Global Energy Transition and Its Impacts on Arab Oil-Exporting Economies

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ABSTRACT

The discovery of hydrocarbons in the Gulf Cooperation Council[1] (GCC) countries, Iraq, Libya, and Algeria, hitherto Arab Oil and Exporters (AOEs), largely contributed to their economic development and improved their people's well-being. However, excessive reliance on hydrocarbons is believed to have slowed their structural transformation from natural resource-based to industrial, diversified economies. As the world economy gradually shifts toward clean energy, AOEs are deemed to face the long-term risk that hydrocarbons will lose their dominance in the global energy mix and that the vast resources they generate will be greatly reduced.

This paper sought to investigate this difficult issue, given the significant uncertainty surrounding the future of fossil fuels, by addressing two major questions. First, what are the implications of the global shift in the energy mix for AOE countries, and second, what strategies do these countries need to implement to continue developing at least at their past pace? To investigate both questions, we used the International Energy Agency's (IEA, 2021) Net Zero Emissions (NZE) scenario as a benchmark to evaluate the impact of global energy shifts on these countries. We developed a counterfactual path in which AOE will grow until 2050, based on IMF projections through 2030. Based on some assumptions, we projected major economic aggregates for 2050. In the event of NZE, countries would need to find alternatives to hydrocarbon production and exports. Under the full NZE scenario, AOE will need to replace around $800 billion in real terms of oil and natural gas exports in 2050. To achieve this target, AOE countries would require manufacturing output to grow at the rate of 8% until 2050, double the historical growth rate (4%). This additional output would require an additional $5.3 trillion in new investments between 2025 and 2050 for the AOE economies to face the economic repercussions of the NZE scenario.

Key Words: Arab Oil Economies, Global Emissions Scenarios, Energy Transition, Climate Change, Oil Dependence.
JEL Classification : Q43, Q48, F18, O13, Q56

1. Introduction

Human energy needs have been met throughout the centuries by various sources. As described by Grübler (2008) and Robert C (2013), humans initially harnessed energy from biomass, human and animal physical force, and charcoal to meet their energy needs. However, with the advent of the Industrial Revolution, most of the energy humans required came from vast reserves of fossil fuels such as coal, oil, and natural gas. The large amounts of energy derived from these fossil fuels have made possible the substantial economic growth that has taken place on our planet. This growth, in turn, has brought about a significant increase in the standard of living and the general welfare of the world's vast population. However, there have been negative consequences from the use of fossil-fuel energy. The use of energy extracted from fossil fuels has created a great deal of pollution globally through large amounts of greenhouse gases (GHGs) emitted into Earth’s atmosphere. These greenhouse gases have caused significant global warming, as well as climate change and even climate disruption.

While there are many very negative impacts from the use of fossil fuel energy already, excessive amounts of fossil fuels are still at the center of most human activities on earth. These activities continue to generate huge amounts of polluting Greenhouse Gases (GHGs) and other pollutants, causing severe climate change and more environmental destruction. The impacts of increased amounts of atmospheric carbon dioxide on the Earth’s atmosphere have been well established for many years. Fourier (1824) was the first to demonstrate the Greenhouse Effect and its resulting increase in Earth’s temperature. Arrhenius (1896) quantified the impacts of increased levels of atmospheric carbon dioxide, and Keeling (1958) measured the atmospheric concentration of carbon dioxide. The impacts of the expected changes in the climate on the world’s economy and the population were explored in the famous report “Limits to Growth” by the Club of Rome written by Meadows et al. (1972, 2004). In Stern (2006, 2007), the author quantified the costs to humans of continued atmospheric pollution and demonstrated that the costs of no action will be even higher. There have been huge advances in energy technology that have increased efficiency

[1] GCC countries are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE).

B. Laabas and W. Abdmoulah (eds.), *Proceedings of API Conference 2025: Empowering the future: Energy Transition and Economic Diversification in Arab Countries*, Atlantis Highlights in Sustainable Development 10,
https://doi.org/10.2991/978-94-6239-743-9_2

and reduced the rate of emitting atmospheric pollution. However, as the world's economies continue to grow, GHGs and other pollutants will continue to be released into the atmosphere.

Growing global warming is causing natural disasters such as flooding, droughts, extreme heat, and the disintegration of parts of the Antarctic ice mass. This ecological disaster has led to calls from the environmental community and institutions worldwide for governments to act concretely to combat global pollution by drastically reducing GHG emissions and developing strategies to mitigate the consequences already a reality. Since then, a succession of Climate Summits has been held worldwide. Conferences of the Parties (COP) established by the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 during the Rio Earth summit became the world's main forum for climate change action. As the COP's recommendations are implemented only voluntarily, many scientists and environmentalists are calling for more concrete actions. As the 'carbon balance' continues to shrink, current efforts to limit emissions are judged by many authors, such as Keohane, R. O., & Victor, D. G. (2011, 2016), to be insufficient. To keep the average global temperature, rise at or below 1.5°C above pre-industrial levels, all countries are expected to achieve Net Zero Emissions (NZE) by 2050 at the latest. This huge undertaking could be achieved by replacing all fossil fuels with 100% renewable energy, or by more innovation in energy technology that eventually captures all emissions associated with fossil fuels in use.

The number of countries committing to or pledging NZE by 2050 or 2070 is increasing. The future of fossil fuels, and thus that of Arab oil-exporting countries, could be dramatically affected by new international environmental policies that challenge their very development. Oil and natural gas exports are the main sources of revenue and foreign exchange earnings for these countries. Fasano and Wang (2001) and Wang and Fasano (2002) showed that economic activity in oil-based economies is closely tied to hydrocarbon revenues, primarily through government spending and imports of goods and services. Furthermore, inflation, population growth, and rising costs of living in oil-producing countries will necessitate higher oil prices to maintain their internal and external balances.

Although natural resources are often regarded as a "curse" (Auty, 1983; Gelb & Associates, 1988; Sachs & Warner, 2001), Arab oil-producing countries, thanks to their natural resource endowments[2], have, in general, built relatively stronger economies, enjoyed rapid increases in national income, and achieved human development beyond what their non-oil-producing Arab counterparts have achieved. However, their natural resource endowments also pose challenges to their long-term economic and social development. In addition to the global challenges the energy transition poses for oil-producing countries, there are economic challenges stemming from their dependence on hydrocarbon production. These challenges include limited diversification of export commodities and slow structural transformation, leaving oil-producing countries heavily dependent on a volatile major revenue source. As a result, oil-producing economies are extremely sensitive to large fluctuations in energy prices and are vulnerable to them, and their economic growth closely follows global business cycles. Yet the large foreign reserves or sovereign wealth funds these countries possess so far have helped them absorb global nominal and real shocks and maintain macroeconomic stability despite a volatile economic environment. However, relying on government spending and oil revenues as the drivers of economic growth has constrained growth in the non-oil sectors and introduced significant uncertainty, particularly for private investment. With oil production remaining quasi-constant, pressure is mounting on government budgets to meet the needs of an increasingly large population and an inflated public administration. As a result, the breakeven[3] oil price for fiscal revenues and external balance has increased, while the government's fiscal space to respond to challenges or invest in the economy has decreased.

This study investigates the effects of the global energy transition, driven by environmental change policies, particularly those targeting net-zero emissions (NZE), on the economies of Arab oil-exporting countries. It seeks to identify strategies and policies that AOE countries could pursue to avoid an economic catastrophe that would jeopardize decades of economic achievements built on oil and natural gas wealth. It also highlights the development experiences of Arab oil exporters and how these could be affected by environmental change policies and challenges. Section two examines the relationship between economic development and climate change, and how human behavior responds to environmental imbalances. Section three describes the current economic and institutional structures of oil-based economies and the numerous challenges they face that would be affected by the energy transition. Section four discusses different energy transition scenarios and their projected impacts on global energy markets. Using historical growth rates, counterfactuals are constructed for major economic and financial indicators

[2] Arab Oil Producers hold around 43% of global oil reserves, 31% of global oil production, 47% of global oil exports, and 28% of global natural gas reserves. Energy Institute (2025), Statistical Review of World Energy 2025, 74th ed., London: Energy Institute. Available at: https://www.energyinst.org/statistical-review
[3] Source: World Economic Outlook April 2026, International Monetary Fund

for Arab oil-exporting countries through the middle of this century. In section five, we examine the implications of Net Zero Emissions (NZE) for individual Arab oil-exporting countries, highlighting how expected declines in global oil and gas demand will shape their economies. Section 6 of the report examines the implications of phasing out fossil fuels in the NZE scenario on AOE economies and policies needed to sustain previous economic growth.

2. Economic Development and Climate Change

Despite recurring economic and financial crises, the global economy has witnessed robust, although uneven, economic growth over the past decades. In fact, global output, in real 2015 prices, increased from around $11 trillion in 1960 to $96 trillion in 2024. To sustain this enormous economic growth, energy consumption rose sharply, particularly in energy-intensive polluting industries such as steel and cement, as well as in the transport sector. The corresponding greenhouse gas (GHG) emissions even increased to alarming levels. The emissions calculated by the EDGAR[4] database show a 1.7% rise from 31.3 billion tons of CO2 equivalent in 1990 to 54 billion tons in 2024 (71% is CO2, 18% is CH4, 6% is N2O, and 5% is other gases). Although there is a positive correlation between global economic activity and GHG emissions, the latter have increased less than global output, mainly due to increased efficiency, as depicted in Figure 1.

For decades, developed countries have been held by critics as responsible for polluting the atmosphere and thus for causing global warming and climate change. Newly Industrialized and Emerging Economies (NIEs) are, however, also emitting more pollution into the atmosphere, as shown in Figure 2. Latest data on air pollution indicate that the share of the high-income countries in ecological pollution decreased from 69% in 1970 to 33% (World Development Indicators, WDI, 2026). The upper-middle-income countries have more than doubled their emission share from 22% to 46%. In marked contrast, low-income developing countries saw a modest increase in their emissions share from 1% to 2%, while lower-middle-income countries increased their emissions share from 8% to 15%. The ecological pollution by the most industrialized countries of the world is the root cause of global warming and climate change. But newly industrialized and emerging countries are increasingly becoming major polluters. The bulk of GHG emissions are emitted by activities located in the high- and upper-middle-income countries.

According to the International Energy Agency (IEA, 2026), total emissions in 2025 reached 37.4 Gt of CO2e, 42% of total carbon dioxide emissions were from coal, with 68% of that from the power sector. Emissions from burning oil account for 33% of total emissions and originate mainly in transport (63%). Emissions from natural gas account for a further 23% of total emissions produced mainly in industry (46%) and the power sector (27%). The energy sector accounted for 37% of total GHG emissions, followed by the industry by 24%, the transport sector by 22%, and buildings by 8%. Figure3 illustrate the structure of global emissions by major energy sources.

Based on historical data from 2000 to 2025 (WDI, 2026), global energy supply increased by an average of 1.6% p.a, from 422 Exajoules (EJ)[5] in 2000 to 655 EJ in 2025. This growth is much lower than global economic growth due to increased efficiency, as shown in Figure 4. However, a large share of the global energy supply is still provided by fossil fuels, which dominate the global energy mix at 80% in 2025, while only 5% is provided by nuclear energy and 15% by renewable energy. Despite the clear dominance of fossil fuels, progress in energy efficient technologies and stricter environmental protection policies kept the rate of emissions relatively low. Data from WDI (2026) show that emissions increased only by 0.8 % p.a. during 2000-2010, decreasing further to 0.41 % p.a. for the period from 2010 to 2025. Global GHG emissions increased from 23.5 Gt in 2000 to 37.4 Gt of CO2e in 2025. The carbon budget[6] is estimated between 400 and 500 Gt of CO2e, which corresponds to a temperature increase of 1.5 °C above the pre-industrial level, and at the current emissions rate, will be exhausted in about 10-14 years. This remaining carbon budget corresponds to only a small fraction of the potential emissions from the over 3.5 trillion tons of fossil fuel equivalents already on Earth, which is estimated at 48 GT of CO2e, more than 12 times the remaining 1.5 °C carbon budget. Climate change cannot be addressed if the global economy continues to depend on fossil fuels for its energy supply. One of the main reasons cost-effective solutions are not being deployed to cut emissions is the high cost of alternative energies, non-mature technology, and political skepticism about climate change. Yet things are changing. The annual review by the international think tank EMBER (2026) published in early 2026 stated that renewable energy's share of the global energy mix is increasing fast and is already dominant in power generation; however, it is still not big enough to seriously cut global emissions. The annual review noted that in the European Union 47.7% of the electricity is already generated from renewable energy sources. Moreover,

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[4] Global greenhouse gas emission estimates vary among international organizations due to differences in methodologies, data sources, and measurement ranges used in each assessment. IEA estimates GHG at 37 Bn Tons, because higher estimates of EDGAR include all greenhouse gases, including methane and nitrous oxide

[5] One Extra Joule equals 10^{18} Joules

[6] https://unclimatesummit.org/three-years-left-of-remaining-carbon-budget-for-1-5c/?utm_source=chatgpt.com

the review stated that in the EU the share of electricity produced from fossil fuels has declined to 16.7%, and that of coal decreased to 9.2%, whilst globally renewable energy accounts for 40% of total electricity generation; with 14% produced by hydropower, 8.1% by wind power, 7% by solar power, and 2.3% by bioenergy. Thus, as noted above, in the global power generation market, the share of electricity produced from renewable energy sources is increasing rapidly and in most cases is becoming the dominant source of power generation. However, it remains true that the global energy mix is comprised of 66% of energy from fossil fuels, followed by 34% from other sources of energy.

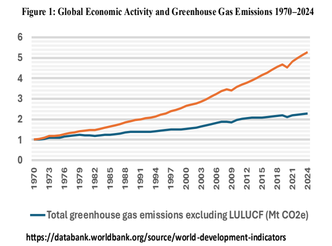

Figure 1: Global Economic Activity and Greenhouse Gas Emissions 1970–2024

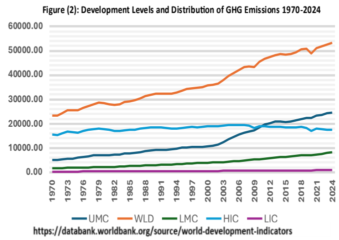

Figure (2): Development Levels and Distribution of GHG Emissions 1970-2024

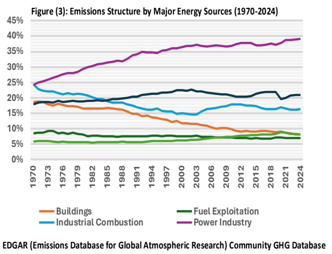

Figure (3): Emissions Structure by Major Energy Sources (1970-2024)

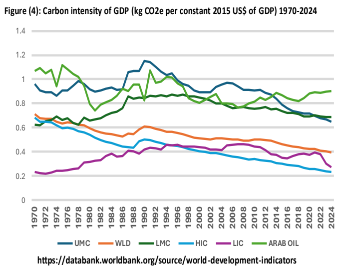

Figure (4): Carbon intensity of GDP (kg CO2e per constant 2015 US$ of GDP) 1970-2024

3. Developmental Challenges of Arab Oil-Exporting Economies

The energy transition, which aims to quickly eliminate emissions from fossil fuels to fight climate change, is rapidly revolutionizing the global energy model. As Arab oil-exporting countries rely on hydrocarbons for their economic development, they face a dual challenge of transitioning to low-carbon economies to address the consequences of climate change and pursuing a long-term vision for new, non-fossil-fuel-based economies. The transition to a low-carbon economy will be complex, as these countries are struggling to come to terms with the consequences of climate change while simultaneously grappling with the rapid changes driven by the global energy transition and the new global energy model, which is gradually but inevitably turning away from fossil fuels.

Revenues from hydrocarbon exports remain the largest single source of finance of the balance of payments accounts and public expenditure of oil-exporting countries, as shown in Table 1. Although these revenues provide comfortable financial leverage, the excessive increases in imports and public expenditure have raised budget breakeven oil prices to levels that are either close to or exceed current market oil and gas prices[7], leading to an increase in the public debt ratio, as shown in Table 1. Oil and natural gas prices are also highly volatile, and there is a risk that they will decline sharply in the event of new, more efficient energy technologies, reduced demand relative to supply, or geopolitical shifts. The world is currently undergoing an energy transition and as such the oil and gas market is expected to shift from a 'peak oil price' model to a 'peak demand' model[8] with low oil prices in the future bringing severe consequences for countries with economies heavily reliant on their oil and gas exports. Therefore, the task of implementing structural reforms to mitigate the effects of the global energy transition is a particularly difficult one for oil-exporting countries.

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[7] IMF data portal

[8] McGlade, C., & Ekins, P. (2015). Nature, 517, 187–190.

Table (1): Public Revenue Structure 2022-2025

Country	Total Revenue % GDP	Tax revenue % GDP	Oil revenue % GDP	Non-tax revenue % GDP	non-tax % of total revenue	Net budget deficit % of GDP	Primary budget deficit % of GDP	Non-oil budget % GDP	Public debt % of GDP	Budget Breakeven Prices 2025 (Market Price 68) US$
Emirates	32.82	17.47	--	15.36	47%	6.4	7	-10.5	34.9	50.0
Bahrain	20.85	2.79	12.21	18.07	87%	-10.6	-4.1	-24.2	133.4	137.0
Algeria	28.92	8.5	--	20.41	71%	-13.8	-12.7	-29.6	48.1	157.0
Iraq	42.85	1.0	--	41.85	98%	-4.1	-3.5	-63.2	46.5	79.0
Kuwait	63.05	1.04	47.72	62.01	98%	23.8	-1.1	-79.3	2.9	80.0
Libya	85.78	0.76	83.94	85.02	99%	-25.1	-25.1	-244.5	--	67.0
Oman	34.39	3.49	--	30.9	90%	3.3	3.6	-98.8	36.5	57.0
Qatar	22.79	3.11	17.91	19.68	86%	0.7	2	-33.2	41.2	45.0
Saudia	30.56	7.9	20.37	22.66	74%	-2.5	-2.4	32.3	26.2	92.0
Average	40.22	5.12	36.432	35.11	83%	-2.43	-4.03	-61.22	46.2	85.0

Source: EDGAR DATABASE

Arab oil-exporting (AOE) countries are financially and economically dependent on hydrocarbon extraction and export. However, this strategic resource enabled them to achieve considerable progress in economic development, especially in small-population countries or countries with huge oil and gas endowments. In fact, the AOE countries' real GDP[9] reached almost three trillion USD in 2024, accounting for nearly 87% of the total Arab output. Likewise, AOE countries' per capita income reached $29,000, and that of the Gulf Cooperation Council (GCC) countries $35,622. Large-population countries like Algeria and Iraq have lower per capita income than GCC countries but exceed that of Arab non-oil-exporting countries. Thanks to hydrocarbon, Arab oil-based economies achieved an average economic growth rate of 4% from 2000 to 2024, compared with just 2.6% for Arab non-oil-exporting countries.

The oil booms enabled the Gulf states to achieve a high-income status[10]. Oil has contributed significantly to higher income levels in non-Gulf oil-producing countries compared with non-oil Arab countries. Hydrocarbon exports have enabled these countries to raise income levels. However, oil and gas endowments are thought to have delayed structural transformation and the shift toward more diversified, endogenous, and sustainable economies. Economic development is regarded as a process of structural transformation from a low-income, resource-based primary economy to a modern, industry-based economy, and ultimately to a post-industrial, service-based economy. Structural change is reflected in production and foreign trade structures, as well as in labor distribution and productivity. The literature on these issues goes back to work of Clark (1940), Lewis (1954), Kuznets (1966), and Chenery and Syrquin (1975a, 1975b, 1979). Structural transformation is a process of economic development that increases per capita income. It is characterized by changes in the relative sizes of the primary (agriculture and extractive industries), secondary (industrial), and tertiary (service sector) activities. Lal (2000) also noted a shift in the share of low-tech (extensive) and medium- and high-tech (intensive) activities within each sector.

The work of Chenery and Syrquin at the World Bank has shown that the pace and pattern of structural transformation are generally shaped by several factors, including the size of resource endowments and the size of the economy, the degree of openness to foreign trade, and the production orientation. Postponing industrialization is a common strategy among many naturally endowed developing countries. This phenomenon has been examined from several perspectives and is particularly associated with the Dutch Disease. Corden and Neary (1982) argued that large inflows of resources from the discovery of natural resources lead to a real appreciation of the exchange rate, making goods and services exports more expensive than those of competitors. This, in turn, leads to increased imports at the expense of domestic production. This built-in bias against exports can therefore hinder industrialization in the absence of an industrial policy that corrects this market failure. However, the shift toward non-

[9] Data on GDP in real prices, per capita, and growth, Base year 2015, is from the World Bank WDI.
[10] UNIDO also classifies the Gulf States as high-income countries in the industrialization stage, a category of high-income countries according to the World Bank's classification, excluding OECD members.

tradable goods does not necessarily translate into an improvement in the real exchange rate. Increased domestic spending, driven by the resource boom, is often diverted to rent-seeking and non-tradable activities that do not add significant value to tradable goods production. As a result, Sacks and Warner (2001) argued that increased resource endowments can be a curse rather than a blessing for many countries, and, in Beblawi's (1987) terms, a rentier state.

Globally, the mining sector contributes to output by only a small fraction, and its share declined from 7% in 1970 to just 5.7% in 2024. For Arab oil-exporting countries, the mining sector contributes substantially to output, but nevertheless, its share declined from 57% in 1970 to 27% in 2024. However, there are substantial differences between AOE countries. Contrary to global trends, the share of the manufacturing sector in the output of Arab oil-exporting countries did not progress remarkably between 1970 and 2024 and, in most cases, did not even reach 10%. On average, the share of the manufacturing sector in the GDP of Arab oil-exporting countries was 5% in 1970 and 8% in 2024. This is far below the world average (15%) and below the averages for newly industrializing and fast-industrializing countries (in some cases, even twice the average for these groups). However, there are large differences between individual countries. The non-Gulf oil-producing countries are currently experiencing industrial stagnation and even de-industrialization. This is largely due to the failure of the development model these countries have been following, i.e., a state-driven model rather than a market-driven one, to achieve economic growth. This model of development was unsustainable for several reasons. First, there was a politico-economic crisis of huge proportions in some countries (e.g., Algeria and Iraq in the late eighties and nineties), and second, a period of unrest in others (e.g., Iraq and Libya). The Gulf countries have seen the manufacturing sector's share of GDP increase between 1970 and 2024. However, this increase has been slow. The share of agriculture has remained low, while that of the mining sector has decreased gradually. Consequently, the share of the services sector in GDP has increased across all countries in the region, and in some cases, it even exceeds 50% of total GDP. In most cases, however, growth in the services sector has been concentrated on non-traded activities, such as real estate, as well as in government services.

Changes in production structures are reflected in shifts in trade patterns and in structural transformation. As the share of medium- and high-technology goods and other high-value products in exports increases, the share of natural resources declines. The exports of Arab oil-exporting countries have not undergone major fundamental changes in their composition. Hydrocarbon exports accounted for nearly 88% of the merchandise exports of Arab oil-exporting countries in 2000. This share declined by just 14 percentage points over 24 years, to 74% in 2024. The decline in the share of hydrocarbon exports was more pronounced among the GCC countries. The share of hydrocarbon products in the commodity exports of GCC countries declined from about 84% in 2000 to about 55% by 2024. Crude oil and gas continue to dominate the commodity trade of non-GCC countries, with very high shares, estimated at about 94%. The decline in hydrocarbon exports as a percentage of total exports is more pronounced in Bahrain (around 31%), Oman (56%), and the UAE (40%)[11].

While non-hydrocarbon exports of oil-producing countries have been increasing in recent years, few have yet developed a significant comparative advantage in processed and manufactured goods. Based on UNCTAD data[12] on revealed comparative advantage (RCA) for 2024, the average number of goods for which oil-exporting countries have an apparent comparative advantage (RCA > 1) never exceeded 24. The vast majority of these are natural resources, traded as primary products or semi-manufactured goods. Thus, hydrocarbons remain the major export commodity for most of these countries and are traded in highly concentrated markets due to high logistics costs. The value of Hirschman (1945) and Herfindahl (1950) which measure the extent of commodity export concentration shows high levels of concentration in AOE countries compared to global average. Average export concentration in 1995 was 0.66 in AOE countries, 0.61 for GCC countries, much higher than the global average of 0.05. AOE countries did not show noticeable progress in export diversification, with an index value of 0.49 in 2024. Likewise, export

[11] This increase is due to the expansion of re-export activity. If this activity is excluded, the percentages decrease significantly. https://unctadstat.unctad.org/datacentre/dataviewer/US.TradeMatrix

[12] UNCTAD statistics database: https://unctadstat.unctad.org/datacentre/dataviewer/US.TradeMatrix

market diversification[13] for Arab oil producers decreased from about 0.78 in 1995 to about 0.73 in 2024, indicating high concentration in hydrocarbon markets, probably due to the high transport cost of crude oil and LNG.

The Industrial Competitiveness Performance (ICP) index published by UNIDO[14] is another important metric that helps researchers assess export performance. The ICP is a composite index based on the value and quality of manufacturing production and exports. Over the last 30 years, Arab oil-exporting countries have had ICP Index values below average, with considerable differences between countries. The ICP Index of Arab oil-exporting countries ranged from 0.001 to 0.12, while the leading countries reached index values of 0.32 for Korea and 0.41 for Germany in 2023.

The industrial competitiveness of the Arab oil-exporting countries presented a mixed picture over the last 30 years. The UAE's ranking improved significantly from 79th worldwide in 1990 to 31st in 2023, due to considerable development of re-exports outside the oil sector. This positive development is also reflected in Oman's improved ranking, from 107th in 1990 to 60th in 2023. On the other hand, the ICP rankings of the other Arab oil-exporting countries, i.e., Kuwait, Bahrain, and Saudi Arabia, did not improve. Their rankings in 1990 were 72, 48, and 41, respectively, whereas in 2023 they were 68, 48, and 41. Qatar's ranking even declined from 45th in 1990 to 51st in 2023.

ICP sub-indicators suggest low manufacturing intensity and poor quality of industrialization across most countries. However, some Gulf countries perform better than others on these indicators. From another perspective, for several countries in the region, including Bahrain, Kuwait, Oman, and Qatar, the ratio of medium- to high-technology industrial production to total industrial production increased over the period under review. Moreover, the ratio of medium- to high-technology exports to total exports increased notably for Qatar and Saudi Arabia. While manufactured goods account for a small share of the region's total merchandise exports, resource-based manufactured goods constitute the bulk of these exports. As such, medium- to high-technology manufactured goods would represent an even smaller percentage of the total merchandise exports from countries in the region.

Economic complexity is a powerful predictor of future potential for innovation, sustainable growth, and even industrial transformation. The Economic Complexity Index (ECI)[15], developed by Hidalgo and Hausman (2009) at MIT and Harvard University, measures a country's "intrinsic potential" based on its actual ability to export goods (i.e., its production capacity) and relates this to a country's production capabilities for entering new markets, as well as to its underlying institutions, technology, and human capital. However, it is worth noting that the index is highly biased against countries pursuing import-substitution strategies, such as Algeria. Nonetheless, a high ECI score indicates the country’s potential for future growth. A low ECI score, on the other hand, often reflects a focus on simple, common products and indicates a natural resource-rich country with limited diversification and industrial complexity, leaving the economy vulnerable to external shocks.

ECI estimates for the Arab oil-exporting countries over the 2012-2024 period are presented in Table 2 below. Most of the countries in this group today are at a low level of economic complexity because the commodity space of high-complexity goods they can produce is very narrow. Some countries have traveled further along the complexity path than others, but for most, the distance their 2024 ECI indicator is from the 2012 level is not very large. Looking at the indicator scores for the AOE countries in 2024, we see that Saudi Arabia, the UAE, and Bahrain (0.50, 0.37, and 0.27, respectively) achieved positive values, followed by Kuwait and Qatar (0.26 and 0.06, respectively). Among Arab oil-exporting countries,

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[13] The diversification index published by UNCTAD measures the absolute deviation of a country's trade structure from the global structure. This index is a modified measure of trade similarity based on the Finger-Krainen (model, with a value ranging from 0 to 1. A value closer to 1 indicates a greater divergence from the global pattern.
[14] https://stat.unido.org/data/table?dataset=cip#data-browser
[15] MIT Observatory of Economic Complexity: https://oec.world/en/resources/data/

four countries improved their rankings between 2012 and 2024: Oman, Iraq, Libya, and Algeria, but the ECI indicators for all these countries remain below the group average and registered negative values.

Table (2): Industrial Complexity Index 2012-2024

Country	2012		2024		Change in Rank
	Index Value	Rank	Index Value	Rank	
Algeria	-1.43	130	-1.06	118	12
Bahrain	0.5	53	0.27	65	12-
Iraq	-2.27	142	-1.55	130	12
Kuwait	-0.41	92	0.26	66	26
Libya	-2.47	145	-1.71	134	11
Oman	-0.37	90	-0.54	100	10
Qatar	-0.27	84	0.06	78	6
Saudia	0.44	56	0.50	50	6
Singapore	1.41	9	1.45	5	-4
Korea	1.61	3	1.56	4	1-
Emirates	0.68	45	0.37	57	12-

Source: Atlas of Economic Complexity https://atlas.hks.harvard.edu/rankings. ECI is a standardized Z-score variable ranging between -3 and +3

Using ECI alone does not fully capture the range of opportunities and challenges facing countries, because economic complexity does not depend only on the variety of goods a country exports but also on the complexity of the goods it produces. The Product Complexity Index (PCI) for a product reflects the knowledge applied to its production and a country's potential to export it. PCI data for 2014 showed that the most complex product traded internationally was "photographic plates and films, excluding motion pictures" (HS 3705), with a PCI of 2.21, followed by other industrial and high-technology goods and services. By contrast, the simplest exported commodity was "cocoa beans, whole or broken, raw or roasted" (HS, 1801), with a PCI of -4.83. Many primary commodities have the lowest complexity levels because they account for a large share of most countries' total exports, implying that the conditional probability of exporting other commodity pairs is very close to zero.

The average PCI for all hydrocarbon products (crude oil, natural gas, and refined products such as gasoline and diesel) is approximately -1.5. Most of the natural resources used in these products, and therefore in the industrial complex that produces their exports, are limited. The average PCI for the petrochemical group is rising from 0.6 to 0.8. The growing share of more industrial and technology-oriented products in the manufacturing value added of oil-based countries can serve as a platform to increase the complexity of their exports over time. For oil-exporting countries, however, most of their exports consist of low-complexity hydrocarbon products, so they cannot shift to more complex manufacturing and are therefore exposed to commodity price volatility. Table 3 ranks several hydrocarbon and petrochemical products by their PCI. The table lists the weighted averages of petroleum exports by product for oil-exporting countries in 2024, for which data are available.

Table (3): Complexity of Hydrocarbons and Petrochemicals In Arab Oil Countries, 2024

Country	PCI Hydrocarbons	PCI Petrochemicals	
Saudia	−2.1	0.8	Large crude oil exports, but a relatively advanced petrochemical sector
Kuwait	−2.1	0.6	Heavy reliance on oil with less developed petrochemicals
Iraq	−2.1	0.3	High oil exports with limited petrochemical activity
Qatar	−1.9	0.9	Relatively strong gas and petrochemical exports
Emirates	−1.9	0.7	Mild mix of hydrocarbons and petrochemicals
Algeria	−2.0	0.4	Most exports are hydrocarbons, with a small petrochemical industry
Libya	−2.1	0.1	Almost entirely focused on crude oil
Oman	−1.9	0.7	Oil and gas exports with moderate petrochemical capabilities
Bahrain	−2.0	0.6	Limited oil exports and moderate petrochemicals

Source: Computed by author, data from the Observatory of Economic Complexity and UNCTAD https://oec.world.en

The Economic Complexity Observatory also provides Country Profiles in the so-called “Commodity Space.” Commodity Space is a network that maps possible interconnections among products that require specific production capabilities. Focusing on Arab oil-exporting countries, we find that the commodity space for these economies is very sparse, largely concentrated in a small cluster of low-complexity energy-related industries, including the production of refined petroleum products, petrochemicals, fertilizers, and basic plastics. In contrast to South Korea and Singapore, with their highly diversified economies, the oil-exporting Arab countries, such as Algeria, Saudi Arabia, Kuwait, Qatar, Iraq, and Libya, are positioned at the rim of the product space. Yet they could potentially expand into adjacent (low-hanging fruit) areas of the product space with sufficient industrial capability.

The commodity space for Arab oil-exporting countries is primarily peripheral, with low network density and few opportunities for diversification in the immediate vicinity that could facilitate structural transformation and a shift toward more complex manufacturing activities. Although the countries have production capacity at certain levels, not in absolute terms, their natural resource endowments direct production toward commodity-related activities. In contrast, Korea and Singapore have a dense capacity network for commodity-based activities, which facilitates diversification into highly complex and valuable activities.

4. Future Scenarios for Combating Emissions and the Future of Fossil Fuel

Greenhouse gas emissions, which have increased over the years, have significant impacts on the environment and human health. The large quantities of burnt fossil fuels since the Industrial Revolution have led to global warming. The IPCC (2023) estimated that the Earth's temperature has increased by 1.12 °C, and Bevacqua et al (2025) put the number at 1.3 above the pre-industrial baseline of 15 °C. Scientists expect the increase to exceed 1.5 °C by 2050 and 2 °C by 2100. Only a drastic reduction in emissions, accompanied by a sharp decrease in associated greenhouse gas concentrations, will curb these impacts (IPCC, 2021)[16].

Following the publication of warning reports, such as “Limits to Growth” by Meadows et al. (1972) and its later updates in 1992 and 2004, Stern (2006, 2007), and the Blueprint for the Future” by Dixson-Declève et al. (2022) and the scientific work of the IPCC, the world has become more aware of the serious problems that environmental pollution can cause for humanity. The Club of Rome reports (Limits to Growth) were produced using system dynamics modeling to forecast future impacts of climate change on the global economy and Earth’s ecological equilibrium. The authors relied on Malthus's (1798) philosophical views on limited natural resources and exponential population growth. The Club of Rome reports predicted serious conflicts that will be caused in the future by population growth, pollution, and the “irresponsible” consumption of non-renewable natural resources. To the authors, only technology has given humanity some extra time, but in the end, catastrophe is inevitable. They argue that a radical change in consumption and production patterns, previously focused on fossil fuels, is required to adopt clean energy and promote sustainable development. The key to these changes is responsible consumption and production.

The scientific evidence supporting efforts to combat global warming is now firmly grounded in evidence. More than ever before, scientists are producing more evidence on global warming and its consequences (UN IPCC, 2022)[17]. To combat warming, the global community has convened high-profile summits to build momentum in the fight against climate change. It started with the Stockholm Conference in 1972, which created the UN Environment Program (UNEP); in 1979, the Geneva Conference focused on climate change; and in 1988, the IPCC was established as a scientific organization on environmental issues. This was followed by the creation of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 during the Earth Summit in Rio de Janeiro to oversee global negotiations on environmental issues. In 1995, the first Conference of the Parties (COP) was held in Berlin as a forum for coordinating climate action, and in 1997, the first legally binding GHG targets were adopted under the Kyoto Protocol. In 2015, the landmark Paris agreement was reached to limit global warming. At the UNFCCC conference, around 200 countries reached a historic milestone in the organization’s development by agreeing to the Paris Agreement. The central objective of the Treaty is to prevent global warming from exceeding “well below 2 ° C” and, if possible, from exceeding 1.5 ° C. Since the meeting in Paris, countries around the world have been working to honor commitments already made under the UNFCCC to achieve the objectives of the Treaty to Prevent Global Warming. In this context, many countries are pledging to achieve Net Zero Emissions (NZE) by

[16] IPCC. (2021). Climate Change 2021: The Physical Science Basis. Cambridge University Press.
[17] IPCC (2022) Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report. Cambridge: Cambridge University Press.

2050. The medium-term pledges by countries, presented as their Nationally Determined Contributions (NDCs[18]), are intended to help honor their existing commitments to achieve the 17 Sustainable Development Goals (SDGs) set by the United Nations in 2015 for the period 2024–2030. More than 180 countries have submitted NDCs pledging to substantially curtail emissions; however, critics point out that these pledges are clearly insufficient to meet commitments to prevent global warming from exceeding 1.5 °C by 2050.

There are significant challenges to transitioning to new, green energy systems. Although some steps forward have been taken and environmental "greening" measures have already been incorporated into many countries submitted NDCs, the difficulties outweigh the successes in countries' efforts to combat climate change and to invest in the transition to clean energy. These difficulties stem, above all, from the high cost of transitioning to clean energy, and from the very serious impacts of climate change that have already occurred and continue to unfold in many parts of the world. The World Bank (2010)[19] estimated climate change costs for developing countries between $140 billion and $300 billion in 2030 and between $500 billion and $1 trillion in 2050; and will cost developed countries an average of $2–4 trillion per year between 2023 and 2030 to meet commitments to keeping the temperature from increasing by more than 1.5°C above the levels before the era of industrialization. The Stern (2006) report and its subsequent updates have estimated the global costs of unmitigated climate change at around 5% of the world's GDP annually. In total, the effects of inaction on climate change would cost more than the costs of mitigation. Early action to counter climate change would likely be less expensive than allowing the same effects to worsen over a longer period and then addressing them. Also, a great deal of variability exists among countries in "greening" their NDCs and in investing in the energy systems transition, which introduces considerable uncertainty about future developments in these areas and about the future oil and gas reserves of the Arab oil-exporting countries.

To gain a deeper understanding of environmental policy trends worldwide and the forces driving them, the International Energy Agency (IEA) conducted a detailed study in 2021. The study titled "Environmental Policy Trends for the Global Energy Transition" describes four possible future developments for the energy system around the world in detail. The so-called Current Policy Scenario (CPS) includes the already implemented environmental policies as well as the currently under construction projects around the world. The Stated Policies Scenario (STEPS) includes the announced measures included in the NDCs (Nationally Determined Contributions) of all countries worldwide that countries will implement. In the Announced Pledges Scenario (APS), the voluntary environmental policies of all countries worldwide are assumed to be fully implemented. The Net Zero Emissions Scenario (NZE) describes a fully decarbonized global energy system with zero net greenhouse gas emissions in all regions by 2050. Table 4 gives an overview of the four scenarios.

Table (4): Comparison of IEA Scenarios

Scenario	Definition	Key Assumptions	Climate Ambition Level	Emissions Pathway	Fossil Fuel Demand	Expected Warming
CPS (Current Policy Scenarios)	Baseline/reference case	Only policies already implemented	Low	Limited	Rising strongly	>2.5–3°C+
STEPS (Stated Policies Scenario)	Reflects De Jure policies as stated in NDC	Existing policies are maintained, and highly probable future pledges	Low	Slow decline or stabilization	Relatively high	2.4°–2.6°C
APS (Announced Pledges Scenario)	Reflects announced national commitments	Assumes full implementation of all national pledges (including NDCs and net-zero targets)	Medium	Moderate decline	Gradual decline	1.7°–1.8°C
NZE (Net Zero Emissions by 2050 Scenario)	Achieves global net-zero emissions by 2050	Assumes a rapid and transformative shift in global energy systems	Very high	Rapid and steep decline to net zero	Very sharp decline	~1.5°C

Source: IEA (2021)

[18] Information on NDCs is available at: https://unfccc.int/NDCREG. The registry is the official repository for Parties' NDCs under Article 4.12 of the Paris Agreement.
[19] World Bank. (2010). The costs to developing countries of adapting to climate change: New methods and estimates—The global report of the Economics of Adaptation to Climate Change study. Washington, DC: World Bank.

To project the future of the global energy mix, the International Energy Agency (IEA, 2021) used the Global Energy and Climate (GEC) model to assess different scenarios for future energy development. The scenarios were developed with several assumptions on future population, global GDP, and oil and gas prices. Population size was taken from the UN medium-fertility variants population projection[20]. The world population is expected to reach 9.8 billion in 2050. The future real GDP (in constant 2011 US dollars) is assumed to exceed 300 trillion by 2050 with an average annual real growth rate of 3.0%.

The so-called status quo scenario (CPS) assumes that countries will implement the commitments they declared under the UN Framework Convention on Climate Change (UNFCCC) without any decrease in their GHG emissions until enabling legislation and policies are in place. Global energy-related CO2 emissions are projected to reach 40 Gt CO2e by 2050, with most emissions generated by fossil fuels. Around 75% of the global energy supply will be met from fossil fuels. The expected temperature increase by 2100 in the CPS scenario is expected to be in the range of 2.5-3.0 °C above pre-industrial levels. The annual rate of increase in emissions, in absolute terms, is kept constant at the rate observed in previous years from 2020 to 2050, as shown in Table 5.

In the STEP scenario, total emissions are expected to decline by 36 GtCO2e in 2050, only 10% compared to the CSP scenario, and the share of fossil fuels in the energy supply is expected to decline to 60%, and the share of emissions from the most polluting sectors is expected to decrease in absolute terms but to remain constant in relative terms. The share of power generation in total emissions is expected to decrease from 40% in 2020 to 32% in 2050, mainly due to the shift from fossil fuels to renewable energy in the power sector.

Table (5): GHG Evolution 2020-2050 According to IEA Scenarios (megatons)

Scenario	Year	Power	Industry	Transport	Buildings	Other Sectors	Total
Historical Trends	2000	9,296	5,059	5,770	2,672	1,480	24,277
	2010	12,396	8,060	7,012	2,892	1,873	32,233
	2020	13,504	8,417	7,153	2,850	1,979	33,903
CPS	2030	15,000	10,000	9,000	3,000	3,000	40,000
	2040	13,000	11,000	10,000	3,000	3,000	40,000
	2050	11,000	11,000	11,000	3,000	4,000	40,000
STEPS	2030	12,782	9,264	8,918	2,851	2,209	36,024
	2040	12,477	9,712	9,077	2,759	2,305	36,330
	2050	11,631	9,848	9,233	2,727	2,420	35,859
APS	2030	9,786	8,470	7,786	2,476	1,969	30,487
	2040	6,769	7,537	6,768	1,943	1,796	24,813
	2050	5,626	6,645	6,282	1,712	1,737	22,002
NZE	2030	5,820	6,890	5,720	1,810	910	21,150
	2040	-81	3,480	2,690	690	-459	6,315
	2050	-369	519	689	120	-962	-1

Sources: International Energy Agency (2021), Net Zero by 2050, IEA, Paris

In the APS scenario, total emissions in 2030 will decline further to 30 Gt CO2e and decrease to 22 Gt CO2e in 2050, representing a 35% reduction from 2020 levels. Compared with STEP emissions in 2050, the APS would permit a 14 Gt CO2e decrease in emissions, corresponding to a temperature increase of about 2.1 °C above 2020 levels in 2100. The fossil fuel share in total energy supply will decrease further to 56% in 2050, down from 78% in 2020, as the share of renewable energy rises to more than 36% of total energy supply in 2050, as shown in Table 6.

In the Net Zero Emissions (NZE) scenario, countries are expected to implement all measures required to achieve net-zero emissions of all GHGs for which they are responsible. Total emissions of all GHGs in 2030 would thus have been reduced by 38% compared to 2020 levels and eventually 100% in 2050. Note that net-zero emissions of all GHGs equal zero or negative. This does not imply that all energy supply and other sectors must be completely phased out to achieve net-zero emissions. Instead, the total amount of emissions of all GHGs into the atmosphere

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[20] United Nations, Department of Economic and Social Affairs, Population Division. (2022). World Population Prospects 2022: Summary of Results. Retrieved from https://population.un.org/wpp/World Population Prospects 2022

must be equal to or less than the total amount of removals of these greenhouse gases from the atmosphere. Most of these removals are driven by natural carbon sinks such as forests and oceans. Advanced technologies for capturing and storing greenhouse gases, as well as changes in land use due to changes in agriculture, can also lead to net-zero emissions.

In the CPS scenario, total global energy supply between 2020 and 2050 will rise by almost 1.52% p.a, with the great majority of it from fossil fuels. Thus, by 2050, 70% of total energy supplied will be from fossil fuels, down from 78% in 2020, but still dominant. In terms of changes in the supply of individual fuels, there is a decrease of 9 percentage points in coal's share of the total energy supply, from 26% in 2020 to 17% in 2050 (Table 6). In marked contrast, oil supply rises from 173 EJ (29%) in 2020 to 225 EJ (27%) in 2030 in the CPS scenario, to 203 EJ (27%) in the STEP scenario, and to 151 EJ (22%) in the APS scenario, and just to 17.2 EJ (7.8%) in the NZE scenario. As a result, there will be no increase in the share of oil consumption under all alternatives as compared to 2020. However, the natural gas share is expected to decline more slowly than crude oil and will eventually reach 11% in 2050 under the NZE. Renewables will more than double their share of the total energy supply, from 16% in 2020 to a maximum 67% in 2050, under the NZE.

Table (6): Global Primary Energy Supply by Source and Scenario (EJ[21])

Scenario	Year	Coal	Oil	Natural Gas	Nuclear	Renewables	Total
Historical Trends	2000	97.1	154	87.6	28.3	55	422
	2010	153	172	116	30.1	68	539
	2020	154	173	137	29.5	93.8	587
	Share (%)	26%	29%	23%	5%	16%	100%
CPS	2030	155	195	165	30	95	640
	2040	145	210	190	35	140	720
	2050	140	225	215	40	215	835
	Share (%)	17%	27%	26%	5%	26%	100%
Stated Policies Scenario (STEPS)	2030	147	200	160	33.6	120	661
	2040	139	202	181	37.5	156	716
	2050	127	203	199	39.4	192	760
	Share (%)	17%	27%	26%	5%	25%	100%
Announced Pledges Scenario (APS)	2030	116	179	150	36.9	144	626
	2040	87.1	161	151	45.4	204	649
	2050	75.8	151	152	51.1	250	680
	Share (%)	11.1%	22.2%	22.4%	7.5%	36.8%	100%
Net Zero Emissions Scenario (NZE)	2030	71.9	137	129	41.4	166.5	546
	2040	31.7	79.2	74.6	54.3	294.5	535
	2050	17.2	42.2	60.7	60.6	362	543
	Share (%)	3.2%	7.8%	11.2%	11.2%	67.0%	100%

International Energy Agency (2021), Net Zero by 2050, IEA, Paris

[21] Extra Joul is equivalent to 23.88 million tons of oil.

5. Assessing the Impact of Net-Zero Emission Scenario on Arab Oil-Exporting Economies

Studying the challenges that Arab oil-exporting countries face due to climate change and global energy transition, and measuring their magnitude, can help clarify the nature of the challenges and the policies needed. Given the long horizon of the global energy policies usually set for 2050 or 2070, and the voluntary character of declared policies, a high degree of uncertainty is inherent in any serious attempt to quantify the impact of alternative scenarios on the global effort to combat climate change and to estimate the economic costs to oil-exporting countries of the transition to a Net Zero Emissions (NZE) scenario. This section of the study sets out the main challenges that oil-exporting countries are likely to face in the years ahead and attempts to quantify their likely impact on the economic activity of Arab oil-exporting countries, the volume of their primary and processed commodity exports, and the level of non-oil industrial output, under both an NZE scenario and a business-as-usual trend (BAUT) extrapolation counterfactual. In both cases, the indicators are studied and projected based on past trends. Most countries worldwide have pledged under the Paris Agreement to achieve Net Zero Emissions by 2050, and the study focuses on the implications for Arab oil-exporting countries of the rapid decline of the hydrocarbon sector expected in the NZE relative to the BAUT scenario.

However, large fluctuations in commodity export values made it difficult to establish long-term growth trends among Arab commodity exporters. GDP for 2050 was extrapolated using average IMF-projected growth rates for 2025–30, as available in the April 2026 World Economic Outlook database. These rates are consistent with the performance of Arab economies over the period 2021–24, as highlighted in Table 7. Arab oil-exporting economies grew on average at 3.8 percent per annum between 2021–24, which is lower than the IMF's projected growth rate for 2025–30 (3.6 percent per annum). This, however, is lower than the long-term average economic growth rate for 2000–24, which averaged 5.1 percent across Arab oil exporters. Petroleum prices rose in the early years of the new millennium, enabling countries with significant oil reserves to experience rapid growth. Arab oil-exporting countries enjoyed higher-than-average growth rates in the early years of the millennium due to initially high prices, followed by a period from 2014 to 2021 of sharply declining average growth to 1.2%.

Merchandise exports of AOE economies increased on average by 3.4% p.a. between 2000 and 2024. During the oil boom (2000–2013), export growth jumped to 5.2% p.a. However, during the years of global recession (2014–2024), exports grew by an average of just 1.7% per annum. Export growth is highly volatile, with an average standard deviation of 25%. The export-to-GDP ratio is smoothed by setting it to the historical average over 2010–2024. The value of commodity exports is calculated by multiplying the average export share, assumed to be constant, by the constant-price GDP for the year 2050. The average rate of change in the export share of manufactured goods in merchandise exports for 2000–2024 is used to estimate manufactured- and primary-commodity exports for 2050. The average share of manufactured goods in total merchandise exports for the years 2021–2024 across all countries in the sample was 17%. However, there are large variations between countries: the average share of manufactured goods in merchandise exports for Iraq in 2021–2024 was just 1%, while for Oman and the UAE it was 31%. The average projected share of manufactured goods in total merchandise exports for the sample of Arab countries increased from 17% in 2021–2024 to 43% in 2025–2050. The largest average projected share of manufactured goods in total merchandise exports for the years 2025–2050 among countries in the sample would be 80% for the UAE, while the lowest would be a mere 2% for Iraq. Growth rates of manufactured exports in the counterfactual scenario for the Arab oil-exporting countries show extreme differences among countries. The average rate of change in manufactured exports for 2010–2019 for the whole sample of countries is used as the constant average rate of change for manufactured exports over 2025–2050. Primary goods exports are then calculated as the difference between total commodity exports and manufactured exports.

Table 7 presents projections of the main economic indicators for the oil-exporting Arab countries in 2050. Total GDP for the oil-exporting Arab countries in constant 2015 US dollars would reach $5.8 trillion by 2050. Two countries—Saudi Arabia and the UAE—would jointly account for almost two thirds of the total GDP. Assuming the ratio of exports to GDP is constant, merchandise exports of the AOE countries as a group, in constant 2015 US dollars, would increase from $931 billion in 2024 to $2.6 trillion in 2050.

The average ratio of manufactured exports to total commodity exports between 2010 and 2024 was 17%, with an estimated average annual growth rate of 3.2%. There are considerable differences between the AOE countries. The share of manufactured goods in total commodity exports reached 28% in Bahrain, 31% in Oman and the UAE, 25% in Saudi Arabia, and low contributions in Algeria, Libya, and Iraq. The positive change in the ratio of manufactured exports across most AOE measures their efforts to reduce dependence on hydrocarbon and promote economic diversification. The projected level of economic diversification for the Arab oil-g countries by 2050 would reach 43%. Advanced levels of economic diversification, measured by the share of manufactured goods in total merchandise exports, would exceed 70% in three countries, namely Bahrain, Oman, and the UAE, and 64% for

Saudi Arabia. However, non-GCC countries still depend heavily on primary exports due to low export diversification and need higher levels of industrialization to overcome this major structural constraint.

The outlook for oil and gas exports varies widely across countries. While some countries may reduce their dependence on hydrocarbons, others, such as Libya and Iraq, will remain nearly wholly dependent on it in the medium term. Others, like Algeria, will need to further develop the manufacturing sector in the medium term, given the historically low level of manufactured exports, which is estimated to account for only 11% of exports by 2050. Other countries will need to transition more quickly from an oil- and gas-based economy, as their hydrocarbon reserves will almost run dry before 2050. The reserves-to-production ratio in 2020 from the Energy Institute's dataset indicates when a country's hydrocarbon reserves will be depleted, assuming no new discoveries. This applies to oil and gas for Algeria, Oman, and Bahrain, and only to oil for Qatar.

Exports of manufactured goods from the region are expected to exceed $1.6 trillion by 2050, given the estimated speed of export diversification. As a result, the contribution of primary commodities to total exports of AOE countries is expected to decline in real terms from 83% in 2024 to 56% by 2050 ($988bn), of which $796bn will be crude oil and natural gas, and $192bn will be non-hydrocarbon primary commodities. However, for several countries, substantially increasing their share of manufactured exports in the future will be challenging, and they will probably remain highly dependent on primary commodity exports. Iraq (98%), Libya (94%), Algeria (89%), and Qatar (43%) need to break with past strategies and intensify their drive toward greater diversification.

On average, non-oil primary exports accounted for only 9.0% of total goods exports in 2024. For most countries in the region, oil will remain the major export, driving export growth and revenues. For some countries, non-oil primary commodities will remain important and, on average, account for more than 10% of total goods exports. In the UAE, this average will be slightly above 11%; in Oman, around 12%; and in Bahrain, 17%.

A very large share of the budget revenues of Arab oil-exporting countries consists of oil and natural gas rents. On average, the share of hydrocarbon rents in the total revenues of these countries between 2021 and 2024 stood at 75%. As a percentage of GDP, revenues of Arab oil- and gas-exporting countries reached 40%, of which only 10% consisted of non-oil revenues. This heavy reliance on hydrocarbon rents to finance government expenditure may compel oil and gas-exporting countries to seek alternative sources of financing to sustain economic activities. The expected decline in global demand for fossil fuels will force these countries to seek new export markets and new sources of tax revenue to stimulate growth in the non-oil sector, particularly manufacturing. In some countries without a large tax system, it will be necessary to introduce new direct and indirect taxes, or to broaden and/or make existing taxes more efficient, to sustain public expenditure in the long run.

As the time horizon for implementing new energy policies is rapidly approaching, it is high time for AOE countries to pursue serious alternatives to oil exports by deepening industrialization, especially in energy-intensive sectors, to increase manufactured goods exports and avoid leaving hydrocarbons as stranded assets. Based on past growth rates, manufacturing output in Arab oil-based economies, which grew 4.3% p.a., will reach $866 billion by 2050, up from $445 billion in 2024. However, in terms of GDP share, manufacturing output is unlikely to increase sufficiently to offset the collapse of primary oil exports in an NZE scenario. Thus, if the manufacturing output grows at past trend rates, it will not be sufficient to offset the decline in the value of primary oil exports. Moreover, hydrocarbon exports are expected to reach $796 billion by 2050, compared with $866 billion for manufacturing output. To compensate for the phasing out of oil and gas in the NZE scenario, manufacturing output should be increased further above the trend by at least the value of primary oil exports in 2050, estimated at nearly $800 billion. In addition, while oil exports on average will account for around 50% of the total merchandise exports of Arab oil-exporting countries by 2050, maintaining the merchandise exports at the same level as in the trend scenario will require the manufacturing output to increase from $247 billion in 2024 to $1.7 trillion by 2050 at an average annual rate of 8%. This will also require the manufacturing sector to increase its contribution to GDP from 14% in the trend scenario to 26%. Finally, the growth rates required in manufacturing to sustain future exports will vary from country to country and from one level of export diversification to another. Thus, for example, a 5% increase in manufacturing activity in Bahrain will be sufficient to sustain manufacturing exports at their trend growth rates, whereas a 16% increase will be required in Libya.

To meet the NZE target and offset the decline in the hydrocarbon sector, non-oil manufacturing output must more than double in real terms, necessitating substantial investment in non-oil sectors. To determine the investment required to support this increase in manufacturing output, we first calculated the Incremental Capital Output Ratio (ICOR) and used it to estimate the total investment required in 2050 to sustain the projected growth in manufacturing output needed to offset the decline in hydrocarbon output. Sector-specific ICORs cannot be determined due to insufficient detail on sectoral investment. The ICOR for the manufacturing sector was calculated using the UNIDO industry database. An average value of 6.6 units was applied to assess the required investments to offset oil exports. Arab Oil Countries would need 5.3 trillion USD in new investments over the period 2025-2050 to address the consequences of the NZE scenario. This is clearly a maximum assessment, since it assumes that all primary oil export revenue would disappear. Given the uncertainty surrounding global energy policies, it is almost impossible to predict the outcomes of the different scenarios. For example, the IEA (2025) estimated the odds of NZE at only around 10-20%, compared to 50-60% for the STEPS. However, under decarbonization scenarios, there is a potentially real risk of 'asset stranding' of existing hydrocarbon resources. Rich resource economies may therefore consider using their oil and gas not for short-term consumption but to create energy-intensive, high-value-added industrial sectors such as advanced petrochemicals, hydrogen, metals, and digital communication infrastructure. Converting the hydrocarbons originally intended for fuel into alternative chemicals and embedded energy can also provide a new stream of income in a poor fossil-fuel future.

The oil-exporting Arab countries need to accelerate the shift of their dwindling financial resources from temporary to sustainable sources to provide for future generations. Minimum non-oil fiscal expenditure is crucial to achieving fiscal sustainability. Oil rents constitute the bulk of public spending in oil-producing countries. The ratio of total public revenues to GDP averaged 40% for the period 2021-2024, of which only 10% came from non-oil taxes. Oil revenues in 2050, assuming the oil-to-GDP ratio remains constant at 30%, would amount to $1.86 trillion at 2015 constant prices. In Algeria and the UAE, the share of oil revenues will decrease to 56% and 38%, respectively, in 2050, while in Iraq and Libya it will remain above 90%. In other Arab countries, the average ratio ranged between 70% and 80% in 2015.

To achieve financial and economic sustainability in Arab oil-producing countries, there is an urgent need to shift to a new development model. The new model must place manufacturing-based economic growth at the top of its agenda and ensure that investment is channeled to export-oriented activities and job creation through a diversification-oriented industrial policy. This policy should also aim to increase non-oil revenues and to restructure the government apparatus and public institutions to rationalize expenditure. Meeting these goals within a short timeframe before the energy transition will require the formulation of an effective industrial strategy for Arab oil-based countries. The strategy must highlight the importance of the private productive sector and develop public-private partnerships to invest in current and future production sectors with export potential. A system of performance-based smart incentives must be established to prevent rent-seeking that has undermined similar strategies in the past. Creating a conducive environment for transparent, accountable monitoring of the development process and adopting good governance are also crucial. Industrial policies should focus on developing the manufacturing sector by channeling support and investment to competitive industries, such as energy-intensive sectors, and to sectors that generate high levels of knowledge and added value and require high levels of skill. However, the industrial policies and measures taken must also be general, fair, transparent, and cost-effective. Policies and measures to improve the quality of human capital and to cultivate competition, affordable financing, and a stable macroeconomic environment with a low inflation rate are also very significant.

6. Conclusion:

The Arab oil-exporting countries have made significant progress in economic development, and their economic fortunes have largely depended on their vast oil resources, a vital commodity for human welfare and global economic growth. All Arab oil-based countries are either high-income countries with very high human development (the Gulf States) or upper-middle-income countries with high human development. The huge windfalls from such natural resource-based development have created opportunities for prosperity and stability at the national and global levels, but they have also posed economic challenges at both levels. While price volatility and global business cycles affect the economies of oil-exporting countries, those with high oil revenues have mitigated their effects by building large reserve stockpiles.

As the world considers the future of oil and gas, a non-renewable, polluting fossil fuel, in light of climate change and the global energy transition to clean, renewable sources, there is enormous uncertainty about future international environmental policies regarding global warming and the curtailment of carbon emissions, which directly affect the long-term future of oil as the main resource for oil-exporting countries. In this research, we examined the economies of the main Arab oil-producing countries, their economic challenges, and the impact of environmental policies, particularly the net-zero emissions policy, on these economies.

The economic characteristics and challenges faced by oil-producing countries were discussed. The most pressing challenge is that the oil and gas sectors constitute a large share of GDP, while the manufacturing sector accounts for a very small share. On average, the manufacturing sector accounts for 10% of GDP, while the mining sector contributes about 25%. In addition, the oil and gas sector accounts for the largest share of merchandise exports, averaging 74%, and oil revenues account for the largest share of government general revenues, averaging a third of GDP and around three-quarters of total revenues. Hence, any decrease, whether gradual or rapid, in global demand for oil and gas, driven by economic, technological, or political factors, will sharply affect economic growth in oil-exporting countries. Nevertheless, it is hoped that Arab oil-exporting countries will be able to break free from the oil stranglehold and hasten the process of industrial transformation toward an economy based on production and on generating revenue from the sale of goods and services outside the energy sector.

This paper explored the long-term economic development of oil-dependent countries through 2050. The additional manufacturing investment required to potentially replace most oil exports by 2050 is calculated in the NZE scenario. The calculations were based on the historic growth rates of the Arab oil-dependent countries. Based on the constant export-to-GDP ratio, the merchandise exports of oil-exporting countries are expected to increase from $931 bn in 2024 to $2.6 trillion in 2050. Also, the total of primary exports of these countries is expected to increase to $988 bn in 2050. The share of manufactured exports is estimated to increase by an average of 3.2% per year. Thus, the share of manufactured exports in merchandise exports will reach 43% in 2050, 17 % points above the calculated share for 2024.

The growth model of oil-dependent economies is not highly productive in manufacturing. On average, oil accounts for 74% of the merchandise exports. In some countries, up to 90% of exports are oil and natural gas. Average manufacturing growth is expected to reach 4.3%, though at significantly different rates across countries. This growth in manufacturing output will not be sufficient to offset the heavy weight of oil in the export structures of most oil-exporting countries. High growth rates for 2050 are due to scale effects and do not reflect higher productivity growth or structural change. The economic and fiscal structures of most oil-exporting countries are highly rigid and almost entirely dependent on oil. Oil accounts for more than 70% of the revenues of these countries' governments.

The simulation results for the NZE scenarios indicate substantial transition costs for oil-exporting countries. More than $5 trillion in new investments will be required. Manufacturing would need to grow at an average of 8% per annum so countries can face the NZE phasing out of oil and gas. The oil industry's share of GDP is expected to decline from 25% in 2024 to almost 17% in 2050. AOE countries will experience some economic diversification away from oil and other primary products; however, oil and gas exports still account for a sizable share of total exports. In fact, oil will continue to account for half of commodity exports in 2050, posing a high risk for the economy under the NZE scenario. Implementing meaningful economic transformation will require large investments and even deeper institutional and industrial policy reforms in oil economies in a carbon-constrained world. The advanced reformers (UAE, Saudi Arabia, Oman) will benefit from structural change in their economies over time, while the hydrocarbon-dependent laggards (Iraq, Libya, and, to a lesser extent, Algeria) will need higher efforts to avert the dangers of climate change and the shifts in the global energy mix.

Table (7): Economic Structure and Net Zero Transition Requirements in Oil-Producing Economies: A Comparative Assessment"

Indicator	Algeria	Bahrain	Iraq	Libya	Kuwait	Oman	Qatar	Saudia	UAE	Oil Economies
1. Macroeconomic Outlook										
Real GDP Growth (2021–2024)	3.7	4.4	2.1	7	1.1	3.35	2.4	5.2	4.8	3.8
Real GDP Growth (2025–2030)	2.8	3.2	3.3	4.7	2.6	3.7	4.2	3.5	4.5	3.6
GDP 2024 (USD bn)	220	41	190	55	120	91	180	880	460	2237
GDP 2050 (USD bn)	451	93	442	182	234	234	525	2150	1440	5751
2. External Sector Structure (2024)										
Exports (% of GDP)	15.0%	32.0%	53.0%	29.0%	40.0%	51.0%	37.0%	23.0%	88.0%	0.41
Non-Oil Exports (% Total Exports)	0.02	0.43	0.01	0.01	0.04	0.12	0.03	0.04	0.11	0.09
Oil Exports (% Total Exports)	0.94	0.29	0.98	0.96	0.79	0.57	0.84	0.71	0.58	0.74
Manufacturing Export (% Total exports)	0.04	0.28	0.01	0.02	0.17	0.31	0.13	0.25	0.31	0.17
4. Trade Outlook (2024)										
Merchandise Exports 2024 (Bn USD)	32.5	13.2	101	15.8	48.4	46.1	66.7	204	403	931
Manufactured Exports 2024 (Bn USD)	1.3	3.7	1	0.3	8.2	14.3	8.7	51.1	125	214
Oil Exports (Bn USD)	30.6	3.8	99.0	15.2	38.2	26.3	56.0	144.8	233.7	648
Non-Oil Primary Exports (Bn USD)	0.65	5.676	1.01	0.158	1.936	5.532	2.001	8.16	44.33	69
Primary Exports 2024 (bn USD)	31.2	9.5	100	15.5	40.2	31.8	58.1	153	278	717
4. Trade Outlook (2050)										
Total Exports 2050 (Bn USD)	66.6	30	235	52.2	94.4	119	195	500	1270	2562
Manufactured Exports 2050 (Bn USD)	7.3	21.6	4.7	3.1	41.5	93.7	64.2	320	1010	1566
Oil Exports 2050 (Bn USD)	57.9	3.4	228	48.6	49.1	10.7	124	160	114	796
Non-Oil Primary Exports 2050 (Bn USD)	1.3	5.0	2.4	0.5	3.8	14.2	5.8	20	139	192
3. Export Diversification (2050)										
Manufacturing Export (% of Total Exports)	0.11	0.72	0.02	0.06	0.44	0.79	0.33	0.64	0.80	0.43
Oil Exports 2050 (Bn USD)	0.87	0.11	0.97	0.93	0.52	0.09	0.64	0.32	0.09	0.50
Non-Oil Primary Exports 2050 (Bn USD)	0.02	0.17	0.01	0.01	0.04	0.12	0.03	0.04	0.11	0.06
Primary Export Ratio 2050	0.89	0.28	0.98	0.94	0.56	0.21	0.67	0.36	0.20	0.56
5. Fiscal Structure										
Public Revenue (% GDP)	27.7	20.1	39.2	77.2	69.7	35.3	31	26.8	29.7	39.63
Oil Revenue (% GDP)	15.5	14.7	35.3	71.8	60.6	24	19.5	17.7	11.3	30.04
Non-Oil Revenue (% GDP)	12.2	5.4	3.9	5.4	9.1	11.3	11.5	9.1	18.4	9.59
Oil Revenue Share (%)	56	73	90	93	87	68	63	66	38	70.44
6. Industrial Structure										
Manufacturing Share (2020–24)	9.60%	17.70%	6.50%	1.00%	9.80%	9.80%	8.30%	14.00%	10.10%	9.6%
Oil Sector Value Added 2024	19.8	3.69	48.6	30.8	68.4	8.46	52	127	86	445
Non-Oil Sector Value Added 2024	200	37.3	141	24.2	51.6	82.5	128	753	374	1792
Manufacturing Output 2024	21.12	7.257	12.35	0.55	11.76	8.918	14.94	123.2	46.46	247
Manufacturing Output 2050	69	17	68	1.6	35	17	28	450	180	866
Manufacturing Share 2050	0.15	0.18	0.15	0.01	0.15	0.07	0.05	0.21	0.13	12.3%
Manufacturing Growth Rate	4.7	3.3	6.9	4.1	4.6	2.5	2.4	5.2	5.3	4.3
7. Energy Transition & NZE Requirements										
Investment Needs (USD bn)	382	25	1500	321	324	70.5	822	1060	752	5257
Required Manufacturing Output	126.9	20.4	296	50.2	84.1	27.7	152	610	294	1661
Required Manufacturing Growth	7%	2%	12%	17%	8%	4%	9%	6%	7%	8%
8. Oil vs Non-Oil Economy Structure										
Oil Share of GDP 2024	9.0%	9.0%	25.6%	56.0%	57.0%	9.3%	28.9%	14.4%	18.7%	25.3%
Oil Share of GDP 2050	4.4%	6.0%	36.5%	15.1%	43.8%	8.0%	25.9%	6.1%	10.0%	17.3%
Non-Oil Value Added 2024	200.0	37.0	141.0	24.0	52.0	83.0	128.0	753.0	374.0	1792.0
Non-Oil Value Added 2050	478.0	90.3	279.0	187.0	129.0	239.0	422.0	2160.0	1440.0	5424.3

Source: Calculation made by the Author. Data From World Bank WDI, IMF World Economic Database, UNCTAD, and UNIDO

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