftermath of the 1979 Iranian Oil Crisis, pessimism about oil supply translated into concerns that production would be increasingly concentrated in the Arabian/Persian Gulf, making consumers much more vulnerable to disruptions of supply. Famously, the U.S. Department of Energy regularly projected that the world would need ever-increasing amounts of oil from Saudi Arabia, assumed to be the residual supplier, meeting whatever oil demand was left after all other countries' production. (Figure 1) Although this assumption proved to be incorrect, the concept remained a major factor behind energy policy projections, such as Curtis and Romm (1996) who argued for increased research on renewable energy to avoid over-dependence on Middle Eastern oil.[1]

Figure 1
1996 EIA Oil Capacity Assumptions (mb/d)

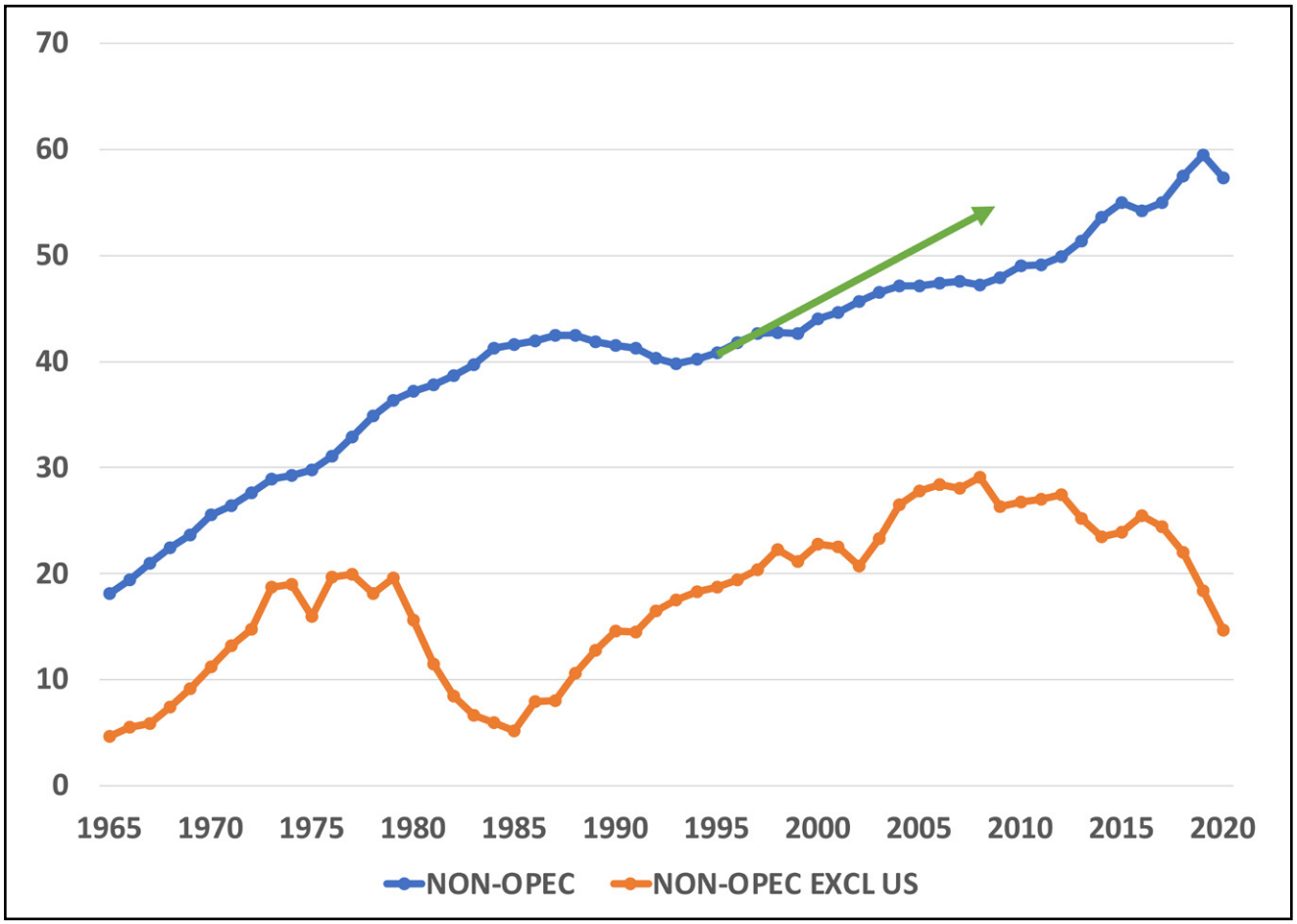


Source: Energy Information Administration, International Energy Outlook, 1996.

Warnings of under-investment have also been common, usually after periods of low oil prices, but are often misguided. One repeating concern has been the increase in costs that occurs when rising prices spur inflation in oil field services and goods, which is assumed permanent. Another is the low level of exploration and discoveries, which reflects the fact that developing a field typically costs much more than finding it, and more barrels are added to reserves through development than exploration.

On the other hand, the price collapse of 1998 saw a sharp decrease in drilling outside the U.S., much worse than in 1986, because 1998 prices dropped from $30 whereas in 1986 they dropped from $65 (in 2020 dollars). The result was that non-OPEC production growth slowed notably (Figure 2), one factor behind the subsequent price surge to over $100.

Figure 2
Non-O Non-OPEC Oil Production Growth Decline from 1998 (mb/d)



Source: Data from BP Statistical Review of World Energy

However, expectations for the oil industry have changed, with some analysts forecasting that oil demand has or will soon peak while political leaders are pressuring banks and companies to reduce investment in fossil fuels. For oil companies, especially in the U.S. shale industry, stockholders have put pressure on firms to emphasize financial discipline to reduce debt and improve revenue. The impact of both could be similar and the long-term consequences to the national economy and security interests of the U.S. should be properly evaluated by policymakers.

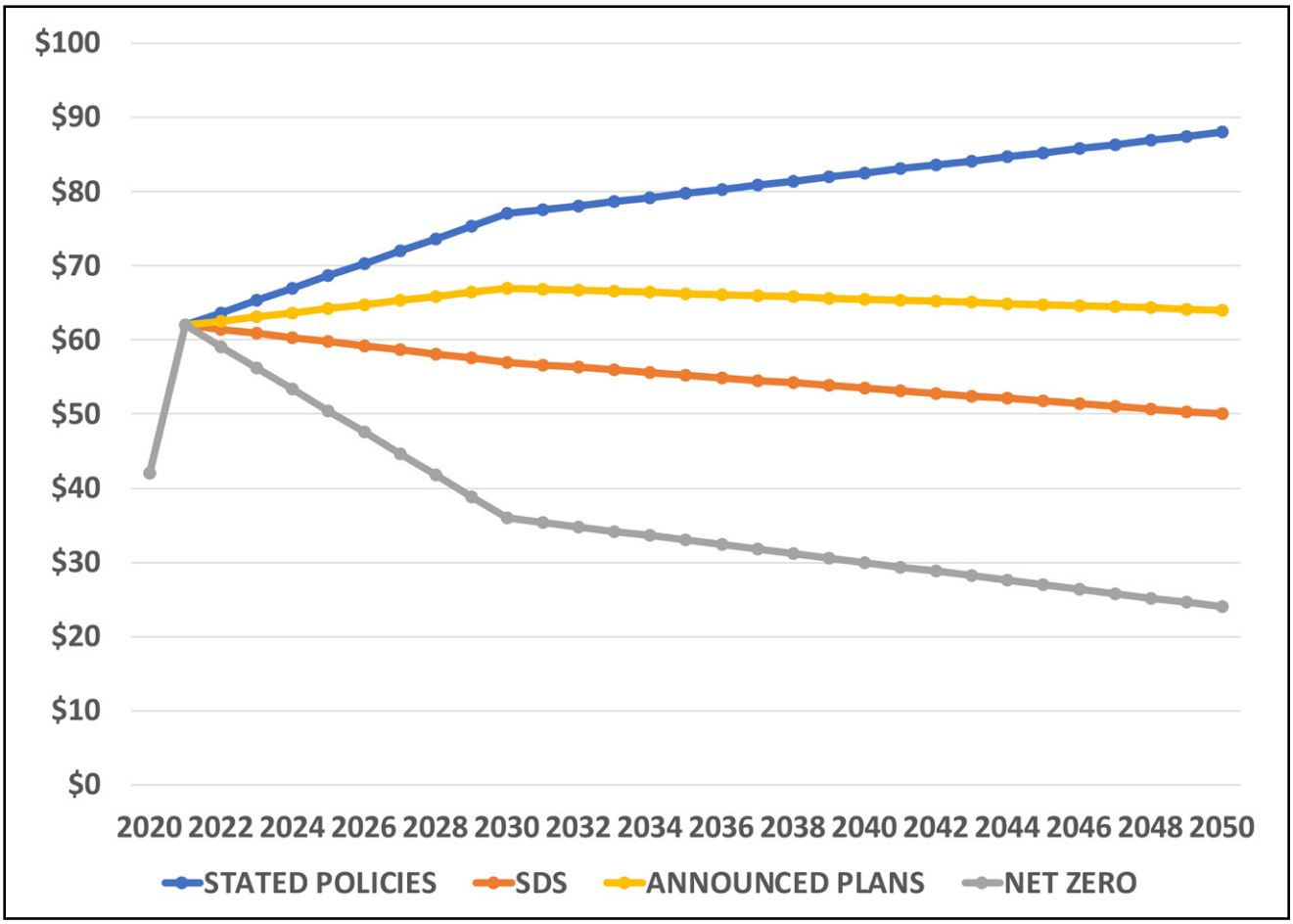
PEAK OIL DEMAND

The idea that peak oil supply was near (or passed) was always based on bad math, ignorance about the oil industry, and questionable assumptions.[2] Peak oil demand is however quite possible, although as I have noted elsewhere, stone is still a major commodity despite the Stone Age ending millennia ago. However, it seems increasingly likely that oil demand will be suppressed somewhat by climate change policies of one sort or another, and this has some important consequences for energy security and the market longer term.

Of course, efforts to discourage the production of oil are entirely misplaced since consumption is not driven by supply but demand. (Indeed, curbing supply to reduce demand is a proven fallacy on which many nations' narcotics policies are based on.) This is especially true when not all oil producers are likely to cooperate and allow production to decline. (Natural decline rates mean that a complete cessation of investment would cause production to decline by 5-10% per year, depending on the region and type of oil.)

As Figure 3 shows, the IEA projects that under its Sustainable Development scenario oil prices would be much lower than in the Stated Policies scenario, in this case because climate change policies will mean that by 2040, oil demand will be one-third lower than in the Stated Policies scenario. Since the IEA's Stated Policies Scenario projects oil demand increasing from 2019 to 2040 by less than 7%, or about 0.3% per year, their rising price projection implies that costs will increase over time as cheaper oil is depleted (or removed from the market by political considerations). The belief in inexorably rising costs is a fallacy as explained in the work of M. A. Adelman, among others.[3] However, the idea that a shifting of the demand curve to the left, either because of policy or technological advances (such as better batteries for electric vehicles), could lower prices significantly is theoretically sound. Indeed, more extreme scenarios for oil demand could drive prices much lower.

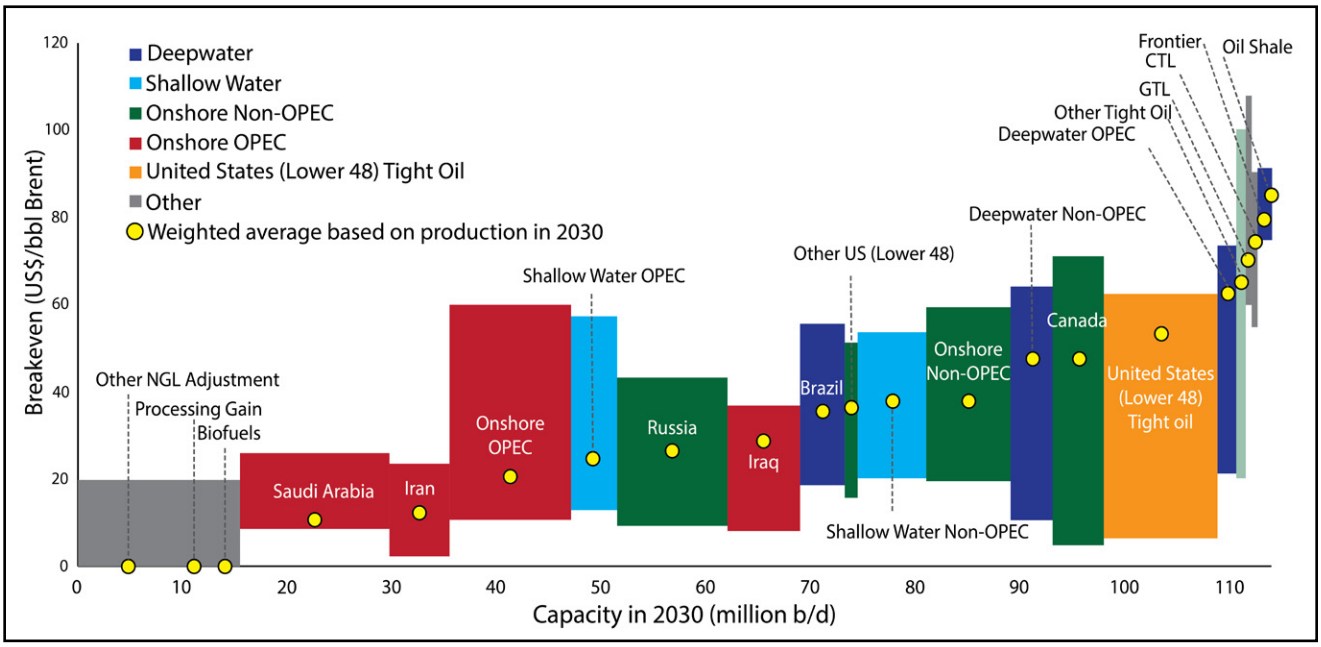
Figure 3
Oil Prices in IEA Scenarios (2020$/bbl)



Source: International Energy Agency, World Energy Outlook 2021.

The impact of lower oil prices on future oil supply is likely to vary substantially by region. The IEA has apparently not published a long-term oil supply (cost) curve in some years, but there are numerous estimates done by various firms which typically will indicate similar findings: Middle Eastern and Russian oil is generally the cheapest and most non-OPEC oil is more expensive with U.S. tight oil being the highest cost of major supply volumes. Other areas, most notably the North Sea and Canada, fall in-between. Figure 4 is a typical curve.

Figure 4
Global Liquids Capacity in 2030 by Breakeven Price



Source: Wood Mackenzie.[4]

Although most supply curves present a data point for a given source, others show a range and, as above, a weighted average. At $50/bbl oil, investment would not cease in many places such as Latin America, Africa or the Asia-Pacific but in the absence of improved technology and efficiencies would constrain output growth in other regions.

RESTRICTED INVESTMENT

"Producers are still chafing at memories of the price crash early in the pandemic. Wall Street is even less enthusiastic. Not only have banks and investors lost money in the boom-bust cycles that whipsawed the sector over the past decade, but many also say they are prepared to pare their exposure to fossil fuels to meet the commitments they have made to fight climate change."[5]

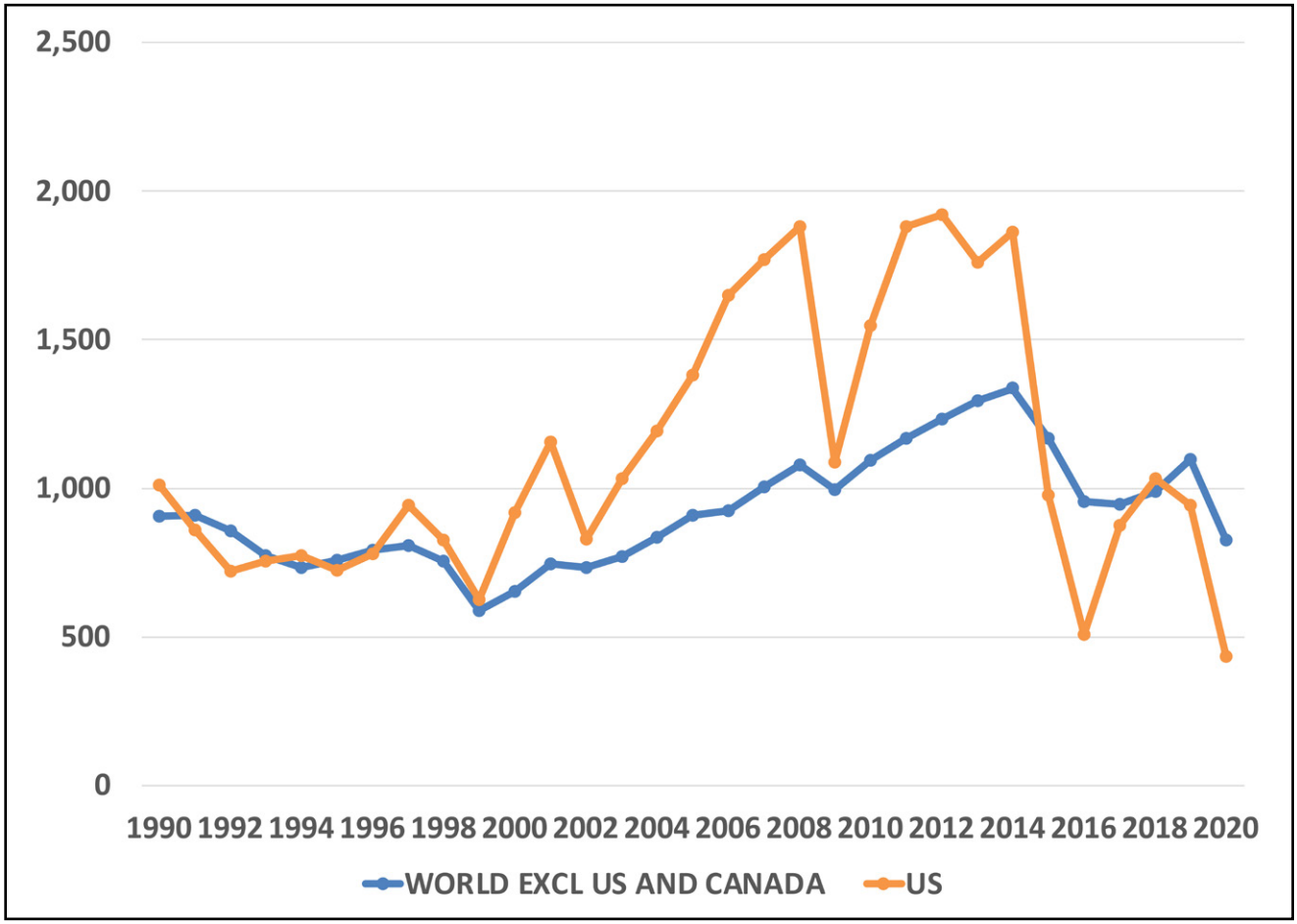
There has long been concern about insufficient investment by the petroleum industry causing tighter markets and higher prices, most frequently after a sharp drop in prices. Generally, the problem has been exaggerated by assuming rising factor costs, pessimistic projections of non-OPEC supply, and the general difficulty of making long-term predictions of investment patterns. The recent oil price collapse and the rise of ESG politics have the potential to make this a very real obstacle to the development of oil supply, or at least to shift how and where it occurs.

Financial markets have long complained about the tendency of petroleum companies to underperform, that is, to achieve a low return on their investments, including in petroleum exploration and production. One of the arguments about BP's Deepwater Horizon disaster was that the company was trying to satisfy investors' complaints of poor returns by aggressively cutting costs. As the official report to the President noted, "Absent major crises, and given the remarkable financial returns from deepwater reserves, the business culture succumbed to a false sense of security."[6] Needless to say, some national oil companies such as Pemex do not have a noticeably better safety and environmental record.

Concern of so-called "over-investment" in petroleum resources was a central theme during the shale boom in the United States, when a land rush combined with high oil and gas prices resulted in what appeared to be excessive expenditures to acquire leases and hurry supply into production. Some companies paid too much for their leases and some developed resources that later proved to be uneconomical, although a significant amount of that reflected cyclically high factor input costs (labor, materials, rig rentals, and other oil field services), which was reversible.

Still, quite a number of smaller players suffered financially when oil prices dropped in 2015 and then again in 2020, many entering bankruptcy protection or being acquired by healthier companies. One firm reported over 250 bankruptcy filings by shale firms from 2015 through mid-2021.[7] Investment in the sector collapsed, the number of oil rigs active in the U.S. dropping by 3/4s in 2015. The market weakness and pandemic saw another dip in operations, more in the U.S. than globally (Figure 5).

Figure 5
Active Drilling Rigs in the United States and Worldwide



Source: Baker Hughes.

Investors who had all-too-willingly bought into the shale land rush mentality were furious and have pushed the companies to not only reduce their debt levels but to restrain upstream investment to avoid a new price collapse. This was particularly true after the 2020 oil price collapse but in that case was also due to the lower prices just before and during the covid pandemic. The six super-majors cut upstream investment by 1/3 in 2020, while 21 leading U.S. E&P companies, heavily concentrated in the shale basins, reduced their capital expenditures by 50%.[8] (Table 1 below.)

Table 1
Upstream Investment Trends ($billion)

		2019	2020	2021
NOCs	Aramco	32.8	27.5	25
	Petrobras	27.4	8	10
	Rosneft	13.2	10.8	13
	CNOOC	11	13	14.5
	Sinopec	21.3	20	25.7
	TOTAL excl Petrobras	78.3	71.3	78.2
		105.7	79.3	88.2
Majors	ExxonMobil	31.2	21	17.8
	Chevron	21	13.5	14
	BP	19.4	14	13
	Shell	24	18	20.5
	Equinor	10	7.8	9.75
	Total	17.4	13	12
	TOTAL	123	87.3	87.05
Independents	32 US E&Ps	60.6	32.5	31.7

Source: Xu, Conglin, "2021 Capital Spending to be Mostly Conservative," *Oil & Gas Journal* April 5, 2021.

ESG AND CLIMATE CHANGE

"Beyond projects already committed as of 2021, there are no new oil and gas fields approved for development in our pathway…"[9]

Pressure on the industry to engage in Environmental, Social, and Corporate Governance (ESG) includes encouraging a reduction in upstream oil and gas investment, with funds moved into 'green' energy (mostly renewables). The IEA estimates that meeting the Net Zero by 2050 targets would mean a cessation of new oil field development, as the quote above illustrates. CarbonTracker's recent report estimated that even with a more moderate target of 2-degree Celsius warming (versus 1.5 in the Net Zero by 2050 scenario), "a majority of companies would see at least half of their business-as-usual investments on currently unsanctioned assets at risk of stranding under a low carbon scenario (SDS)."[10]

It is far too early to say whether this will mean that the private oil sector will be starved of funds, but it appears highly likely that relative to national oil companies, the effect will be less upstream investment. Again, a shift towards greater NOC market share long-term, reinforcing the impact from calls for financial discipline.

Because national oil companies usually have their budgets set by their governments, their expenditures do not follow the same pattern as for private companies. In particular, their spending is much less price-responsive and tends to be more stable. This has pluses and minuses for the companies and the markets, but it also implies that political pressure on investors, such as the ESG movement, is much less likely to affect them.

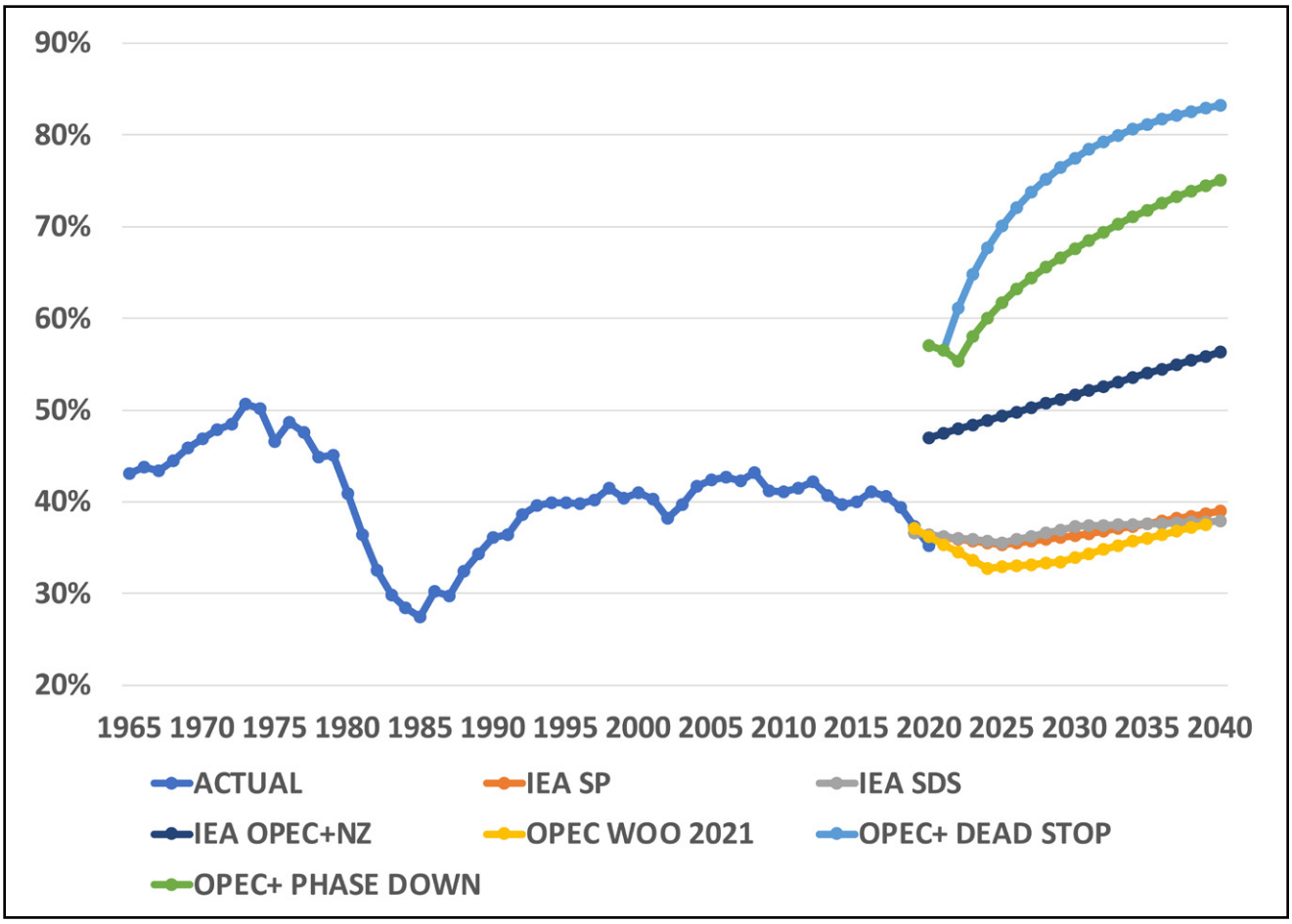
Longer term, this could mean that if private companies see their upstream investment shrink, then the impetus in production will shift towards national oil companies. The nationalizations of the 1970s represented an enormous shift of control from the (mostly Anglo-American) multinational oil companies to the NOCs. Should we enter an era where oil demand is declining while NOC production is growing, their market share and power could increase significantly. Table 1 showed investments over the past few years for some of the major NOCs, MNOCs, and the total for 32 U.S. E&P independents.

SUPPLY EFFECT

The pace and implications of a larger role for NOCs in world oil supply is complex and depends on both production costs in different areas and the split between private and national oil companies. Saudi Arabia is a pure case, with cheap oil and no private sector operations. Brazil, on the other hand, includes a mix of state and private companies, plus high costs. U.S. production, private and now largely from shale, could decline rapidly especially if U.S. policy restricts leasing on public lands and engages in costly regulatory initiatives. Canadian oil sands do not really have a decline rate and supply from there should be relatively flat. Australia and the North Sea, with a higher decline rate than conventional onshore production, should also see supply drop noticeably. Deepwater production, mostly run by private oil companies, should decline significantly.

The IEA has not at this writing published detailed oil production figures for its NetZero2050 Scenario, but in the 2020 *World Energy Outlook*, they did include forecasts for the Stated Policies and Sustainable Development Scenarios. Figure 6 shows the historical and forecast OPEC market share and surprisingly, along with the projection from OPEC's 2021 *World Oil Outlook*, there is only a marginal difference between the two. Given the assumed policies and lower oil prices, the Sustainable Development Scenario should see a significant increase in market share for OPEC.

Figure 6
OPEC Market Share Actual and WEO 2021 Forecasts



Sources: International Energy Agency, World Energy Outlook 2021, OPEC World Oil Outlook 2021, and the author.

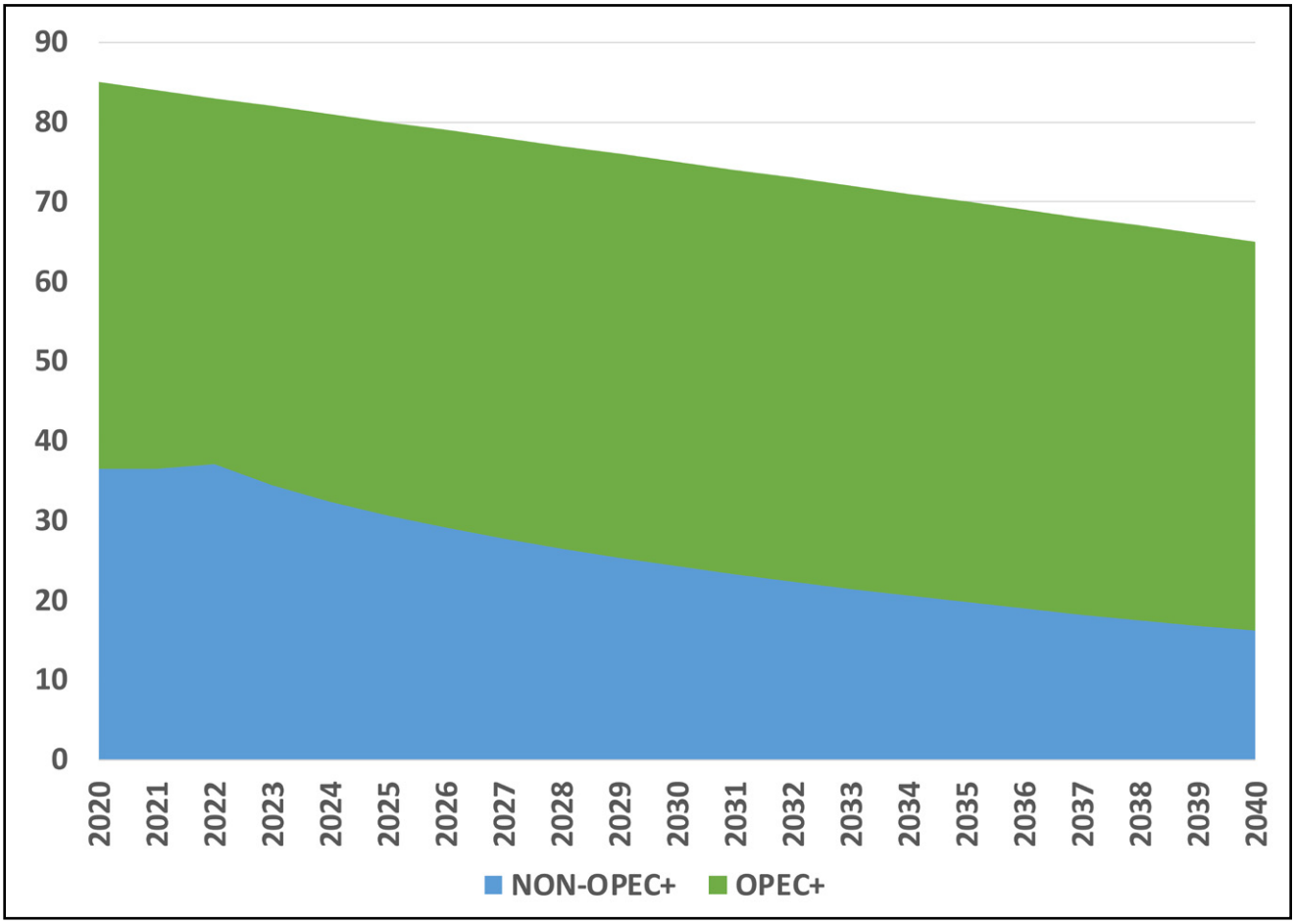
Predicting actual investment patterns is beyond the scope of this paper, but several possibilities can be tested. First, assuming no new field developments (or investment in new capacity in existing fields) is unrealistic. Rather, the most extreme case, which will be labelled Dead Stop, will assume that all upstream investment by the private sector ceases. Production trends will then be determined by the decline rates described as shown in Appendix A. In both scenarios, it is assumed that the reduction in investment in 2020 represents a withdrawal of funding for new field exploration and development, and all remaining money was dedicated to offsetting depletion (which normally takes about 80% of investment).

In the Phase Out scenario, upstream investment by the private sector is assumed to drop by half by 2030 and stop by 2040. This means that the decline rates gradually take hold and cause production to drop from 2022, beginning at zero (assumed declines offset) to the natural decline rate in 2040, when no investment is being made.

In the Dead Stop scenario, upstream investment by the private sector is assumed to completely halt, as suggested by the IEA in its Net Zero 2050 scenario. As a result, production trends immediately follow the natural decline rates and continue to do so throughout the period.

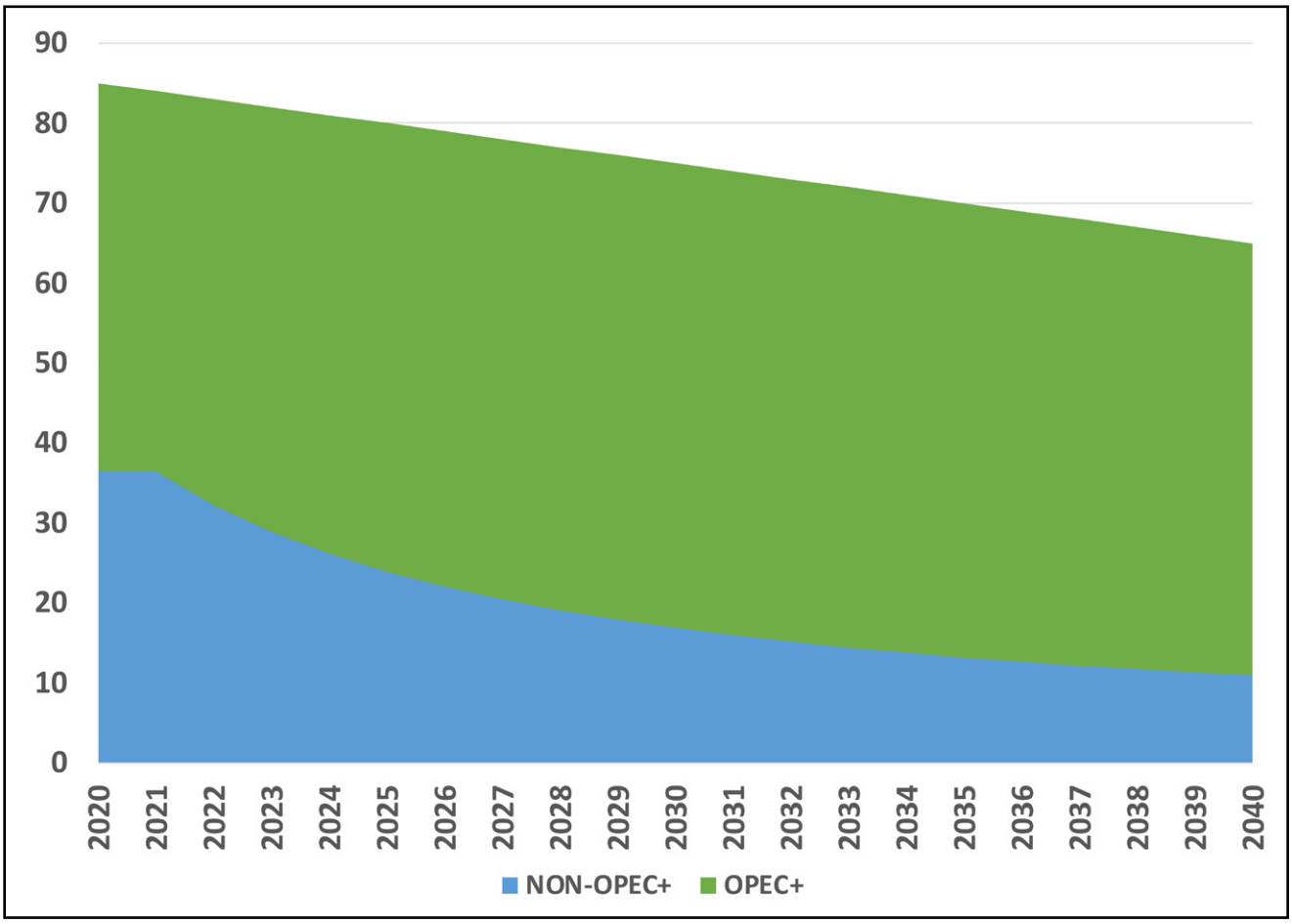
Figure 7 shows the impact on the split in production between OPEC+ and all other producers in the Phase Out scenario, with OPEC+ production assumed equal to the difference between global oil demand in the IEA 2020 Sustainable Development Scenario, which declines from 85 to 62 mb/d, and non-OPEC production. (Only crude oil production is considered.) Figure 8 is the similar forecast for the Dead Stop scenario.

Figure 7
Phase Out Scenario (mb/d)



Source: Based on the author's calculations described in Appendix A.

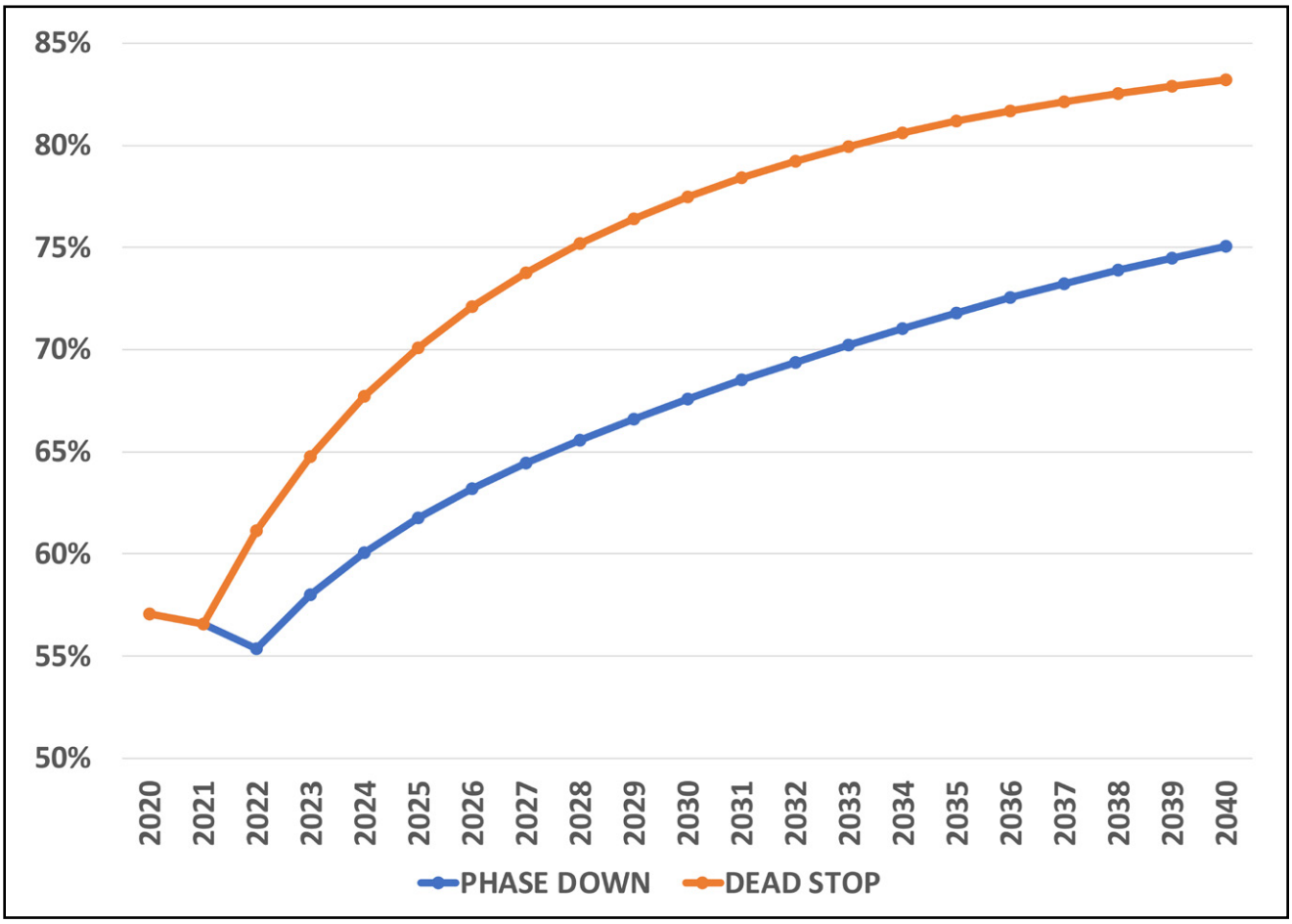
Figure 8
Dead Stop Production Scenario (mb/d)



Source: Based on the author's calculations described in Appendix A.

Even in the Phase Out scenario, non-OPEC+ production drops by just over half, which means that OPEC+ market share rises to 75% from 55% now, definitely increasing the market power of the group. In the Dead Stop scenario, the change is much more dramatic, with OPEC+ achieving 75% market share by 2028, and 83% by 2040. Given that OPEC's market share has been roughly flat for three decades, this represents a seismic shift in the market.

Figure 9
OPEC+ Market Share (Crude only)



Source: Based on the author's calculations described in Appendix A.

THE IMPACT ON ENERGY SECURITY

There are two main concerns about energy security that arise from these possible shifts in oil supplies. While it might be true that a lower share of oil use in the global economy will mean less damage from oil supply disruptions and price shocks, there are also offsetting effects that could increase the vulnerability of the world economy. After all, in the 1970s, countries that were not oil importers like Canada and the United Kingdom (in 1979), nonetheless sank into recession along with the oil importers. No country is an economic island except for North Korea, hardly an example worthy of emulation.

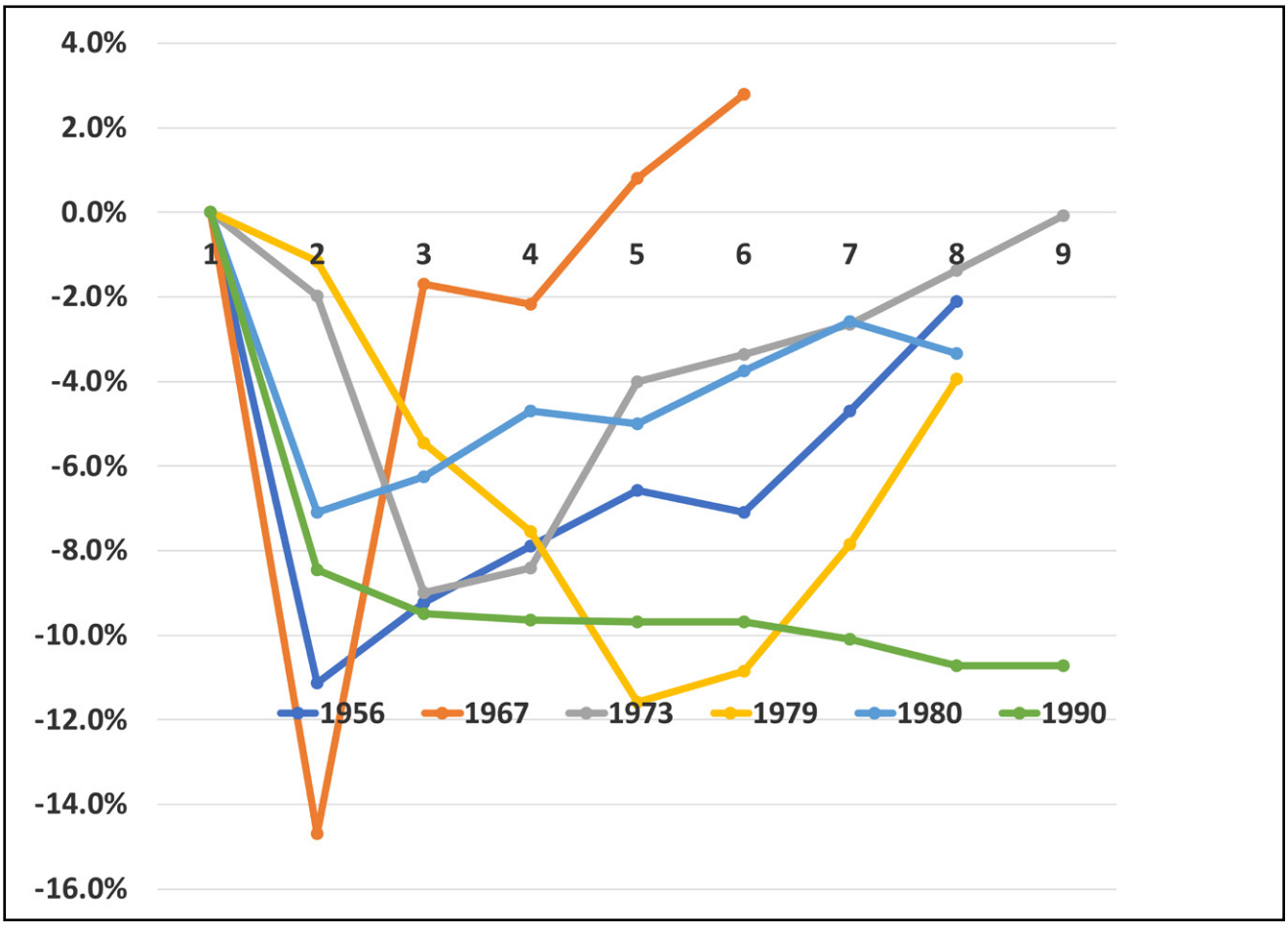
The loss of oil supply and the ability to offset that loss through spare capacity or strategic reserves were the main determinants of whether a supply disruption would morph into a full-blown crisis and price spike.[11] (The secondary concern being whether, after the disruption ends, exporters try to restrict production to maintain prices at the disequilibrium level, as in 1979-1985.) Even if nations like Iraq, Russia, and Saudi Arabia do not increase production to offset declining production in North America, as described above, their production levels are now high enough that major political unrest could take a major amount of supply off the market, conceivably for an extended period. Political risk is not a feature only of petrostates as political leaders in the developed world pose risks to oil production. President Obama's suspension of offshore drilling, President Biden's halt to onshore leasing, and the Dutch decision to end production from the Groningen gas field all provide relevant examples.

If oil demand has declined to 62 mb/d by 2040, as in the IEA's 2020 Sustainable Development Scenario, Russia or Saudi Arabia could then each comprise 15-20% of the market, while Iraq, Kuwait, and Saudi Arabia could account for 1/3 of global production. This presents a supply risk well in excess of past supply disruptions, as shown in Figure 10, especially if it persisted for any time. The impact would disproportionately affect non-OECD nations; presuming they have not restricted oil consumption with any great verve, it could still have significant political effects, including:

- The disruption of commodity supplies as exporters can't find or afford fuel;
  - Which could include agriculture supplies, as they become more dependent on fuel and fertilizer with modernization;
- An increase in political inequality and thus unrest;
- Global inflation as the impact of higher oil and gas prices, as well as commodity supply disruptions as mentioned, spreads from oil consuming nations to their customers; and
- Recession in OECD countries as their non-OECD markets sink into recession.

Quantifying this would be challenging but there are certainly many analogues, including the current pandemic.

Figure 10
Supply Disruptions Relative to Global Production (Months from initial point)



Source: Data from Petroleum Press Service and Energy Information Administration.

Industrial Organization

The second energy security concern centers on the possibility that more and more oil will be coming from national oil companies, including those in OPEC, but also primarily Russia though other smaller ones such as Ecopetrol (Colombia), Pemex (Mexico), and PDO (Oman). Additionally, major national oil companies like Oil and Natural Gas Corporation (India) and Chinese National Offshore Oil Corporation which are not exporters will control a growing amount of the market, largely as their own domestic markets expand. Table 2 shows production by company type (2019 data).

Table 2
Production by Company Type

	2019 Production mb/d
OPEC NOCs	29.85
OPEC+ NOCs	10.84
Other NOCs	11.94
MNOCs	13.31

Source: Oil & Gas Journal.

The behavior of these companies during a future oil supply disruption should be of concern. In the first oil crisis in 1973, the multinational oil companies (known as the Seven Sisters) controlled nearly all of the world's traded oil and largely equalized the shortage that occurred. In 1979, these companies were still buying much of the exporters' production, but that swiftly changed as exporting nations discovered that spot market sales were more lucrative (for a time). Additionally, many negotiated government-to-government sales which often included foreign aid as a sweetener but removed oil from the open market. The market became a free-for-all as refiners and governments scrambled to locate supply, bidding up scarce spot volumes.

Clearly, it would be nice to say that governments of the major oil importers tried to manage the market in 1979, but the reality was more a case of beggar-thy-neighbor. While governments collectively argued against panic buying on the spot market, nonetheless some demanded that companies build their inventories and others sought their own preferential deals with exporters—which usually translated into another customer losing supply and making panic purchases on the spot market. Several governments put pressure on private companies to give them preferential treatment, although not always successfully.

Similar behavior has occurred in other areas, including quite recently. Droughts have seen governments try to keep domestic food prices low by banning exports and the pandemic has seen a number of vaccine manufacturers attempt to block exports—including sometimes internally between states and provinces. Even in the U.S. there was an early scramble for medical equipment like ventilators with competing bids from different states that caused prices to spike.

In a new oil crisis, the IEA is supposed to implement the Emergency Sharing System to reduce hoarding and the detrimental effects of unequal shortages. Should this be used in the future, it seems unlikely that countries like Brazil, India, and China would cooperate. Whereas in 1973 and 1979, governments were largely unable to force domestically-based oil companies to give them preferential treatment, in a future crisis, it is unimaginable that, say, Chinese national oil companies will not obey government dictates to refuse any sharing of their supply, even if adequate for their own needs. Since China is certain to be an importer for many years, this would not mean withholding exports from the market but rather refusing to share their planned imports with nations in a worse situation.

The greater market share of state-owned enterprises will also mean more control over pricing and allocation through administrative decisions rather than market signals. Political interference with those decisions will also increase, which could prove to have negative economic consequences.

Other national oil companies in places like Mexico or Russia could, depending on leadership at the time, use their oil supplies to achieve political goals. A left-wing president of Mexico or Brazil might use their oil exports to get more favorable treatment of an ally, such as ending economic sanctions on Cuba or Venezuela. Conversely, a right-wing government in an exporter could use their supplies to hurt their enemies, such as discouraging trade with the aforementioned sanctioned nations.

Again, this could mean political instability as poorer nations that rely on the market or the private sector for their supplies find that shortages are concentrated on them. Whether this would be more severe than the impact of soaring prices and hoarding in 1979 is not clear but is certainly conceivable. And again, numerous scenarios in which instability in those nations affects the global economy can be created.

Spot Market

Something that has been largely unheralded is the role of the spot market in balancing 'shortages' when supply disruptions occur. In the 1970s, the spot market was fairly small, with most companies keeping their production within their own systems. By the 1980s, largely because national oil companies took greater control over their operations including marketing their crude, spot volumes increased dramatically. This was especially important in 1979-81, when spot prices were often quite high (and before NOCs abandoned the use of

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posted prices). Arguably, the first Gulf War in 1990 saw a moderate price increase in part because the availability of crude on the spot market reduced 'panic' buying and hoarding.

However, NOCs appear less likely to rely on spot sales than the private sector and if they come to dominate trade in the future, this could mean that the spot market will shrink. A future supply disruption could result in the kind of scramble seen in 1979, with companies and importing country governments trying to pry loose crude from existing trading patterns. Additionally, it seems unlikely that NOCs in importing countries like China and India would voluntarily yield some supplies to other importers, meaning unequal impacts. This could not only produce political instability but also cause supply chain bottlenecks as we have seen during the pandemic.

In such instances, strategic reserves of petroleum will be an important tool, but if OECD nations shrink consumption and imports, they will also probably reduce or even eliminate strategic reserves. Even if they don't, it's not clear that they would release them in a crisis that primarily affects non-OECD oil importing nations.

CONCLUSION

The IEA has suggested that, to reach the more extreme climate goals of Net Zero emissions in 2050, the oil industry should cease developing new oil and gas fields. However, since only the private sector is likely to follow such advice, oil production will become increasingly concentrated in the Middle East and Russia, which will not only affect market behavior but could have negative consequences in future oil supply disruptions. The ability of the IEA to implement its Emergency Sharing System during such a disruption will decline dramatically, and a severe recession in such a case is significantly enhanced. This policy advice could prove as detrimental as the 1980s insistence by the IEA that scarce (sic) natural gas should not be used in power generation, which resulted in a major increase coal burning.

APPENDIX A: ESTIMATED DECLINE RATES USED IN CALCULATIONS

As a first attempt, these numbers will be somewhat imprecise but give a sense of what could happen. Table A-1 shows the countries assumed to be affected. Production from OPEC+ countries are assumed to be the difference between non-OPEC+ and global oil production under the Sustainable Development Scenario of the IEA from 2020's World Energy Outlook. India and China are assumed to continue investment to maintain production. Brazil's decline rate is assumed halved given the important role of its NOC in the upstream. The data is for crude oil only, excluding NGPLs as they are driven partly by natural gas production.

Table A-1
Decline Rate Assumptions

		Production tb/d	Decline Rate Assumptions
North America: Canada	Offshore	285	12%
	Onshore conventional	920	7%
	Oil Sands	2,848	1%
North America: US	Offshore	1,614	15%
	Shale	7,500	30%
	Onshore conventional	3,800	7%
W. Europe	North Sea	3,100	12%
	Other	400	7%
Africa	West Coast	2,000	10%
	Onshore conventional	1,300	7%
S. America	Onshore conventional	2,300	7%
	Brazil	3,000	15%
Asia	China	3,900	7%
	India	770	7%
	Other	2,750	10%
	Total	36,487	

Source: The author.

In the Phase Out, the assumption is that upstream investment is currently just enough to offset depletion, so the production trend in year 1 is flat for all regions. After that, it is assumed that investment drops to 50% of 2020 levels by 2030 and zero by 2040. Thus, the trend in production grows gradually towards the natural decline rate from 2020 to 2040.

In the Dead Stop Scenario, it is assumed that no further investment occurs in the non-OPEC+ oil sectors and that production declines at the rates shown in Table A-1. Onshore generally is taken to decline at 7% per year, offshore at 12% per year. Oil sands, because they are more like a mining process, only decline at 1% per year, while shale oil production in the U.S. is assumed to decline at 30% in the first year. Many sources have noted that production from shale wells declines rapidly in the first year, often as much as 70%, but since the existing production is a mix of older and newer wells, 30% is taken for the decline in year one (2022), and after that the decline rate drops by 2% per year.

FOOTNOTES

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