

OPEC’s Role in the Path to Our Sustainable Future

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Abstract—We discuss the role OPEC producers can play in the transition to a net-zero future through shifting their financial investment capacity into alternative energy sources. OPEC producers, especially Saudi Arabia, could establish a significant advantage in becoming a dominant player in the hydrogen market.

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I. INTRODUCTION

Most energy scenarios paint a significant yet declining role for fossil fuel producers as we transition to a greener and possibly 1.5 - 2-degree COP 26 world (Paltsev, Ansari & Holtz). Of course, getting there by 2050 requires a huge – many trillions of dollars – investment in our energy infrastructure, particularly following the Ukraine war with the dramatic shift in Europe / Germany from Russian gas to LNG and sustainable sources. (Rystad, IEA). Global energy producers are fully aware of the uncertainties and climate pressures surrounding investment in our energy transitions. The question is how fast, how much investment, and how to finance?

TABLE 1

Contribution (%) to global primary energy use in 2018 and 2040.

	Current (2018)	Descriptive Scenarios in 2040				Prescriptive Scenarios in 2040			
		IEA	ExxonMobil	BP	MIT	IEA	Shell	BP	MIT
Fossil Fuels	81%	74%	76%	76%	73%	58%	61%	59%	56%
Hydro	3%	3%	3%	5%	2%	4%	2%	3%	4%
Nuclear	5%	5%	7%	3%	4%	9%	9%	8%	8%
Biomass	9%	10%	8%	3%	9%	12%	11%	4%	11%
Other renewables	2%	7%	6%	13%	12%	17%	17%	26%	21%

Notes: BP does not include traditional biomass (which affects other shares). For consistency, nuclear and hydro for BP and MIT are adjusted to the IEA conversion factors. The "Other renewables" category includes solar, wind, and geothermal. Shares may not add up to 100% due to rounding.

Figure 1: Scenario Comparisons from [2].

Needless to say, meeting our disparate energy needs as we transition towards a net zero world while making reasonable returns is particularly challenging for oil & gas producers, utilities, and burgeoning energy ventures. Many want fossil fuel companies to disappear, while some recognize the ongoing role of our heterogeneous energy producers. One

set of transition scenarios outlined by IEA, Rystad, the Hydrogen Council describes an increasing role of green and blue hydrogen / ammonia (with carbon capture) in our energy mix / industrial economies.

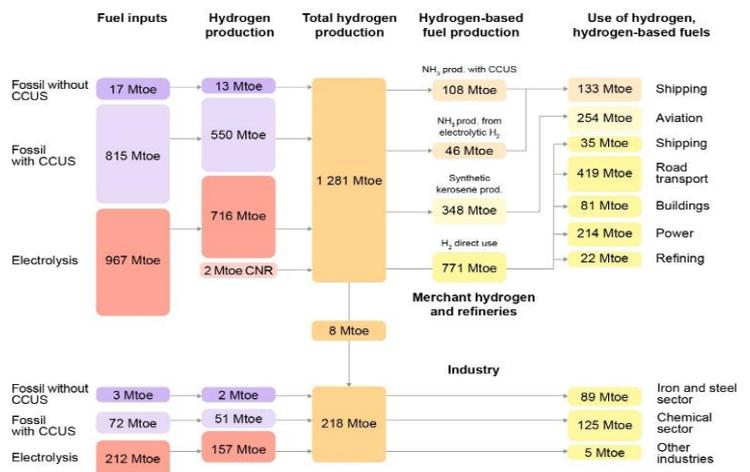


Figure 2 IEA Future of Hydrogen from [3].

II. ENERGY AGENTS

Today’s fossil fuel world which provides over 80% of energy supply is roughly divided into three stylized sets of producers with vastly different operating objectives, costs, resources (reserves), and management goals – Independent producers (IOCs), OPEC and National Producers (NOCs) + 1 (Russia), and shale producers. (note, not including coal agents.)

Each of these disparate group of producers, or agents, invests and produces with very different patterns that result in boom-bust investment cycles and varying degrees of production / supply flexibility (Saudi Arabia, as the primary swing producer – Pierru, et al). Given the variability and shifts in our energy markets (supply: demand shocks) oil prices have been extremely volatile and hard to predict over the past fifty years (IEA, scenarios; VAR, Killian, Hamilton, et. al). Consequently, making long-term thirty-year investments where there is a tremendous commitment of capital, people, and uncertain returns is extremely challenging. The war in Ukraine, climate crisis, shale revolution, demand shift to Asia, and continuing political upheavals are part and parcel of our complex energy history (IEA, Yergin, The Prize, The Quest)

Needless to say, energy company profits and investments reflect these market dynamics. In our research, we model an agent-based framework that differentiates the heterogeneous agent decisions showing the longer-term investment cycles and production flexibility of our energy suppliers. The actions of our messy OPEC cartel, particularly Saudi Arabia, is key to energy markets (shocks) and price volatility. Where and how much OPEC invests – and how other players react (supply and demand) -- matters much more than the majors (IOCs). We need little reminding that the price of oil / gas / electricity impact our everyday activities.

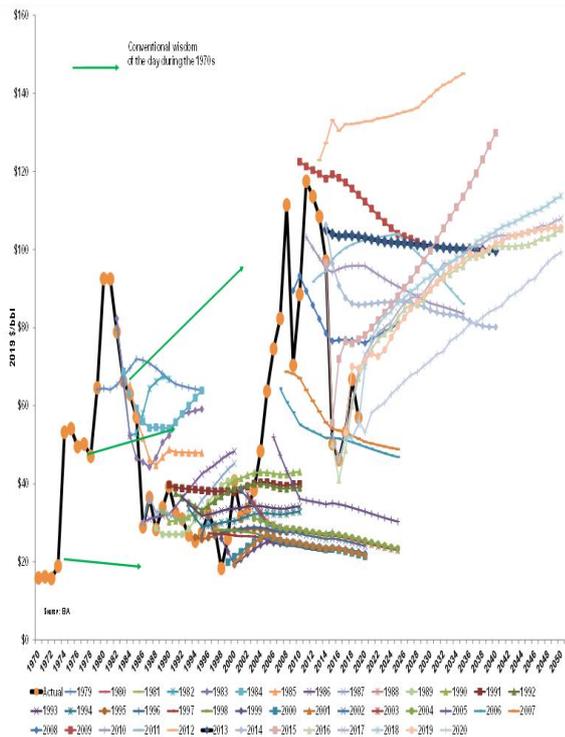


Figure 2: EIA forecasts.

III. INDUSTRY STRUCTURE, BEHAVIOR, AND CYCLES

One of the critical questions as we look to the future is how will energy agents, with tremendous capital, engineering and technical expertise invest over the coming decades. What role will they play in our transition to a cleaner and more sustainable world economy.? And how might the dynamics of energy markets change? Are we stuck with boom-bust cycles, price volatility, and uncertain returns.

IF we look back at fifty years of OPEC and non-OPEC decisions (and shale) there are some clear patterns as the OPEC oligopoly gradually found its supply / production / pricing power (Adelman’s messy oligopoly). In general, OPEC as the lowest cost producer with large reserves and spare capacity has shown more flexibility to adjust to market changes. Whereas non-OPEC producers show much wider investment swings that may lead to supply constraints or excess supply. As a result there is a good deal price volatility to energy market shocks (Killian et al).

AGENTS HETEROGENEITY

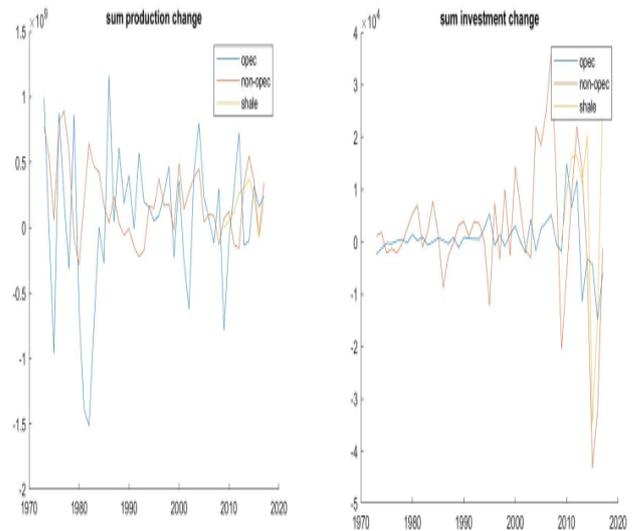


Figure 3: Taken from [3]. Graph shows heterogeneity in production/investment between different producer types.

Today, in our Climate / COP26, Ukraine War world, the NOCs, OPEC, and Saudi Aramco are reacting to differently to surprises and changed market dynamics. The majors seem to be locked in a fight for survival and political push back, trying to find a less risky space in which to operate. While the OPEC cartel (KSA) is actively investing in the future – after all, they will be the last low-cost oil & gas supplier operating in a desert with limited water and agricultural resources. The energy transition for the OPEC producers (and Russia) is key to the survival and vitality of the Middle East and Eurasian producers.

The OPEC agents are investing more than the major IOCs – even though it is difficult to differentiate the type of investment (expand oil & gas E&D, or more sustainable ventures). As we know, OPEC producers and Saudi Aramco are the dominant oil & gas producers with an overwhelming position in low-cost accessible reserves. Over the coming decade, Gulf producers will become the dominant supplier of gas and LNG to Europe and Asia. They are now making significant investments in blue hydrogen, CCS, as they begin to pursue the development of blue ammonia. Of course, the NOCs do not reveal the size, scale, or technical details of their blue energy investments. However, OPEC + clearly has a competitive advantage and incentive to diversify their fossil fuel economies.

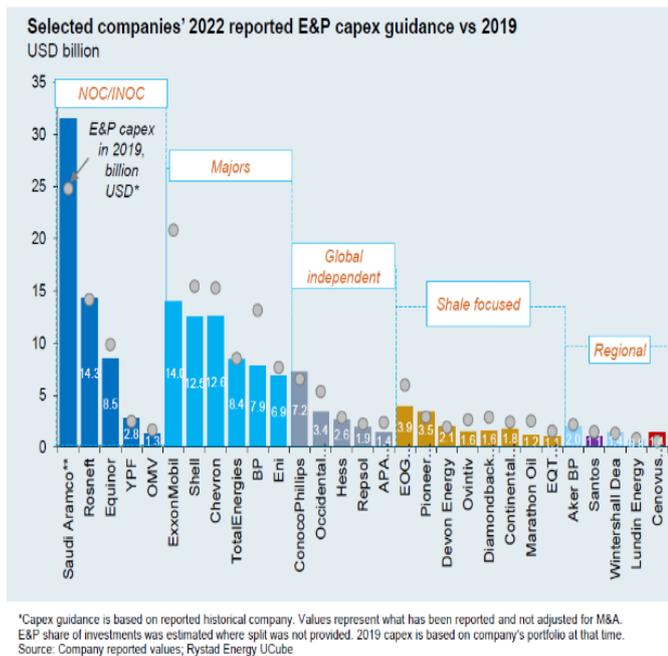


Figure 5: Capex guidance, from [11].

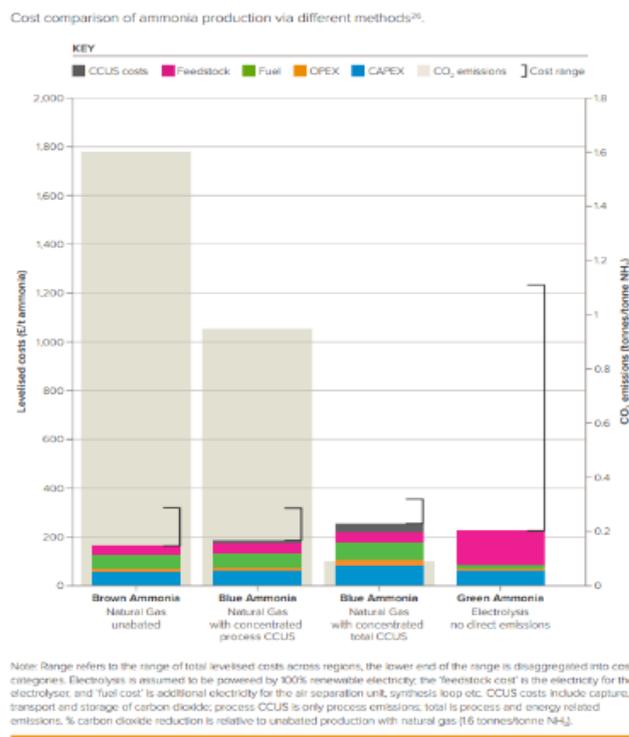


Figure 6: From [1].

IV. MODELING THE ENERGY INVESTMENT CYCLE OF OUR AGENTS

Will we continue to experience boom-bust with more surprises or find a more manageable path forward? We know that OPEC has the lowest production costs of blue hydrogen, and that CCS is essential to reducing its carbon footprint and that ammonia appears to be an easier fuel in terms of transportation logistics. Blue hydrogen and ammonia with CCS has the potential to be the dominant industrial fuel source over the coming decade. IF that is the consuming OECD countries make the necessary infrastructure investments, policy adjustments/coordination, and subsidies to make this happen. (See IEA, Hydrogen Review, Hydrogen Council, etc.)

For example, steel and cement making need to be reconfigured away from coke and high energy / heat fossil fuels to hydrogen / ammonia, which also means that you must have a pipeline, shipping, and port infrastructure to handle such transitions (many billions, if not trillions of euros). This requires a coordinated industrial policy involving producers, shipping / pipeline / transport players, ports / distribution centers, and manufacturing companies across different markets. Not an easy engineering or political task involving a myriad of parties.

Let us look for example, at blue hydrogen produced in the Gulf (Aramco) with an evolving carbon capture and storage (CCS) technology that can be sequestered in the underlying desert geology (less than \$100 / ton) and then the blue hydrogen is converted to ammonia so that it can be transported from the Gulf producing countries at much lower costs (5% or less than hydrogen) and delivered to a remodeled / new industrial / heating infrastructure in EU countries that have moved away from Russian gas. How this happens is another question.

26. International Energy Agency: The Future of Hydrogen, June 2019 <https://webstore.iea.org/the-future-of-hydrogen> (accessed Oct 2019)

The Gulf oil & gas producers are investing in the R&D of hydrogen / ammonia production as they see the revenue possibilities (see Aramco annual report). The EU is reeling from the Ukraine war everyone scrambles to adjust. We live in a very messy world, where it seems that the hydrogen / ammonia producers are making the huge investments to nudge us forward.

Our scenario analysis shows that the agents can adapt to a changing market environment in highly non-linear ways. In fact, as we extend our model to a set of strategies (with limited data), we see that NOC's may diversify their investments in a decarbonizing world that is less uncertain. The boom-bust investment cycles may not be as wide, nor prices so volatile. Getting this transition right – and modeling it – will take a pinch of luck and more coordinated policies across heterogeneous energy agents. This will not be easy.

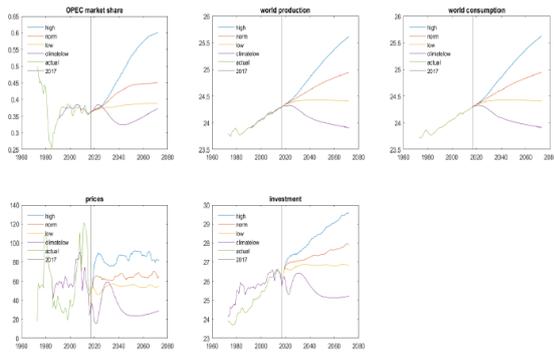


Figure 14: Scenario Outputs

The graphs show the projections under scenarios for OPEC, non-OPEC, and Shale producers. The line separates historical pre-2017 data from future scenario projections. Top-Left: OPEC Share of World Production. Top-Middle: the log of World Production. Top-Right: The log of world consumption. Bottom-Left: Prices in real 2017 USD. Bottom-Middle: The log of total investment.

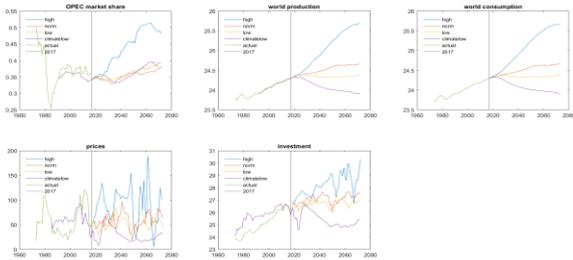


Figure 7: Scenario Modeling results from [3].
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Figure 17 shows a comparison of various fuels (including storage weights and efficiencies) for mobile applications using a range of different energy sources. Although hydrocarbon fuels store more energy, the greater efficiency of ammonia powered fuel cells means that, for example, direct ammonia fuel cells have a similar overall performance to liquid propane gas (LPG) powered internal combustion engines. Potential alternative low carbon energy vectors, such as lithium batteries and liquid-to-gas expansion systems, have a much lower energy density than all chemical storage options and their suitability is dependent on the energy demands of the journey.

Figure 4: From [1]