Energy transition and climate-related policies: A changing environment and its implications for OPEC countries

A Master's Thesis submitted for the degree of
“Executive Master of Business Administration”

supervised by
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Vienna, 21.03.2024

ACADEMY FOR CONTINUING EDUCATION

Affidavit

I, **SURAJ SALISU MATORI, B.A**, hereby declare

1. that I am the sole author of the present Master's Thesis, "ENERGY TRANSITION AND CLIMATE-RELATED POLICIES: A CHANGING ENVIRONMENT AND ITS IMPLICATIONS FOR OPEC COUNTRIES", 132 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 21.03.2024

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Signature

Acknowledgement

Firstly, I would like to thank my supervisor, Univ. Prof. Dr. Sabine T. Köszegi, for the valuable support and guidance she has given during my study. I would also like to thank her for sharing my enthusiasm for this thesis.

I am grateful to OPEC for their support throughout my MBA studies, and also for providing me with internal and external resources to achieve my goals. In addition, I would like to extend my thanks to my family for their patience during my studies, and their continuous support throughout this journey.

Table of Contents

Abstract

Since its formation in 1960, the Organization of the Petroleum Exporting Countries (OPEC) has played a vital role in the global oil market. It consists of 12 nations that produce oil in Africa, the Middle East and Latin America. OPEC holds immense political and economic influence due to its oil supply capacity, which represents a significant share of world oil production. This power to control the global oil market has given OPEC significant influence over the global economy

A key objective of this thesis is to examine the challenges OPEC has faced in recent years, including climate change, alternative energy sources, and energy transition. Oil's role in future energy systems has been challenged by the increased focus on renewable energy sources and pledges from major oil-consuming nations, especially in the developed world, to reduce emissions to zero ((Mehrara, 'Energy consumption: The case of oil exporting countries', 2007).

The first part of the study will examine economic trends of each OPEC member nation, focusing on oil sales revenues, oil demand patterns, and crude oil flows.

Second, the author explores the importance of reducing emissions associated with oil production and consumption by OPEC members (Chontanawat, 'Relationship between energy consumption…' 2020). It is important to emphasize that technology, finance and resilience remain key to reducing emissions in accordance with the Paris climate agreement pledged by OPEC countries. A just and inclusive transition from oil and gas to renewable energy remains a big challenge for these oil-dependent countries.

In addition to reducing CO2 emissions and greenhouse gases (GHG), the analysis indicates that societies also demand energy services. Although oil and gas producing countries provide fuels for the world's energy system, they must now determine how they can contribute quickly to climate change solutions while also ensuring energy security (Alshehry et al, 'Energy consumption…', 2015).

This study found that energy consumption, economic growth, and greenhouse gas (GHG) emissions, also known as CO2 emissions, are all related to OPEC countries' energy consumption. In addition, the results highlight the critical innovative policies OPEC countries are adopting to reduce GHG emissions and diversify their energy sources, particularly those derived from fossil fuels, to further reduce GHG emissions.

Introduction to Research Topic

The author of this study works at the OPEC Secretariat as part of the public relations and communication unit. At present, OPEC is experiencing a period of time in its history when external factors are negatively affecting its influence on global oil markets, creating unforeseen challenges for the organization. The author understands the dilemma OPEC faces, especially on climate change, as part of the communication unit and responsible for creating OPEC's digital messages.

The organization is moving from oil-fueled energy to cleaner, renewable sources of energy, including wind, solar, hydro and nuclear, as well as reducing fossil fuel emissions. Due to the severity of the potential revenue loss for OPEC countries as the world transitions from fossil fuels to renewable sources of energy, the topic of energy transition and climate related policies has been the subject of deliberation by the author's superiors at the management level. A consensus exists that OPEC countries need to mitigate these external factors, coordinate and implement innovative policies to remain relevant in providing clean and sufficient energy in the future.

OPEC countries have this unique advantage to maintain their relevance as energy producers, which is a diversification of their revenue sources, as all OPEC countries are classified as developing countries with various reputable forecasts of their populations growing significantly in the coming decades, such as those of the World Bank. It is imperative that OPEC countries adopt innovative solutions, such as Carbon Capture and Storage (CCUS), Hydrogen, and Direct Air Capture (DAC), in order to ensure sustainable growth and viable economic opportunities for their citizens.

Since OPEC is composed of some of the world's most significant energy producing countries, they provided comprehensive data analyses showing historical trends in energy consumption, forecasts for future energy demand and supply scenarios, as well as innovative solutions and policies for reducing greenhouse gas emissions, both those currently being implemented and those that are to be implemented in the future. With these insights into OPEC, this master thesis topic provides an opportunity to understand what these countries are doing or need to do

Objective

In order to maintain their competitive advantage as major energy exporters, OPEC countries, oil and gas companies, and other energy producers have made reducing greenhouse gas emissions, and transitioning to low carbon economies a priority. So that they can maintain their competitive advantage as one of the world's leading energy exporters, OPEC has to have sustainability and reduce the carbon footprint. A number of external factors are reshaping global energy systems in the near future, especially climate change policies, which are currently being implemented by a majority of energy consuming countries, mainly developed nations such as the Organization for Economic Co-operation and Development (OECD) nations.

OPEC countries have acknowledged that changes in energy systems are inevitable, so they are exploring and implementing solutions that will ensure emissions are reduced and spur economic growth.

The input source of knowledge to the research work:

- Research, publications, reports, articles, reports and forecasts from OPEC as well as other reputable institutions such as the World Bank and the International Monetary Fund concerning oil demand and consumption, carbon emissions, and climate change policies.
- Using data from literature to evaluate OPEC's stance on the thesis topic based on empirical analysis.
- A review of research conducted by stakeholders in the energy industry related to the transition of energy systems in OPEC countries from high to low carbon intensity.

This thesis is to understand and evaluate the following hypothesis:

- Climate change and energy transition policies are overall expected to boost economic growth.
- OPEC countries' exploration and integration of innovative approaches are key factors that trigger change
- Transforming the current energy system to a more sustainable one will be costly and financially intensive

1. Introduction to the Organization of Petroleum Exporting Countries (OPEC)

The Organization of Petroleum Exporting Countries (OPEC) refers to a group of 12 of the world's major oil-exporting nations. The group was founded in 1960 in Baghdad, Iraq by five founding members namely Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela (figure 1) (www.opec.org)

In addition to the five founding members, other sovereign countries joined OPEC at different times over the decades to coordinate their petroleum and energy policies. The additional countries that subsequently joined the group and are still members are as follows:

- Libya joined in 1962
- United Arab Emirates joined in 1967
- Algeria joined in 1969
- Nigeria joined in 1971
- Gabon joined in 1975
- Equatorial Guinea 2017;
- Congo joined in 2018.

OPEC's founding nations are considered full members of the organization, as are any countries that wish to join the organization and whose application is accepted by it. However, these countries must have significant crude oil exports to qualify for full membership. OPEC membership is based on votes from at least three quarters of its full members. Associate membership can also be granted to countries under specific conditions (www.opec.org)

Figure 1: (OPEC Member Countries as at December 2023) Angola exited in January 2024

Source: OPEC.org

The group's stated mission and objective is to coordinate the petroleum policies of its member's countries and ensure the stabilization of international oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital for those investing in the petroleum industry (www.opec.org, 2024)

As part of its mission, the organization is dedicated to maintaining a stable international oil market without major fluctuations. As a result, member nations are able to maintain their interests while providing an uninterrupted supply of oil to other consuming nations that assures a regular stream of income (www.opec.org).

It is estimated that OPEC produces and exports the largest amount of crude oil and petroleum products in the world. In 2021, more than 80% of the world's proven oil reserves were accounted for by the group's member countries, which accounted for 40% of world oil production and 60% of world petroleum market (OPEC, 'World Oil Outlook' 2023,).

In 1976, The OPEC fund that provides grants and loans to non-member countries, organized by OPEC, was established in 1976 as a means of facilitating the flow of resources to developing nations as well as the international community (Hayes, 'Investopedia | OPEC', 2003)

Market stability and OPEC's role in the international oil market are influenced by a number of factors. New technologies have had a major impact on the global oil supply, as well as reduced OPEC's influence. (Hayes, 'Investopedia | OPEC', 2003)

Innovation and new, green technology are challenging OPEC. High oil prices are making some oil-importing countries turn to unconventional, cleaner sources of energy. Alternatives, such as shale production as an alternative energy source, and hybrid and electric cars that reduce dependence on petroleum products, continue to put pressure on the organization. (Hayes, 'Investopedia | OPEC', 2003)

OPEC is responding by trying to reduce production costs and increase the efficiency of their operations. They are also investing in renewable energy sources to reduce their dependence on fossil fuels. (Hayes, 'Investopedia | OPEC', 2003).

1.1 OPEC's organizational structure

OPEC Secretariat, based in Vienna, is the executive body of the organization, and also serves as its headquarters, as defined by the OPEC Statute (opec.org)

Among its duties are implementing every decision made by the Board and carrying out all resolutions passed by the Conference. (opec.org)

The Secretariat is composed of the Secretary General as the Chief Executive Officer of the Organization, as well as such staff members as may be required to perform its duties. Further, it consists of the Secretary General's Office, the Legal Office, the Research Division, and the Support Services Division. (opec.org)

As part of the Research Division, there are departments such as Data Services, Petroleum Studies, Energy Studies, and Environmental Matters (which was created recently in response to the changing landscape of energy research quality outputs) (opec.org)

As part of the Support Services Division, there are three departments: Public Relations & Information, Finance & Human Resources, and Administration & IT Services (opec.org)

The organization has different organs responsible for performing different tasks in the interest of the organization's members. See the organogram below (figure 2):

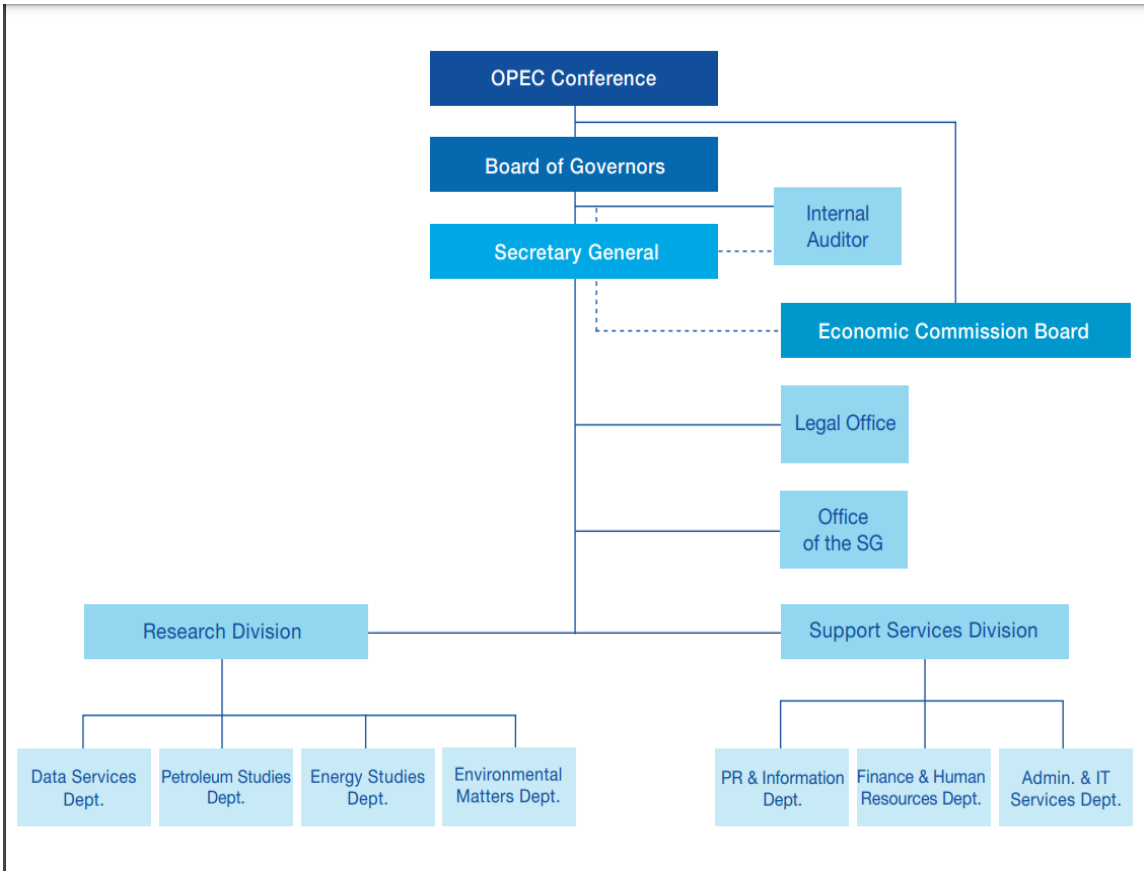


Figure 2: (OPEC's organizational structure, 2024)

Source: OPEC.org

1.2 Oil consumption trends among OPEC Countries

Economic diversification has presented itself to some member states of OPEC recently as a present and future challenge. Despite the different levels of diversification among this group of countries, these challenges require strategic and effective policies and concrete actions aimed at reducing collateral effects resulting from oil production and other fuels by utilizing other economic sectors (Mouthinho & Madaleno 2022).

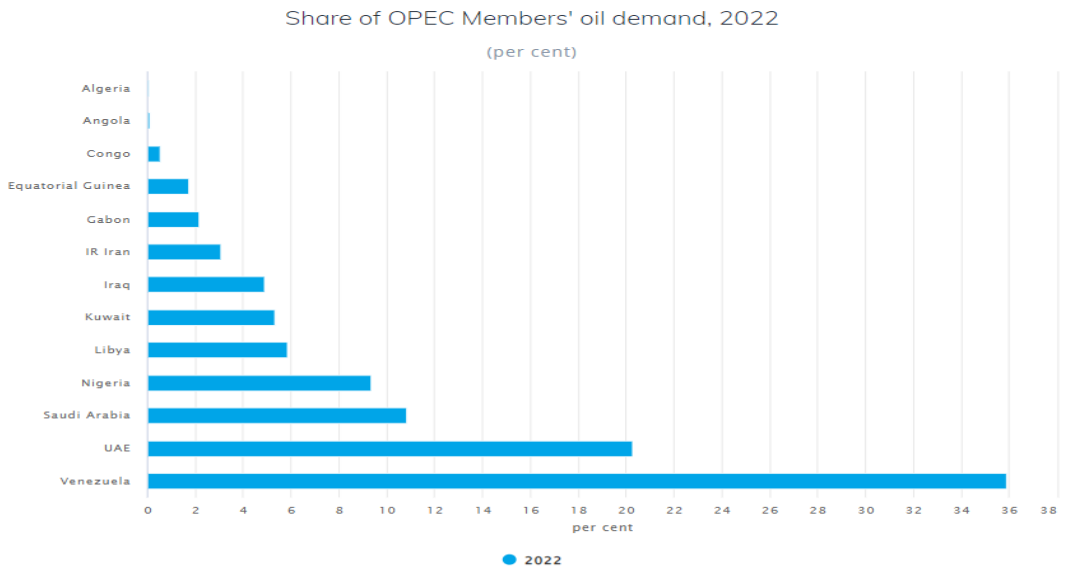


Figure 3: (Share of OPEC members oil demand, 2022)

Source: OPEC Annual Statistical Bulletin (ASB)

OPEC Members' oil demand

(mb/d)

Descriptive Statistics

	2018	2019	2020	2021	2022
Algeria	0.43	0.43	0.38	0.42	0.43
Angola	0.17	0.17	0.15	0.14	0.15
Congo	0.01	0.01	0.01	0.01	0.01
Equatorial Guinea	0.01	0.00	0.00	0.00	0.00
Gabon	0.05	0.05	0.04	0.04	0.05
IR Iran	1.85	1.84	1.69	1.78	1.79
Iraq	0.70	0.72	0.55	0.62	0.83
Kuwait	0.42	0.46	0.46	0.46	0.47
Libya	0.21	0.21	0.18	0.19	0.19
Nigeria	0.45	0.47	0.47	0.49	0.52
Saudi Arabia	3.10	3.14	2.93	2.97	3.17
UAE	0.89	0.90	0.83	0.92	0.96
Venezuela	0.40	0.37	0.19	0.23	0.27
Total OPEC	8.69	8.77	7.88	8.27	8.84

Figure 4: (OPEC Members oil demand, 2018-2022)

Source: OPEC ASB

According to OPEC's World Oil Outlook (WOO), fossil fuels will continue to serve as the world's primary energy source for at least the next two decades, providing more than 80 percent of global energy needs (figure 5). Additionally, projections indicate that renewable energy will increase, although at a slower rate than those determined as energy security goals (OPEC, 'WOO', 2023)

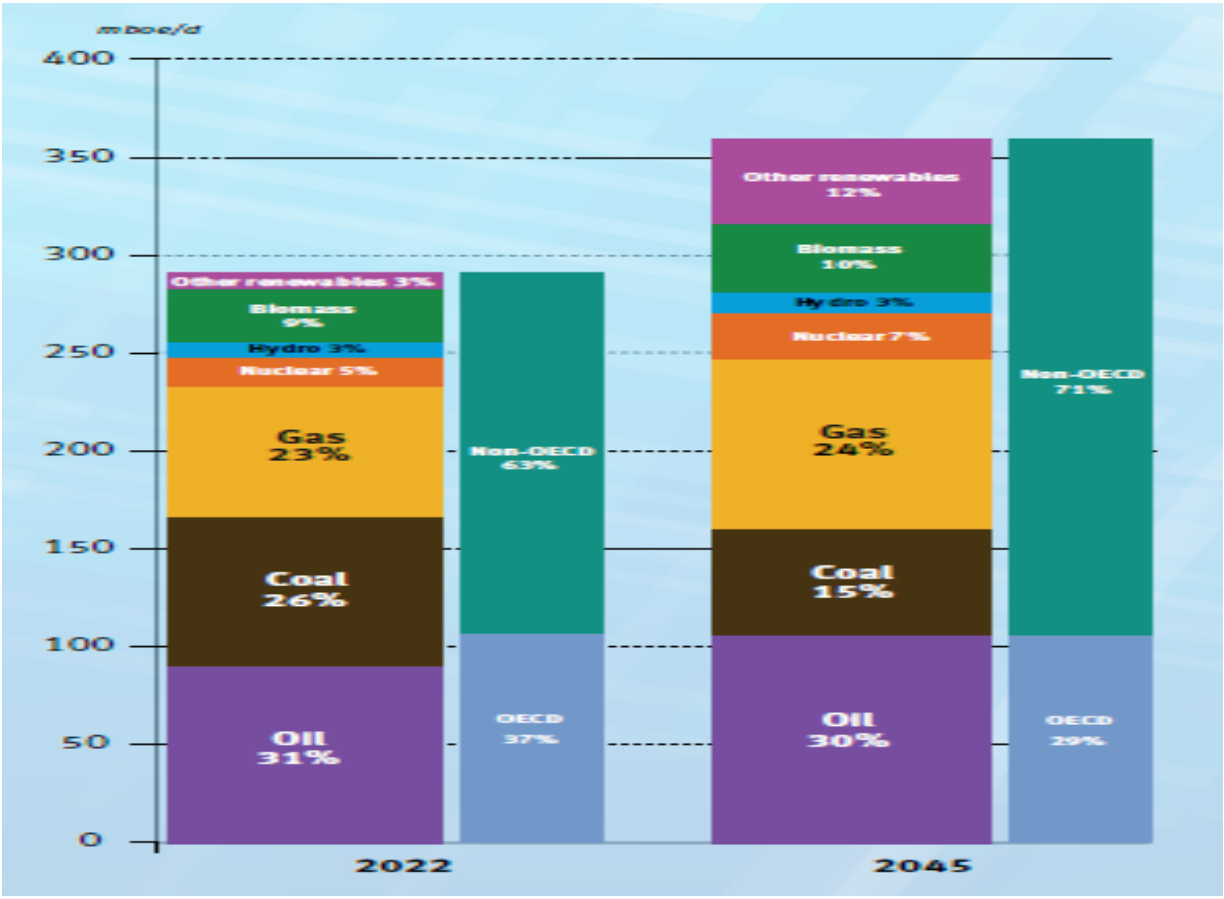


Figure 5: (Share of energy mix, 2022-2045)

Source: OPEC World Oil Outlook (WOO)

1.3 Oil Supply Flows and Economic Outlook in OPEC Countries

1.3.1 Algeria:

The Republic of Algeria is the largest country in Africa, and OPEC's largest member country in terms of geographical area. It is the oil and gas sector that drives the country's economy. (www.opec.org)

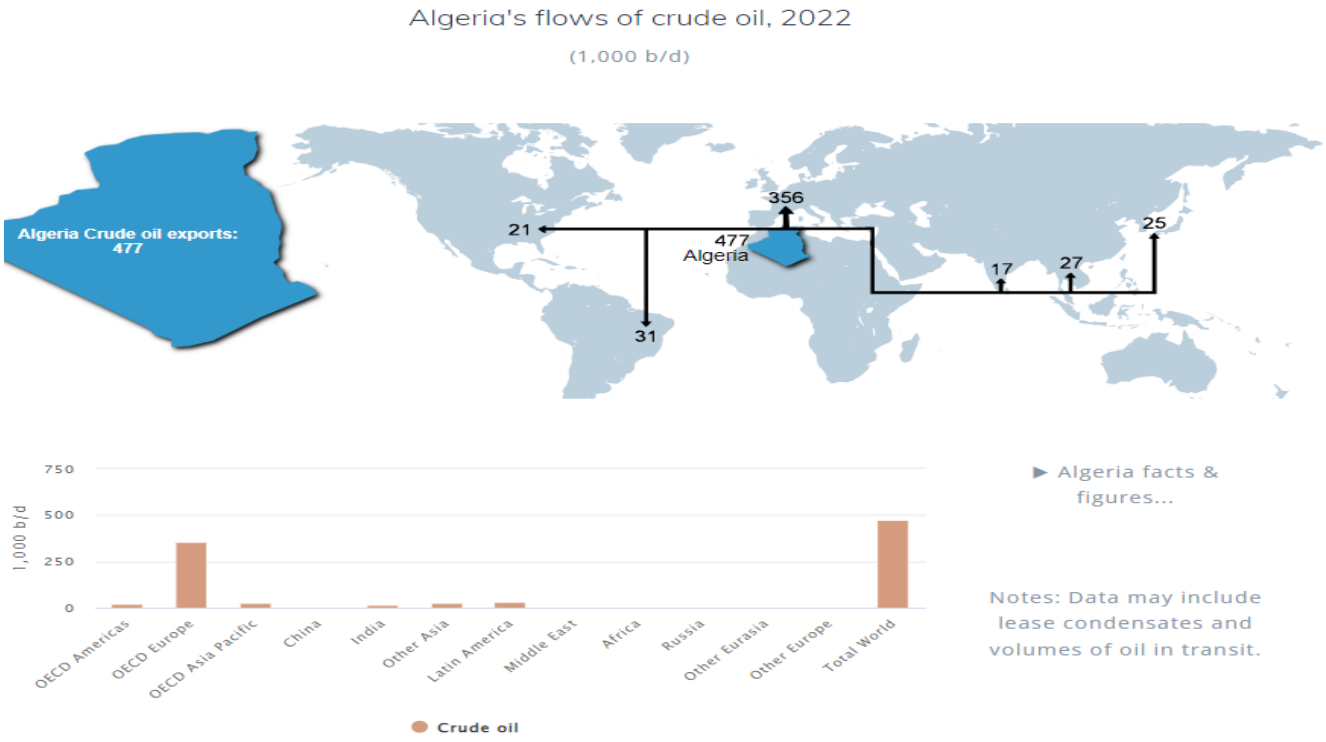


Figure 6: (Algeria flows of crude oil 2022)

Source: OPEC ASB

Additionally, iron ore, phosphates, uranium, and lead are found in the country. Above (figure 6) shows the flow of crude oil to different regions across the globe, with majority of the flow going to OECD Europe (www.opec.org)

Population (million inhabitants)	45.40
Land area (1,000 sq km)	2,382
GDP per capita ($)	4,119
GDP at market prices (million $)	186,995
Value of exports (million $)	69,256
Value of petroleum exports (million $)	32,513
Current account balance (million $)	-4,636
Proven crude oil reserves (million barrels)	12,200
Proven natural gas reserves (billion cu. m.)	4,504
Crude oil production (1,000 b/d)	1,020
Marketed production of natural gas (million cu. m.)	100,513
Refinery capacity (1,000 b/cd)	677
Output of petroleum products (1,000 b/d)	644
Oil demand (1,000 b/d)	431
Crude oil exports (1,000 b/d)	477
Exports of petroleum products (1,000 b/d)	509
Natural gas exports (million cu.m.)	48,920

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 7: (Algeria economic profile, 2022)

Source: OPEC ASB

Despite not reaching the level of revenue generated from oil exports from 2010 (figure 7), Algeria's economy has reverted to pre-COVID levels in terms of growth. In 2022, the budget deficit decreased from 6.9% of Gross Domestic Product (GDP) to 0.2%, but revenue from the oil industry grew. Increasing oil export volumes and value, along with measures to reduce imports, led to a current account surplus of 7.8% of GDP in 2022. (AFDB, 'Algeria Outlook ', 2023).

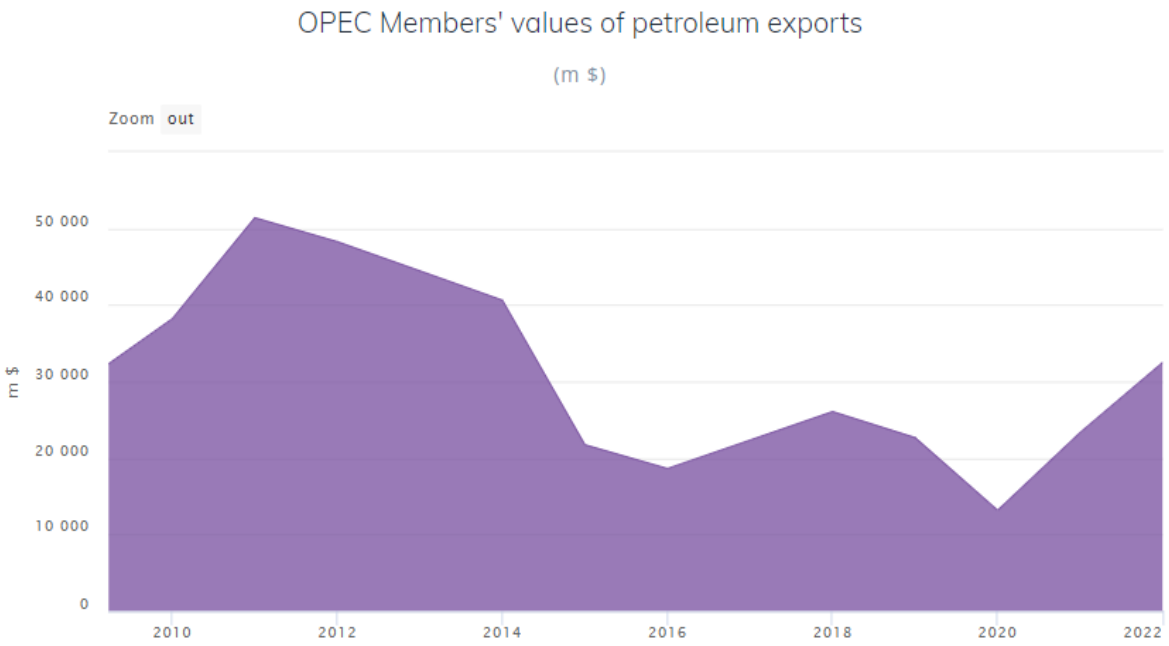


Figure 8: (Algeria's share of oil revenues 2010-2022)

Source: OPEC ASB

1.3.2 Congo

This central African country covers an area of 342,000 square kilometers. To the west, Gabon and the Atlantic Ocean border the country, to the northwest, to the northeast is Cameroon, to the east is the Central African Republic, to the south is the Democratic Republic of Congo, and to the southwest is Angola's exclave of Cabinda (www.opec.org)

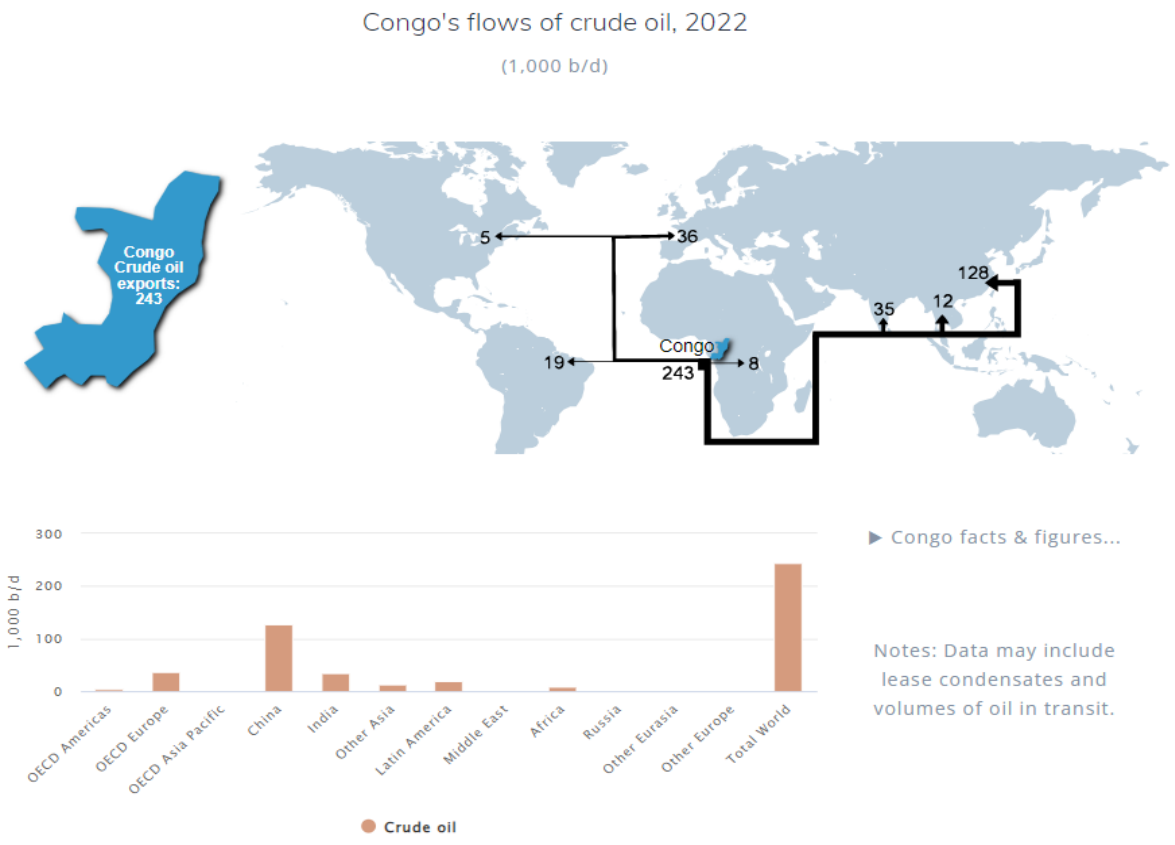


Figure 9: (Congo flows of crude oil 2022)

Source: OPEC

Since it plays an important role in ensuring efficient and regular supplies of petroleum to consuming nations due to its substantial reserves of crude oil and natural gas, the Republic of the Congo is a significant member of OPEC. Crude oil exports to China are the country's largest market (figure 9), (www.opec.org).

Population (million inhabitants)	5.98
Land area (1,000 sq km)	342
GDP per capita ($)	2,095
GDP at market prices (million $)	12,530
Value of exports (million $)	10,800
Value of petroleum exports (million $)	8,297
Current account balance (million $)	3,303
Proven crude oil reserves (million barrels)	1,811
Proven natural gas reserves (billion cu. m.)	284
Crude oil production (1,000 b/d)	262
Marketed production of natural gas (million cu. m.)	423
Refinery capacity (1,000 b/cd)	21
Output of petroleum products (1,000 b/d)	17
Oil demand (1,000 b/d)	8
Crude oil exports (1,000 b/d)	243
Exports of petroleum products (1,000 b/d)	5
Natural gas exports (million cu. m.)	--

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 10:(Congo economic profile, 2022)

Source: OPEC ASB

In 2022, the Republic of Congo experienced a 3.2% real GDP growth from 1.5% in 2021 due to strong performance in both oil and non-oil sectors (figure 10). With the Republic of Congo becoming an increasingly important player in the global economy, this growth is expected to

continue in the coming years (AFDB, 'Congo Outlook ', 2023).

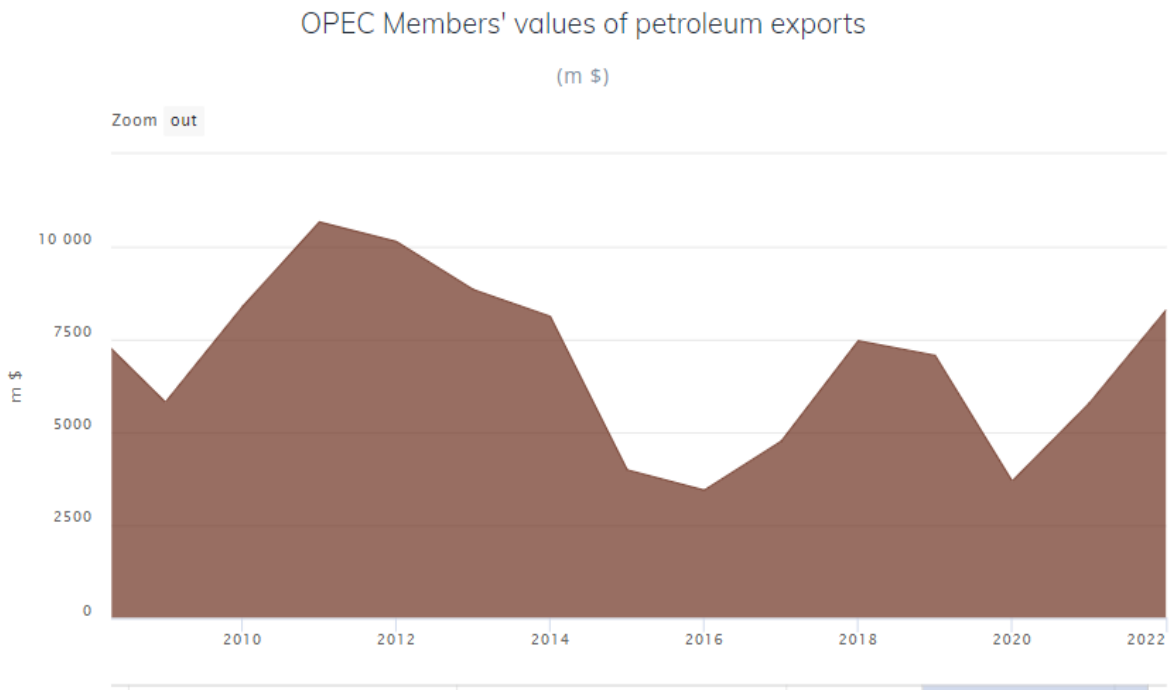


Figure 11: (Congo's share of oil revenues 2010-2022).

Source: OPEC ASB

According to the figures given in figure 11, the revenue generated from oil exports is similar to what the country received between 2010 and 2014 (figure 11). Furthermore, the country is focused on developing renewable energy sources to reduce its dependence on fossil fuels. (AFDB 'Congo Outlook', 2023)

1.3.3 Republic of Equatorial Guinea

This country is in Central Africa, and is a combination of an island and a mainland region. It has an insular region, with several islands, and a mainland region named after the Rio Muni.

Cameroon borders the mainland region on the north, and Gabon borders the south and east. On 25 May 2017, Equatorial Guinea joined OPEC. (www.opec.org)

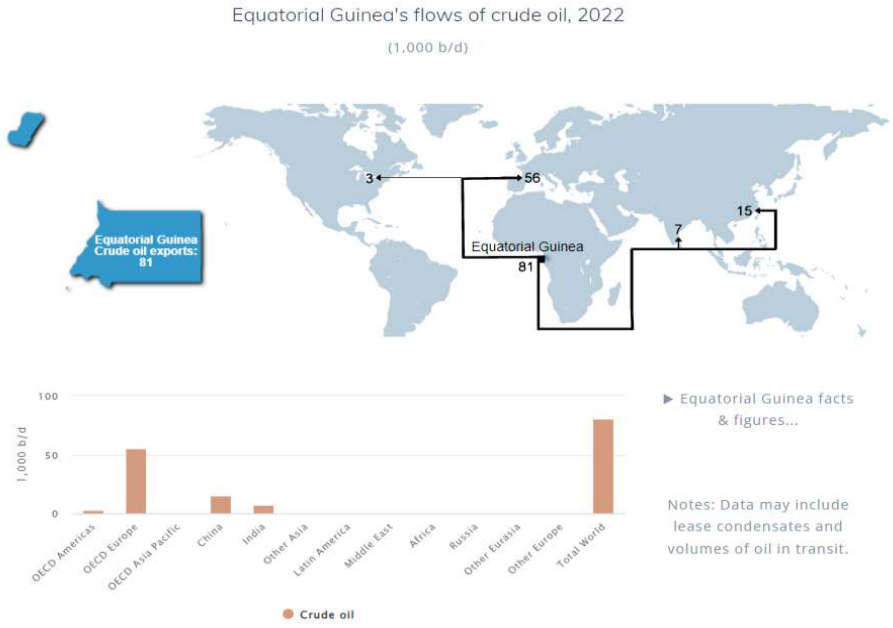


Figure 12: (Equatorial Guinea flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	**1.50**
Land area (1,000 sq km)	**28**
GDP per capita ($)	**10,982**
GDP at market prices (million $)	**16,541**
Value of exports (million $)	**7,900**
Value of petroleum exports (million $)	**3,111**
Current account balance (million $)	**43**
Proven crude oil reserves (million barrels)	**1,100**
Proven natural gas reserves (billion cu. m.)	**39**
Crude oil production (1,000 b/d)	**81**
Marketed production of natural gas (million cu. m.)	**8,105**
Refinery capacity (1,000 b/cd)	--
Output of petroleum products (1,000 b/d)	--
Oil demand (1,000 b/d)	**5**
Crude oil exports (1,000 b/d)	**81**
Exports of petroleum products (1,000 b/d)	--
Natural gas exports (million cu.m.)	**5,737**

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 13 (Equatorial Guinea economic profile, 2022)

Source: OPEC ASB

With the discovery of its large oil reserves in 1996, Equatorial Guinea's economy transformed, and its residents possess the highest literacy rate in Sub-Saharan Africa. (www.opec.org)

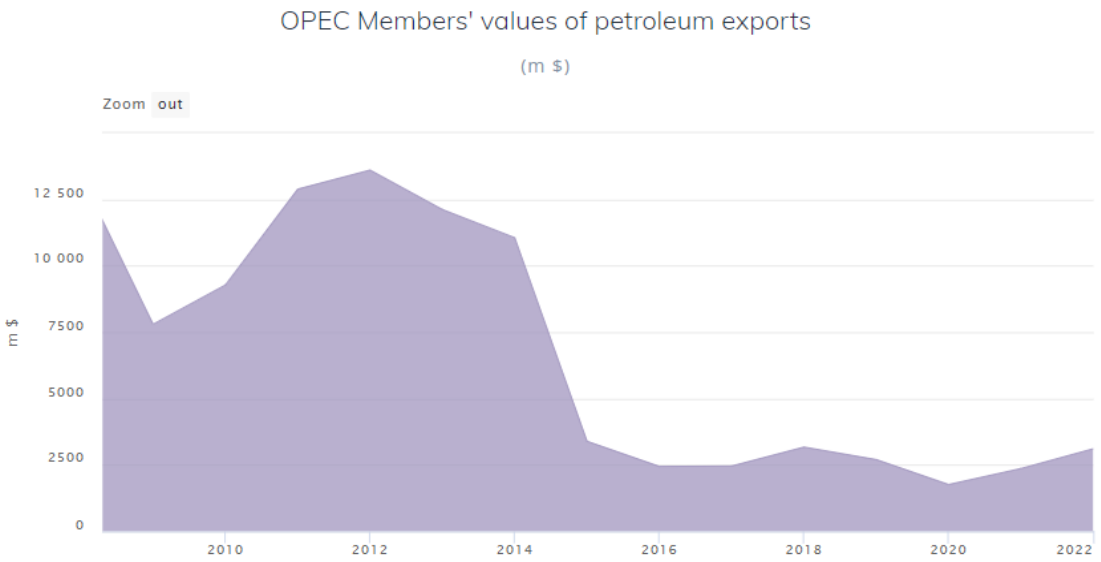


Figure 14: (Equatorial Guinea share of oil revenues 2010-2022).

Source: OPEC ASB

Despite being a major producer of crude oil and net exporter (figure 14), Equatorial Guinea is also a major producer and exporter of natural gas. Equatorial Guinea used to export coffee, timber, and cocoa in the past. In 2022, GDP grew 3.1%, following a contraction of 0.9% in 2021. Household demand also boosted growth. (AFDB 'Equatorial Guinea outlook', 2023).

1.3.4 The Republic of Gabon

On the western shore of Central Africa, Gabon is located. Gabon is an oil producer and exporter as well as a source of primary materials, as well as a growing agriculture and tourism sector. In 1975, Gabon joined OPEC, but terminated its membership in 1995. It rejoined the Organization on 1 July 2016. (www.opec.org)

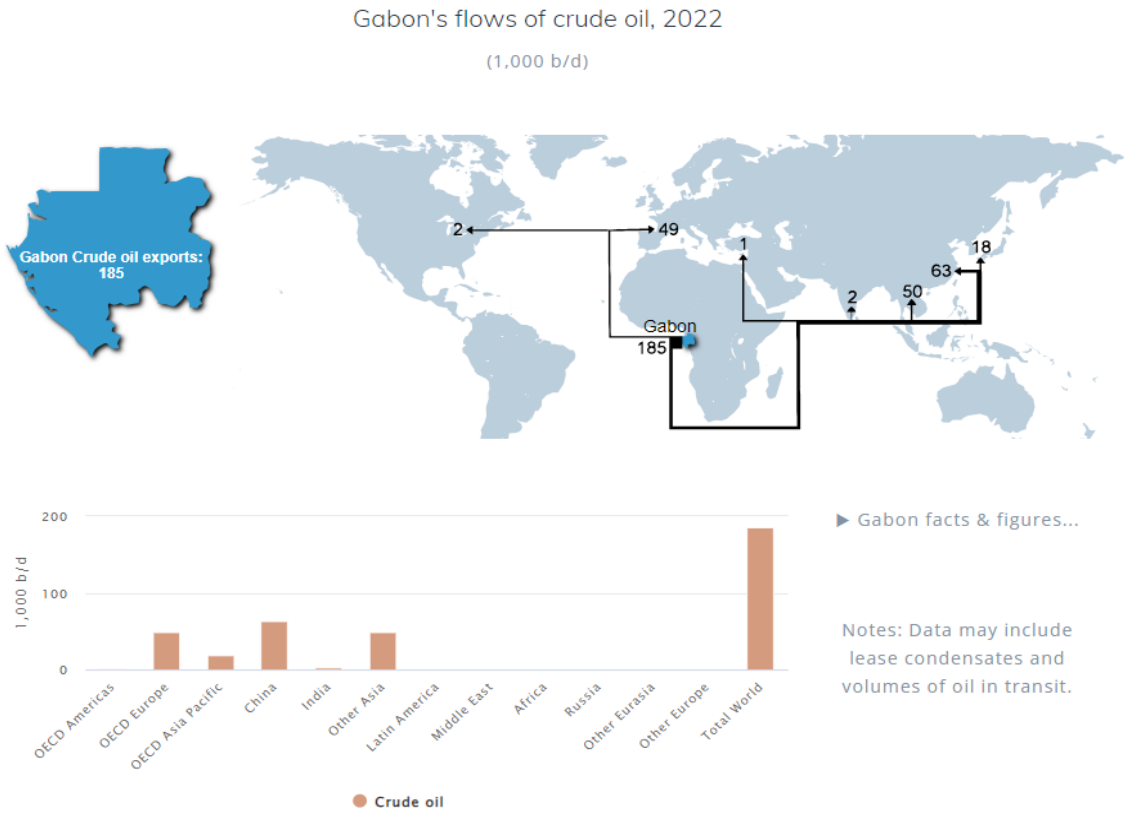


Figure 15: (Gabon flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	2.16
Land area (1,000 sq km)	268
GDP per capita ($)	10,149
GDP at market prices (million $)	21,931
Value of exports (million $)	15,405
Value of petroleum exports (million $)	6,812
Current account balance (million $)	572
Proven crude oil reserves (million barrels)	2,000
Proven natural gas reserves (billion cu. m.)	26
Crude oil production (1,000 b/d)	191
Marketed production of natural gas (million cu. m.)	463
Refinery capacity (1,000 b/cd)	25
Output of petroleum products (1,000 b/d)	20
Oil demand (1,000 b/d)	45
Crude oil exports (1,000 b/d)	185
Exports of petroleum products (1,000 b/d)	10
Natural gas exports (million cu.m.)	--

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 16: (Gabon economic profile, 2022)

Source: OPEC ASB

Gabon's GDP grew 3.0% in 2022, up from 1.5% in 2021, as a result of the healthy oil industry (which grew 7.1% in 2022) and nonoil sector (which grew 2.3% in 2021). In 2022, the oil industry grew 45.3% as a result of 45.3% rise in oil prices and 6.1% rise in oil production. (AFDB 'Gabon outlook', 2023).

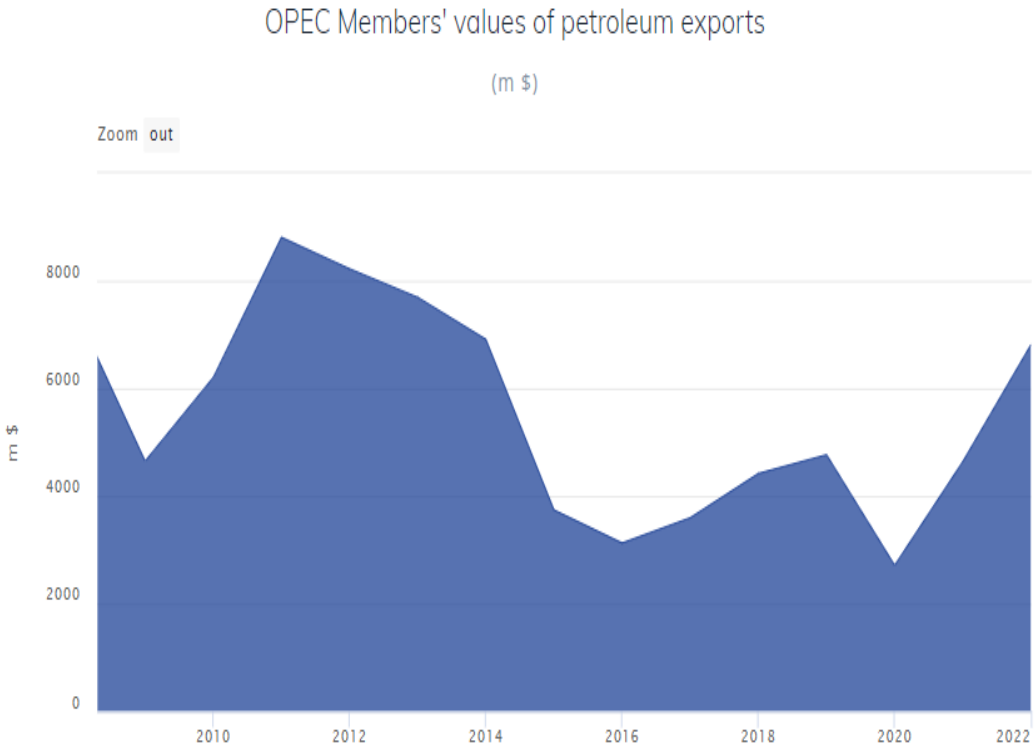


Figure 17: (Gabon share of oil revenues 2010-2022).

Source: OPEC ASB

In Gabon, oil revenues account for a substantial part of GDP and government revenue (figure 17). Upon discovering oil deposits in 1931, Gabon's oil industry was sparked, which led to its growth and subsequent contribution to the nation's economy. (www.opec.org)

1.3.5 The Republic of Iran

Iran was the first country in the Persian Gulf to discover oil in 1908. Oil and gas have been Iranian's primary industries since the 1920s, and continue to do so despite Tehran's efforts to diversify its economy. Approximately 60 percent of the government's revenue in recent years has come from oil (Mohamedi, 'The Iran primer', 2010**).** The country is a Founder Member of OPEC.

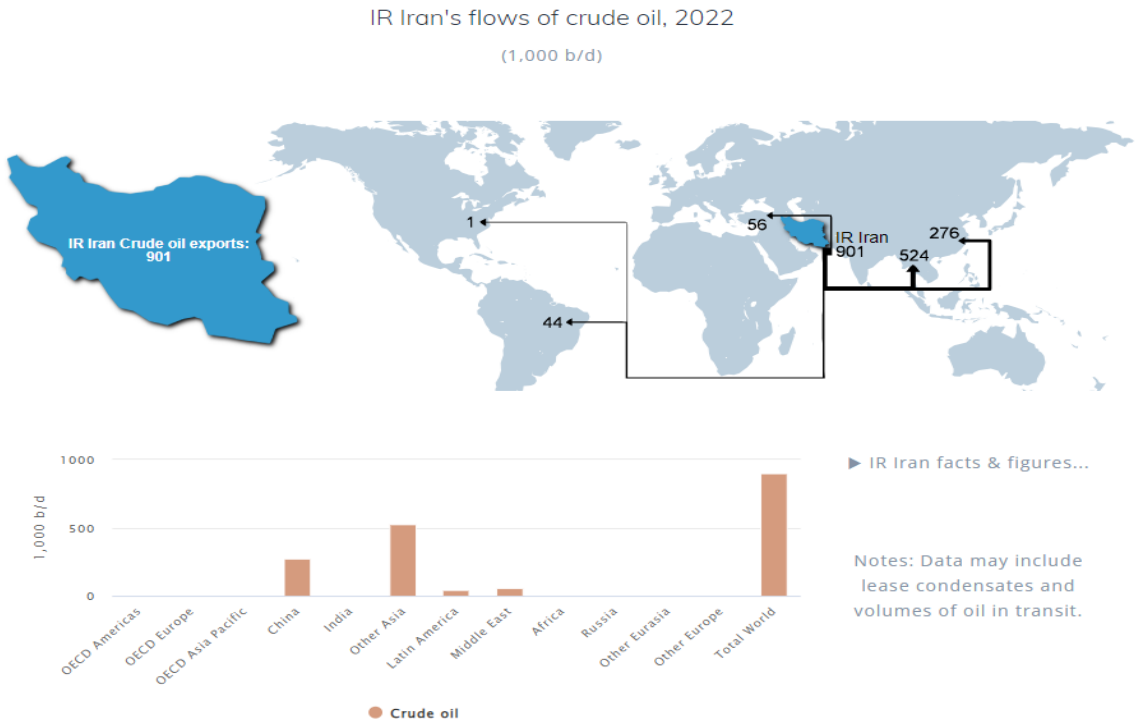


Figure 18: (Iran flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	85.69
Land area (1,000 sq km)	1,648
GDP per capita ($)	4,110
GDP at market prices (million $)	352,213
Value of exports (million $)	77,413
Value of petroleum exports (million $)	42,619
Current account balance (million $)	26,044
Proven crude oil reserves (million barrels)	208,600
Proven natural gas reserves (billion cu. m.)	33,988
Crude oil production (1,000 b/d)	2,554
Marketed production of natural gas (million cu. m.)	262,261
Refinery capacity (1,000 b/cd)	2,237
Output of petroleum products (1,000 b/d)	1,737
Oil demand (1,000 b/d)	1,793
Crude oil exports (1,000 b/d)	901
Exports of petroleum products (1,000 b/d)	383
Natural gas exports (million cu.m.)	18,794

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 19: (Iran economic profile, 2022)

Source: OPEC ASB

As a result of its oil production, which accounts for 23 % of the country s GDP, services make up 51 % of the country s GDP. Manufacturing and mining make up 13 % of the economy, while agriculture makes up 10 %. In the last big sector of the GDP, construction and electricity, gas and water distribution make up 7 %. (Trading economics ‘Iran’, 2023).

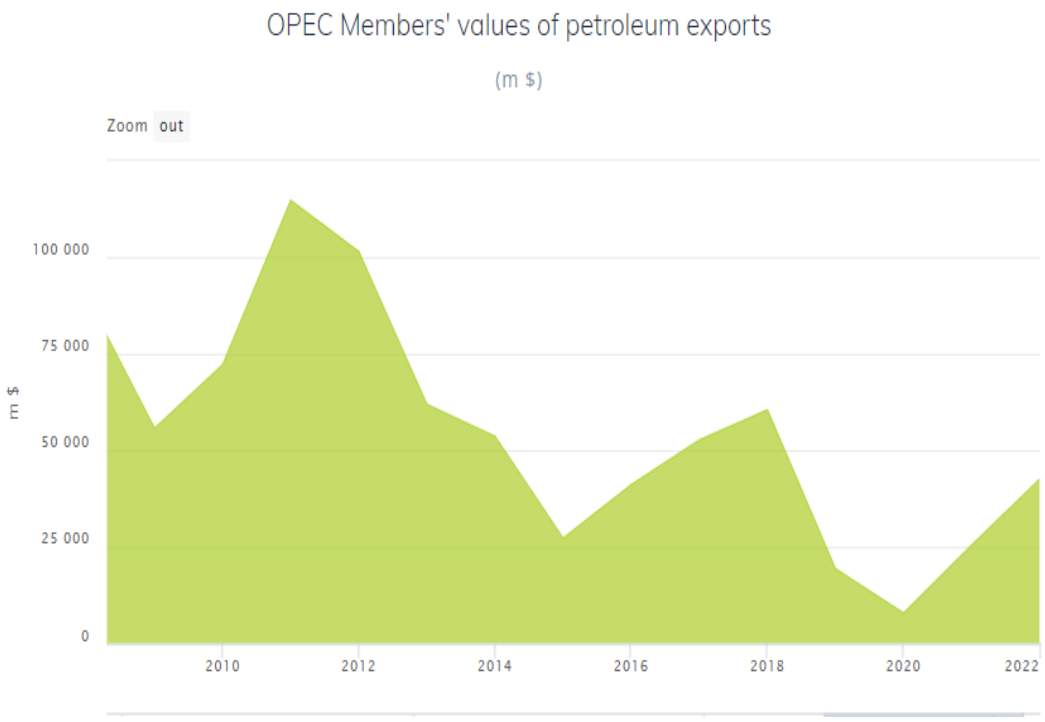


Figure 20: (Iran share of oil revenues 2010-2022).

Source: OPEC ASB

From 1995 to 2021, Iran exported an average of $47.24 Billion of oil per year; the high point was in 2011, when it exported $119.14 Billion, and the low point was in 1998, when it exported $10.9 Billion (Trading economics 'Iran', 2023).

In recent years, oil revenue has accounted for approximately 60 percent of Iranian government revenue. Although efforts have been made to diversify the Iranian economy, oil remains the country's primary driver of economic growth (Mohamedi, 'The Iran primer', 2010**).**

1.3.6 Iraq

Iraq occupies a land area of approximately 438 thousand square kilometers, has a population of roughly 42 million, with about a fifth living in Baghdad, the capital. The majority of Iraqis speak Arabic, although Kurdish is also spoken in the northern parts of the country (www.opec.org)

The country also has vast reserves of coal, copper, and iron ore. In addition to petroleum, Iraq is also rich in natural gas, phosphates, and sulfur (www.opec.org).

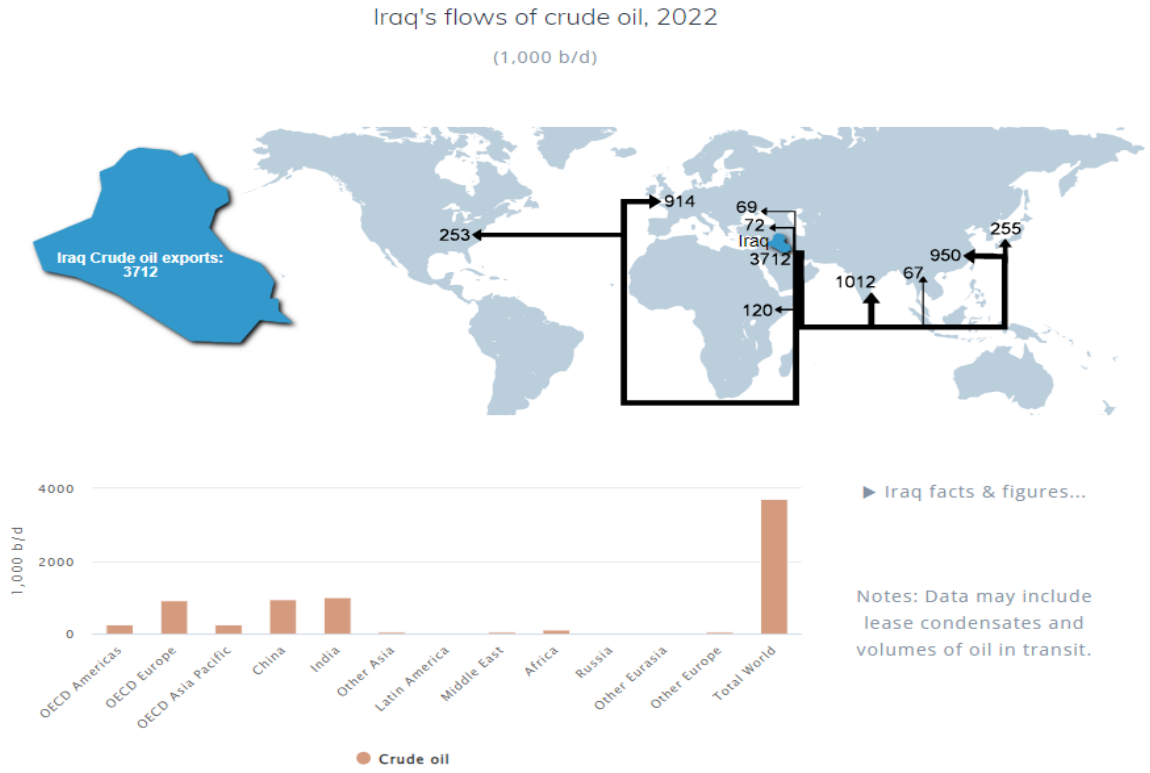


Figure 21: (Iraq flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	42.25
Land area (1,000 sq km)	438
GDP per capita ($)	6,253
GDP at market prices (million $)	264,182
Value of exports (million $)	138,291
Value of petroleum exports (million $)	120,571
Current account balance (million $)	41,339
Proven crude oil reserves (million barrels)	145,019
Proven natural gas reserves (billion cu. m.)	3,714
Crude oil production (1,000 b/d)	4,453
Marketed production of natural gas (million cu. m.)	9,778
Refinery capacity (1,000 b/cd)	1,116
Output of petroleum products (1,000 b/d)	834
Oil demand (1,000 b/d)	828
Crude oil exports (1,000 b/d)	3,712
Exports of petroleum products (1,000 b/d)	172
Natural gas exports (million cu. m.)	--

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 22: (Iraq economic profile, 2022)

Source: OPEC ASB

The GDP of Iraq is projected to grow steadily between 2023 and 2028, by 55.4 billion U.S. dollars (+21.73 %) between the periods. A positive trend indicates the country's economic potential, which could result in a GDP of 310.35 billion dollars by 2028, suggesting it will reach a new peak. (O'Neil Aaron "Iraq GDP", Statista, 2023).

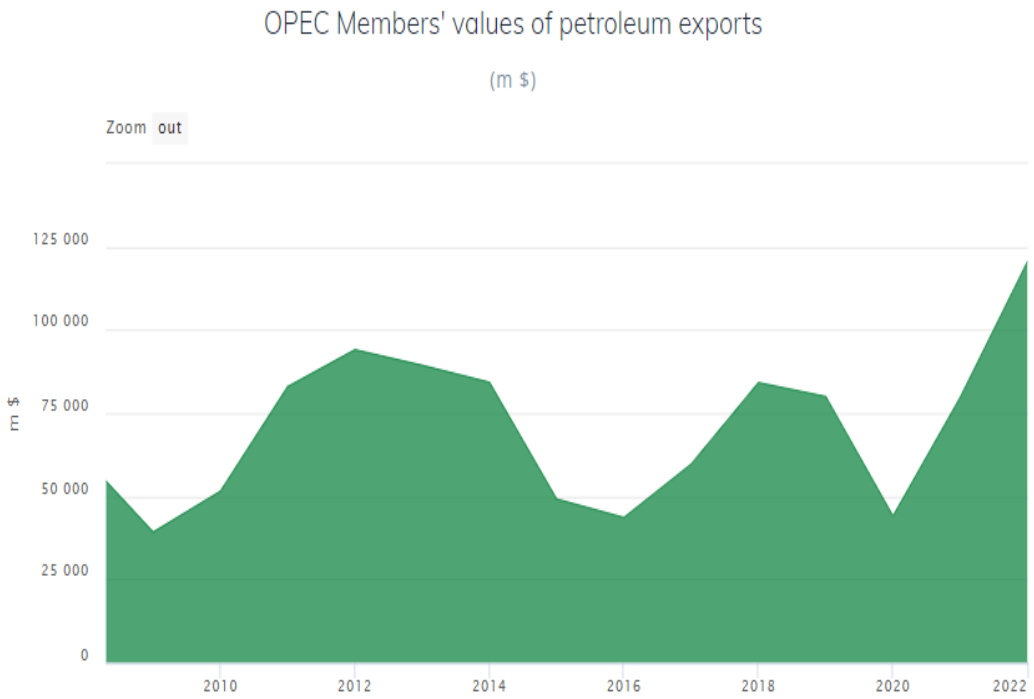


Figure 23: (Iraq share of oil revenues 2010-2022).

Source: OPEC ASB

Oil revenues make up more than 99% of Iraq's exports, 85% of its government budget, and 42% of its GDP (figure 23), making it one of the world's most oil-dependent nations. A high oil dependency makes the country vulnerable to macroeconomic volatility, while budget rigidities limit its fiscal space and ability to implement vital policies (World Bank 'Iraq overview, 2023).

Iraq has a population of 40 million people, and its unemployment rate is at least 10% higher than the rate before COVID19 when it was 12.7%. Displaced persons, returnees, women, self-employed individuals and informal workers remain unemployed (World Bank 'Iraq overview', 2023).

1.3.7 Kuwait

As early as 1938, Kuwait Oil Company drilled the country's first commercial oil well in Al Burqan oilfield. It was in 1946 that crude oil started to be exported commercially (opec.org)

A rapid growth in Kuwait's oil industry contributed significantly to the country's economic development and transformation. Kuwait became one of the world's largest oil producers. (International Trade Administration “Kuwait Oil & Gas”, 2023).

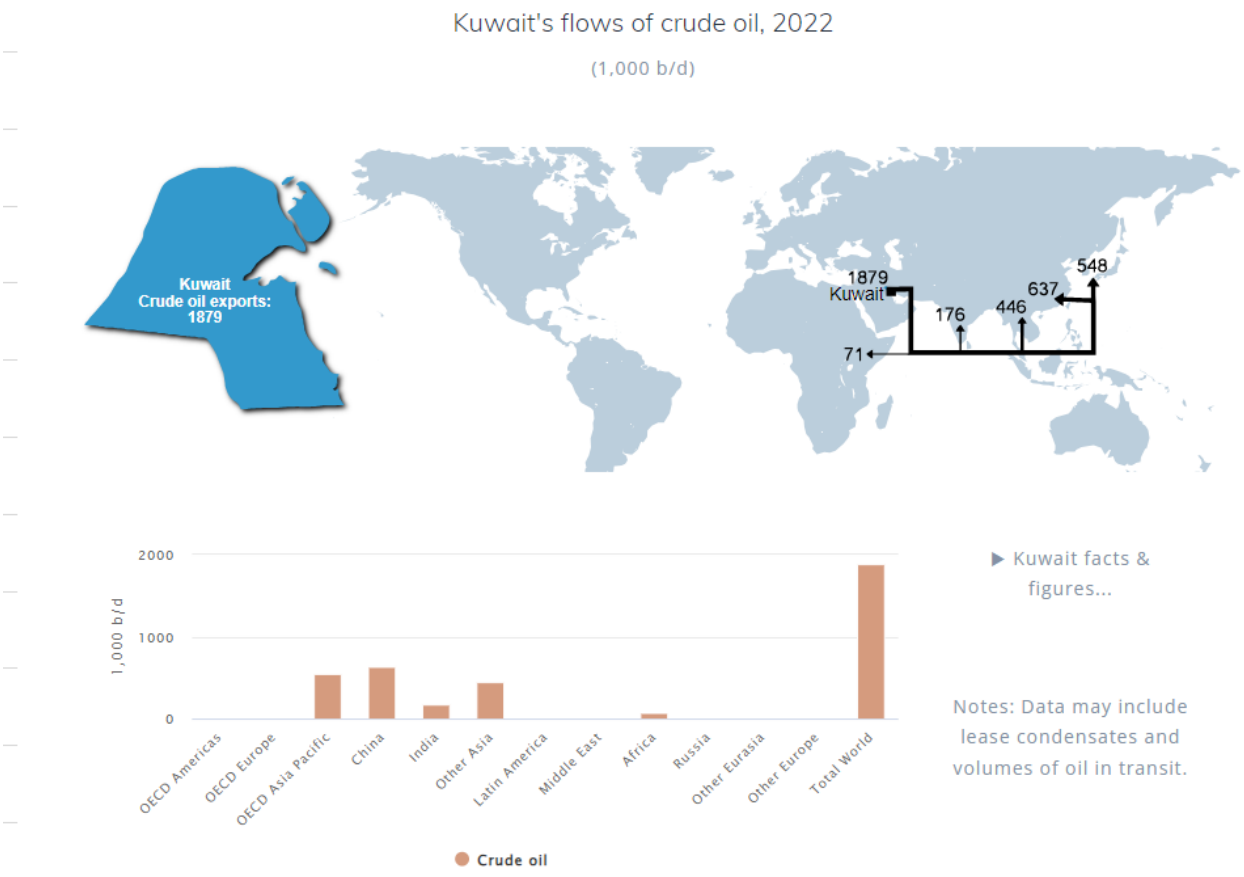


Figure 24: (Kuwait flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	4.39
Land area (1,000 sq km)	18
GDP per capita ($)	41,493
GDP at market prices (million $)	181,978
Value of exports (million $)	110,370
Value of petroleum exports (million $)	95,352
Current account balance (million $)	17,101
Proven crude oil reserves (million barrels)	101,500
Proven natural gas reserves (billion cu. m.)	1,784
Crude oil production * (1,000 b/d)	2,707
Marketed production of natural gas (million cu. m.)	13,883
Refinery capacity (1,000 b/cd)	1,005
Output of petroleum products (1,000 b/d)	983
Oil demand (1,000 b/d)	469
Crude oil exports (1,000 b/d)	1,879
Exports of petroleum products (1,000 b/d)	711
Natural gas exports (million cu. m.)	--

* including share of production from Neutral Zone

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 25: (Kuwait economic profile, 2022)

Source: OPEC ASB

Kuwait is not only a member of OPEC, but is also one of the largest oil producers in the world. The country's oil revenue accounts for 80% of fiscal revenues (figure 25) and 90% of export revenues. A generous distribution of oil revenues contributes to economic growth, which relies heavily on oil production and private consumption. (BNP Paribas “Kuwait Research”, 2019).

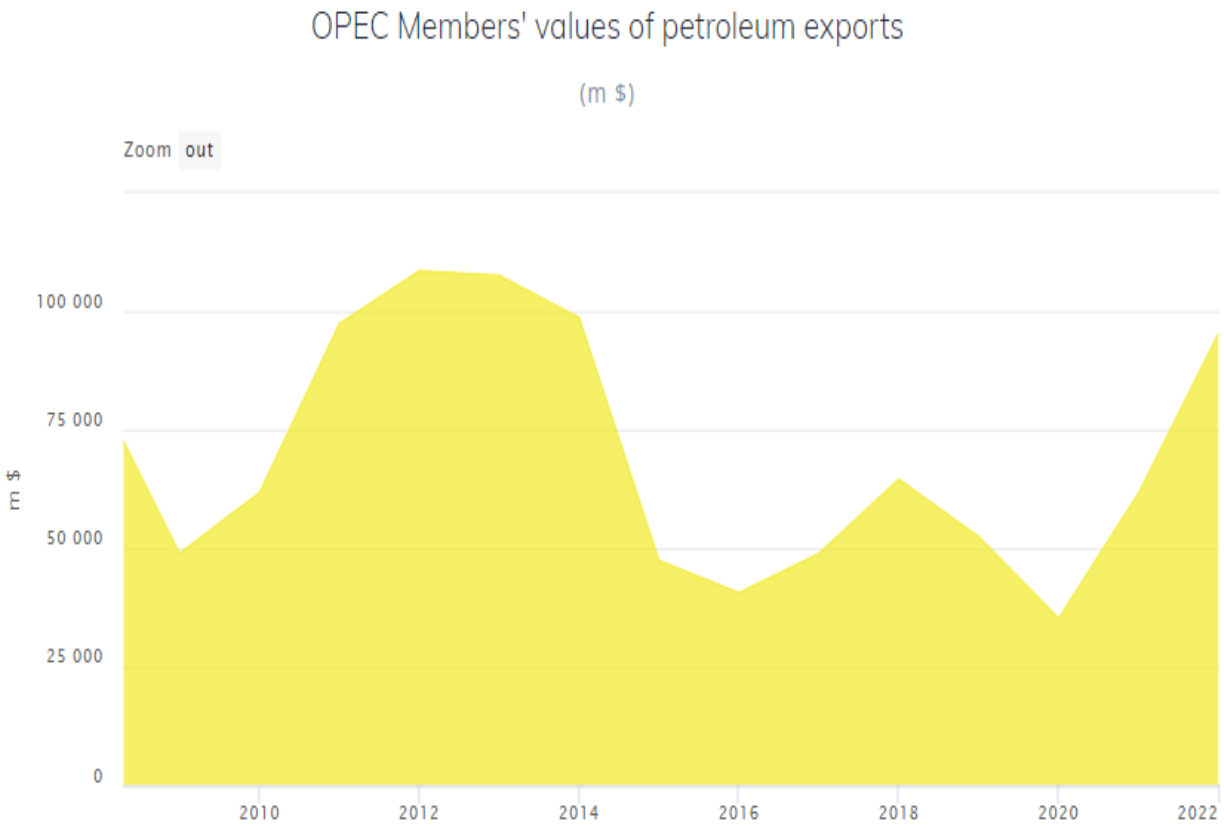


Figure 26: (Kuwait share of oil revenues 2010-2022).

Source: OPEC ASB

The bulk of Kuwait's income is derived from crude oil exports (figure 26). According to the International Monetary Fund, 57% of Kuwait's total revenue in fiscal year 2021 came from oil and natural gas revenues. About 78% of the country's export revenue came from petroleum exports. (US EIA 'Kuwait Analysis, 2023).

1.3.8 Libya

In 2021, Libya ranked seventh among OPEC crude oil producers and third among all African producers of petroleum liquids, after Nigeria and Algeria. As of 2021, Libya had 39% of Africa's proven oil reserves and 3% of the world's proven oil reserves. Although Libya has large oil reserves, political conflicts and militia attacks on hydrocarbon infrastructure have limited its oil and natural gas development. The resulting challenges have also limited its exploration and development since 2011 (US EIA "Libya Analysis", 2023).

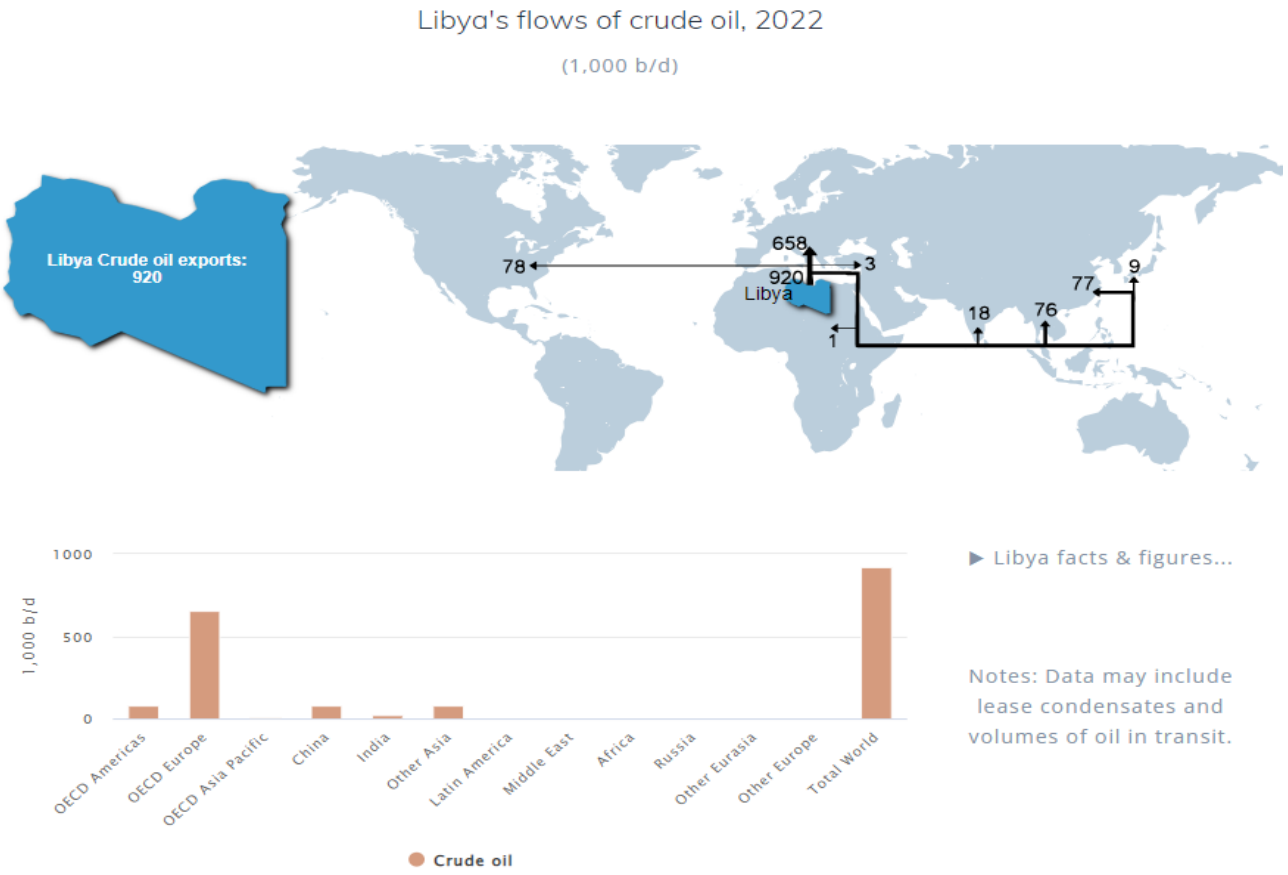


Figure 27: (Libya flows of crude oil 2022)

Source: OPEC

Libya's oil exports are mainly to countries in the OECD European Union, followed by countries in Asia, China, and India (figure 27). A large portion of Libya's economy is derived from oil exports, which account for over 90% of its total revenue. These revenues are essential for the country's development and fund public services.

Population (million inhabitants)	6.78
Land area (1,000 sq km)	1,760
GDP per capita ($)	6,502
GDP at market prices (million $)	44,066
Value of exports (million $)	37,686
Value of petroleum exports (million $)	33,255
Current account balance (million $)	8,116
Proven crude oil reserves (million barrels)	48,363
Proven natural gas reserves (billion cu. m.)	1,505
Crude oil production (1,000 b/d)	981
Marketed production of natural gas (million cu. m.)	23,807
Refinery capacity (1,000 b/cd)	634
Output of petroleum products (1,000 b/d)	148
Oil demand (1,000 b/d)	192
Crude oil exports (1,000 b/d)	920
Exports of petroleum products (1,000 b/d)	99
Natural gas exports (million cu. m.)	2,479

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 28: (Libya's economic profile)

Source: OPEC ASB

Libya's real GDP contracted by 12.1% in 2022 due to rising conflict and lower hydrocarbon and service performance after growing 28.3% in 2021. In 2022, inflation grew to 4.6% from 2.8% as a result of higher food and essential goods prices. Increased oil revenues caused a fiscal surplus to increase from 11.3% in 2021 to 13.8% in 2022 (AFDB 'Libya outlook', 2023).

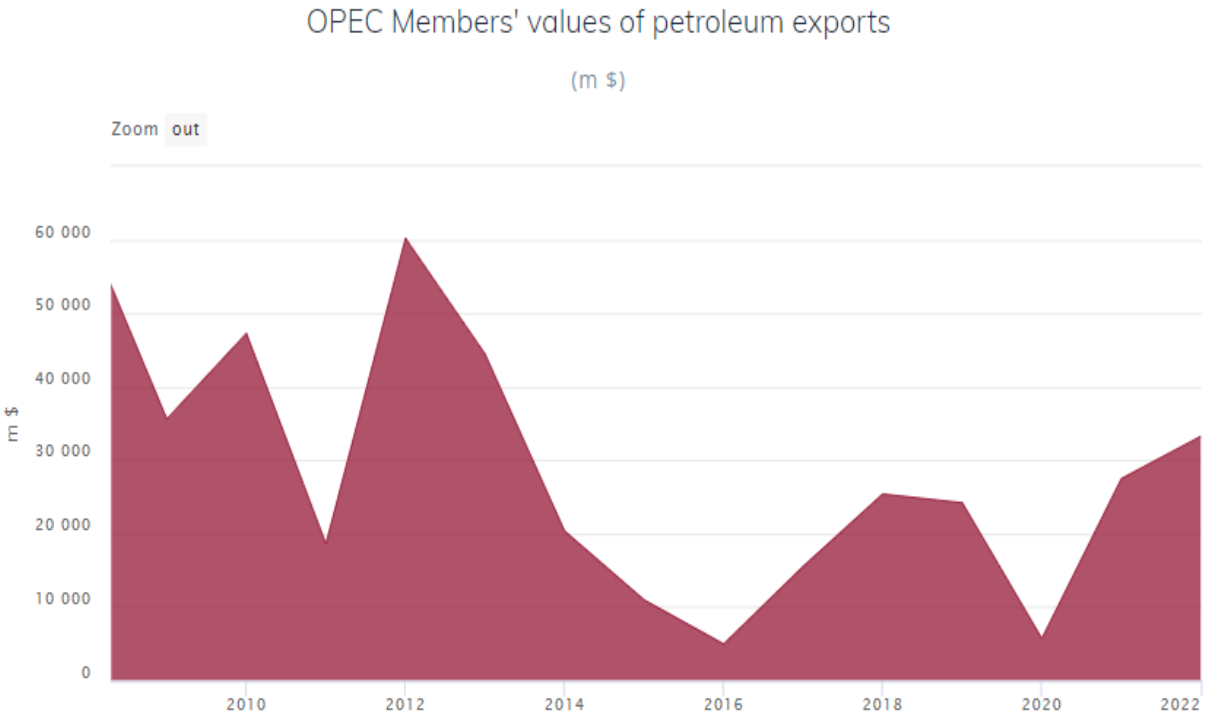


Figure 29: (Libya's share of oil revenues 2010-2022).

Source: OPEC

As of 2020, 73% of Libya's export value was derived from oil and natural gas exports. According to the country's export values for 2020, oil and natural gas exports account for 73% of Libya's total export value. As a result of the political conflicts in the east and west, the blockages and shut-ins of oil export ports, and to a lesser extent, the worldwide COVID-19 pandemic, real GDP growth declined by 31% in 2020 (US EIA 'Libya Analysis', 2022).

1.3.9 Nigeria

A major hydrocarbon producer in Africa, Nigeria has benefited greatly from economic growth in recent years. Any fluctuation in oil prices can adversely affect Nigeria's economy and oil sector, since the country's economy and oil sector are heavily dependent on the global oil market. Oil and natural gas revenue are the primary sources of foreign exchange in this country, and crude oil price changes affect the country greatly (US EIA "Nigeria Analysis", 2023).

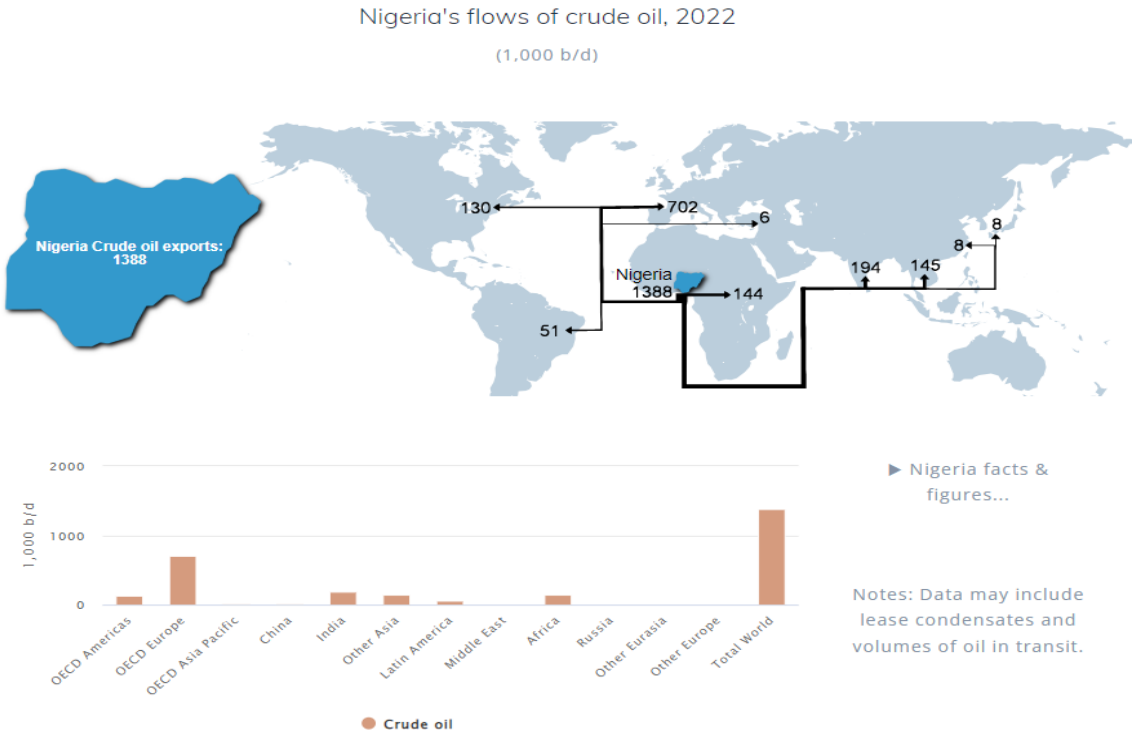


Figure 30: (Nigeria's flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	221.60
Land area (1,000 sq km)	924
GDP per capita ($)	2,122
GDP at market prices (million $)	470,332
Value of exports (million $)	68,119
Value of petroleum exports (million $)	53,457
Current account balance (million $)	-1,010
Proven crude oil reserves (million barrels)	36,967
Proven natural gas reserves (billion cu. m.)	5,913
Crude oil production (1,000 b/d)	1,138
Marketed production of natural gas (million cu. m.)	44,307
Refinery capacity (1,000 b/cd)	486
Output of petroleum products (1,000 b/d)	6
Oil demand (1,000 b/d)	518
Crude oil exports (1,000 b/d)	1,388
Exports of petroleum products (1,000 b/d)	--
Natural gas exports (million cu. m.)	32,190

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 31: (Nigeria's economic profile)

Source: OPEC ASB

Oil production declines have caused the real GDP growth rate to decrease to 3.3% by 2022. Although industrial output decreased by 5%, agricultural and service output increased by 7 and 2% respectively. GDP growth was slowed by public consumption (2.5%) and net exports (80%) in 2021. Per capita income increased by 0.8%, a decrease from 1.2% in 2015 (AFDB "Nigeria Outlook", 2023).

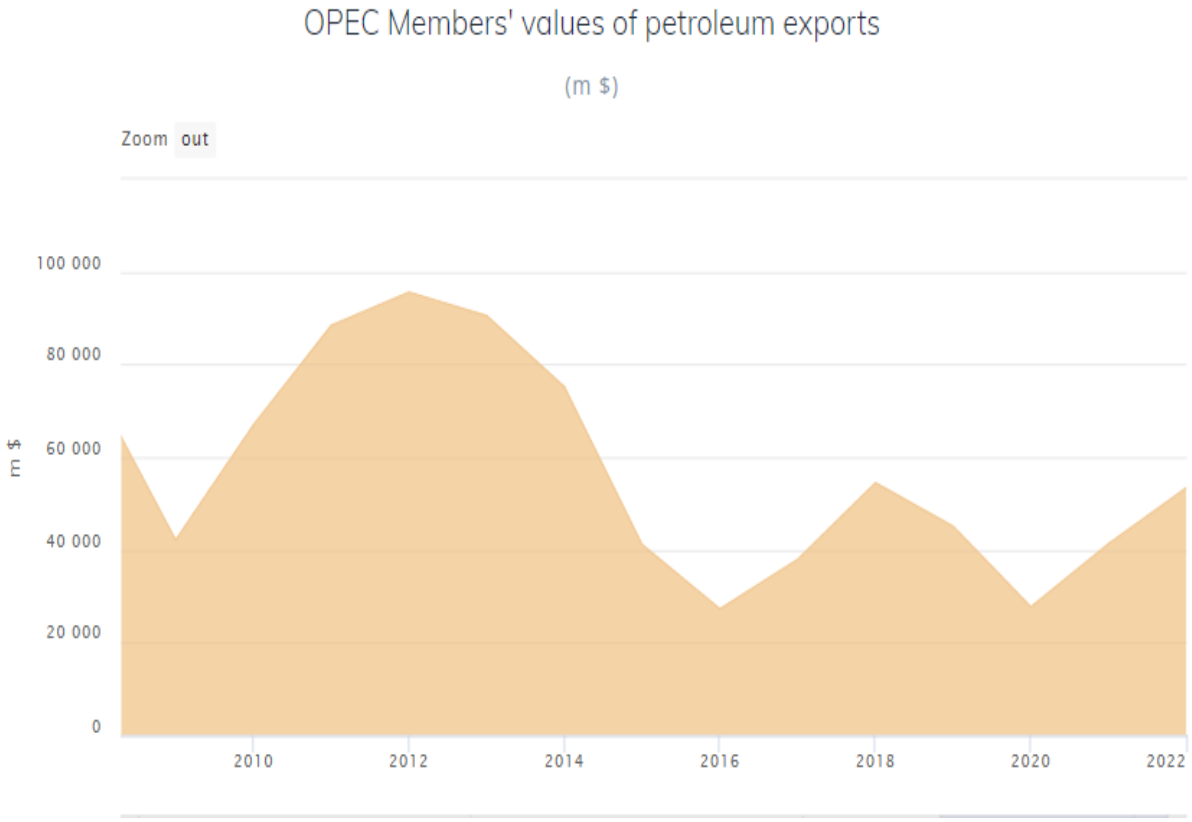


Figure 32: (Nigeria's share of oil revenues 2010-2022).

Source: OPEC ASB

Despite being the largest oil producer in Africa, Nigeria has suffered unplanned outages due to a recent supply disruption. Unplanned disruptions and a reduction in upstream investment have led to significant declines in oil production in the past decade. Due to the disruption of oil production, the government has suffered a decline in revenue and economic stability, making it difficult for the country to fund its budget and implement development projects (US EIA "Nigeria Analysis", 2023).

1.3.10 Saudi Arabia

Approximately 17 percent of proven petroleum reserves in Saudi Arabia are exported, making it one of the largest net exporters in the world. As one of the world's largest integrated energy and chemicals companies, Saudi Aramco operates in upstream, midstream, and downstream segments. It has the second largest proven oil reserves. (International Trade Administration (ITA) "Saudi Arabia", 2024).

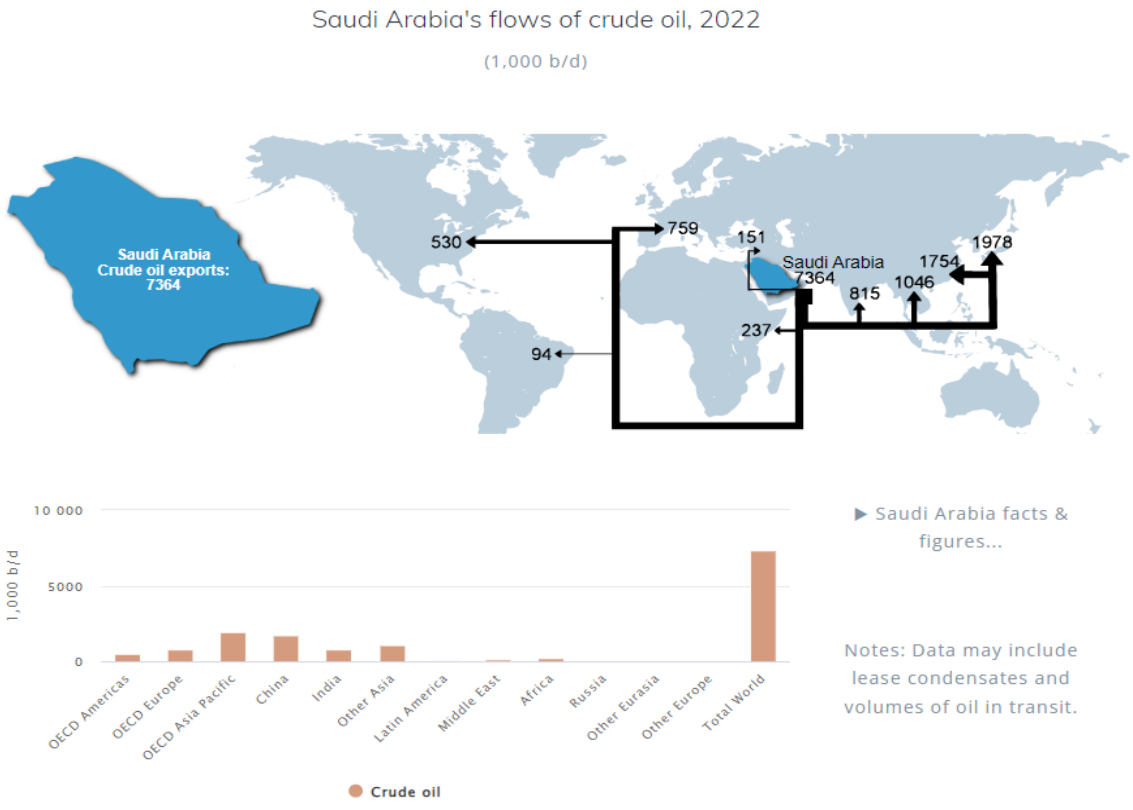


Figure 33: (Saudi Arabia's flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	34.79
Land area (1,000 sq km)	2,150
GDP per capita ($)	31,850
GDP at market prices (million $)	1,108,149
Value of exports (million $)	442,569
Value of petroleum exports (million $)	326,289
Current account balance (million $)	150,753
Proven crude oil reserves (million barrels)	267,192
Proven natural gas reserves (billion cu. m.)	9,514
Crude oil production *(1,000 b/d)	10,591
Marketed production of natural gas (million cu. m.)	122,895
Refinery capacity (1,000 b/cd)	3,291
Output of petroleum products (1,000 b/d)	2,768
Oil demand (1,000 b/d)	3,172
Crude oil exports (1,000 b/d)	7,364
Exports of petroleum products (1,000 b/d)	1,468
Natural gas exports (million cu. m.)	--

* including share of production from Neutral Zone

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 34: (Saudi Arabia's economic profile)

Source: OPEC ASB

It is estimated that Saudi Arabia's GDP will reach 1108.57 billion US dollars in 2022 (figure 34). Saudi Arabia is heavily dependent on oil, despite efforts to diversify its economy. Besides attracting foreign investment and creating more jobs, the government also attempts to reduce the country's dependence on oil. Also, Saudi Arabia aims to diversify its economy further by expanding tourism, services, and agriculture (Mati & Rehman, 'Saudi economy', 2023).

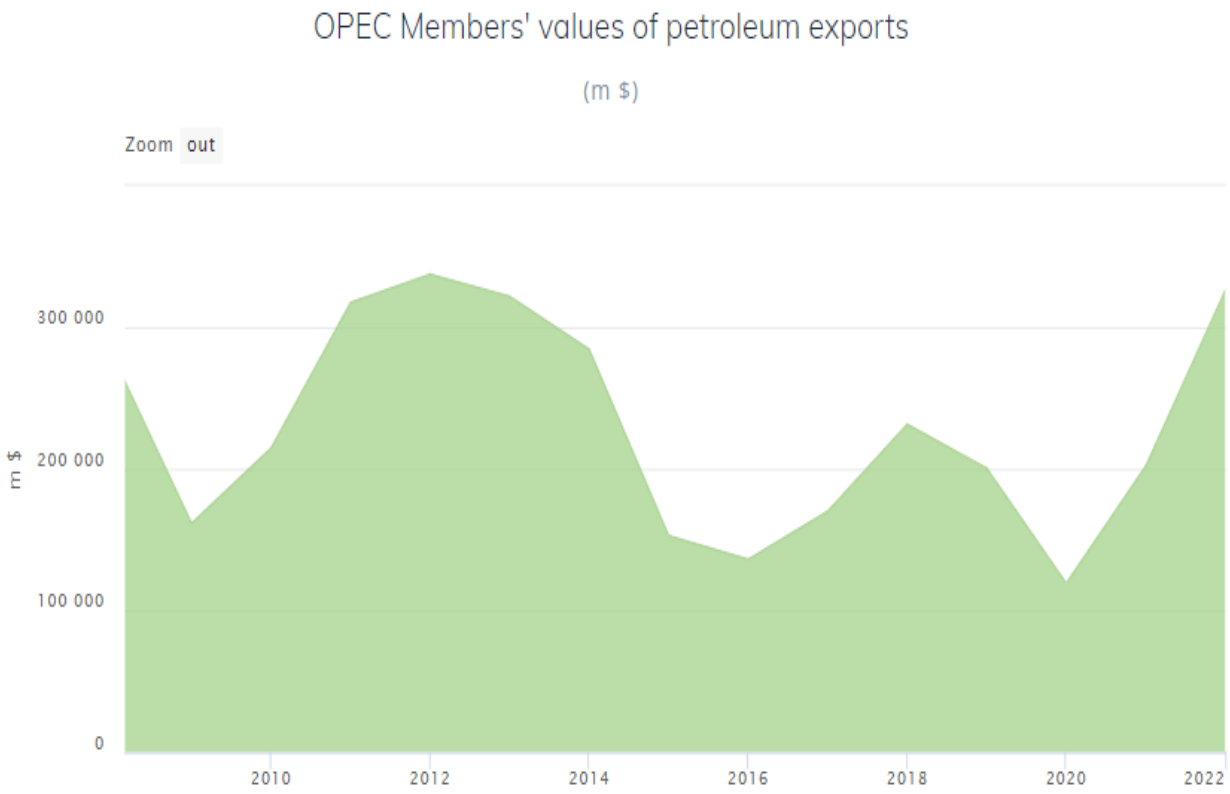


Figure 35: (Saudi Arabia's share of oil revenues 2010-2022).

Source: OPEC ASB

One of the largest export earnings and government revenues for Saudi Arabia is oil revenue, which accounts for about 70% of total revenue. The Saudi economy is heavily dependent on oil, which makes it vulnerable to fluctuating oil prices and highlights the need to diversify it to reduce dependence (Helmi et al, 2023: 2-4).

1.3.11 United Arab Emirates (UAE)

UAE is expected to become the seventh largest liquid fuel producer by 2022 and the third largest OPEC producer by the same time. In case of a shortage of crude oil, the UAE has considerable spare capacity. In addition to exporting gasoline, diesel, and jet fuel, the UAE is also one of the country's top exporters. Petroleum is one of the key factors contributing to the country's economic growth (Carpenter & Agnihotri, 'Middle East exports', 2023).

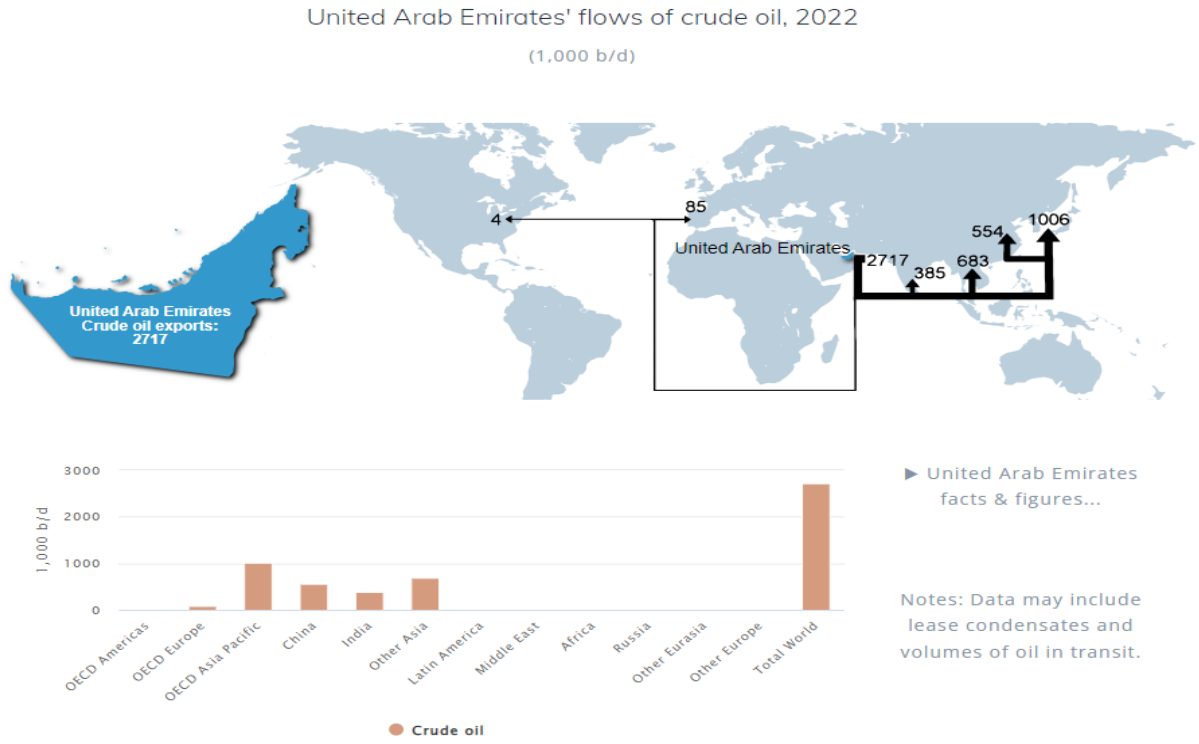


Figure 36: (UAE's flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	9.89
Land area (1,000 sq km)	84
GDP per capita ($)	51,308
GDP at market prices (million $)	507,535
Value of exports (million $)	532,797
Value of petroleum exports (million $)	94,677
Current account balance (million $)	135,927
Proven crude oil reserves (million barrels)	113,000
Proven natural gas reserves (billion cu. m.)	8,210
Crude oil production (1,000 b/d)	3,064
Marketed production of natural gas (million cu. m.)	55,574
Refinery capacity (1,000 b/cd)	1,227
Output of petroleum products (1,000 b/d)	953
Oil demand (1,000 b/d)	958
Crude oil exports (1,000 b/d)	2,717
Exports of petroleum products (1,000 b/d)	903
Natural gas exports (million cu. m.)	7,280

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 37: (UAE's economic profile)

Source: OPEC ASB

According to the World Bank's 'UAE Data', the United Arab Emirates' GDP in 2022 was 507.06 billion US dollars, 0.22 percent of the world's economic output. It has a thriving economy with a wide range of living standards and an expanding middle class. The UAE has about 80% of its population under 40. The UAE is also a major tourist destination (World Bank 'UAE Data', 2022).

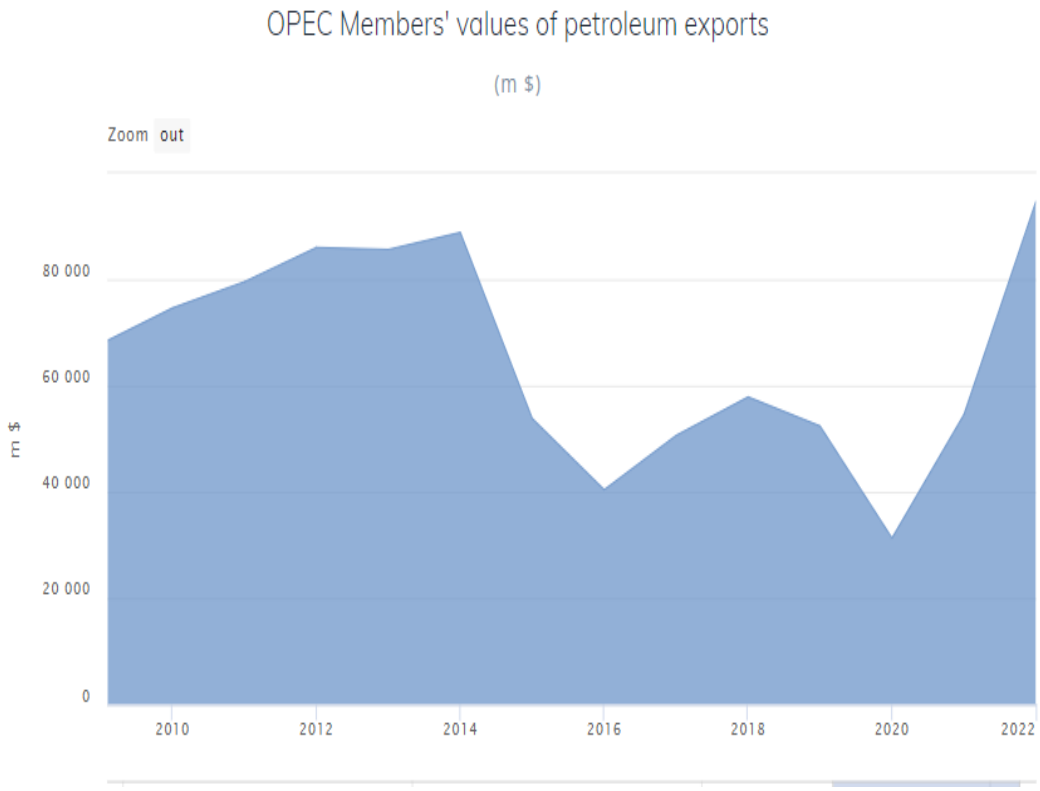


Figure 38: (UAE's share of oil revenues 2010-2022).

Source: OPEC

It is estimated that oil rents generated 15.67 % of GDP in 2021 in the United Arab Emirates, an increase of 5.2% points between 2020 and 2021 (Puri-Mirza, 'UAE: Oil Rent', 2023).

To accommodate future hydrocarbon production growth, the UAE has heavily invested in expanding hydrocarbon production capacity and developing midstream and downstream infrastructure. From 2013 to 2022, the OPEC member produced about 2.9 million barrels of crude oil every day. The UAE's crude oil and condensate production reached a peak of approximately 3.1 million barrels per day in 2019 (figure 35) (US EIA 'UAE Analysis', 2023).

1.3.12 Venezuela

Located along the Caribbean Coast of South America, Venezuela is bordered by Brazil, Colombia, and Guyana (opec.org)

Venezuela dropped from being world's fourth biggest oil producer to just the fourth smallest producer of all OPEC's 13 members in 2019 after being one of the original five large oil producing countries that led to the formation of OPEC in 1960. Congo-Brazzaville, Gabon, and Equatorial Guinea combined are the biggest oil producers in Africa (US EIA "Venezuela Analysis", 2020).

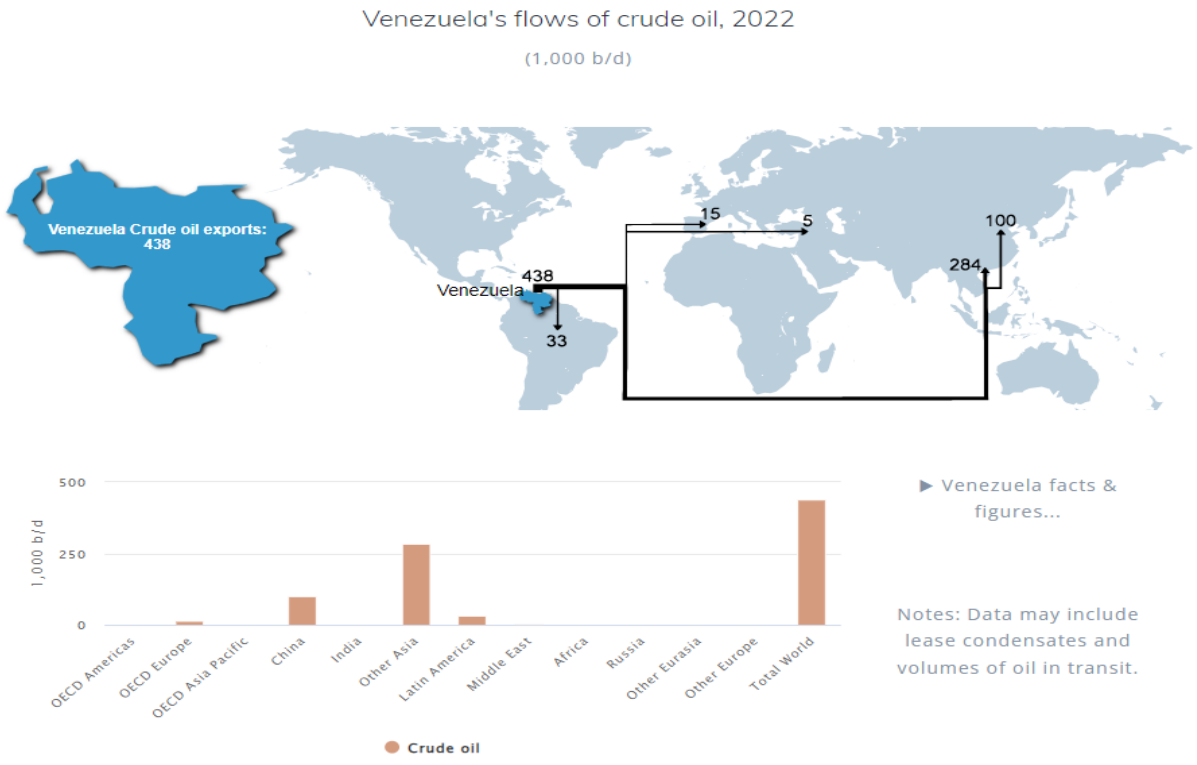


Figure 39: (Venezuela's flows of crude oil 2022)

Source: OPEC ASB

Population (million inhabitants)	33.11
Land area (1,000 sq km)	916
GDP per capita ($)	2,813
GDP at market prices (million $)	93,111
Value of exports (million $)	17,686
Value of petroleum exports (milllion $)	15,379
Current account balance (million $)	1,887
Proven crude oil reserves (million barrels)	303,221
Proven natural gas reserves (billion cu. m.)	5,511
Crude oil production (1,000 b/d)	716
Marketed production of natural gas (million cu. m.)	24,421
Refinery capacity (1,000 b/cd)	2,276
Output of petroleum products (1,000 b/d)	266
Oil demand (1,000 b/d)	272
Crude oil exports (1,000 b/d)	438
Exports of petroleum products (1,000 b/d)	88
Natural gas exports (million cu. m.)	--

- b/d (barrels per day)
- cu. m. (cubic metres)
- b/cd (barrels per calendar day)

Figure 40: (Venezuela's economic profile)

Source: OPEC ASB

From a peak of 372.59 billion U.S. dollars in 2012, Venezuela's GDP is estimated to fall to 43.79 billion U.S. dollars in 2020 (O'Neil Aaron "Venezuela GDP", Statista, 2023). This is largely due to the country's ongoing economic crisis, exacerbated by the COVID-19 pandemic. The fall in

GDP has resulted in a collapse of the country's currency and an increase in poverty.

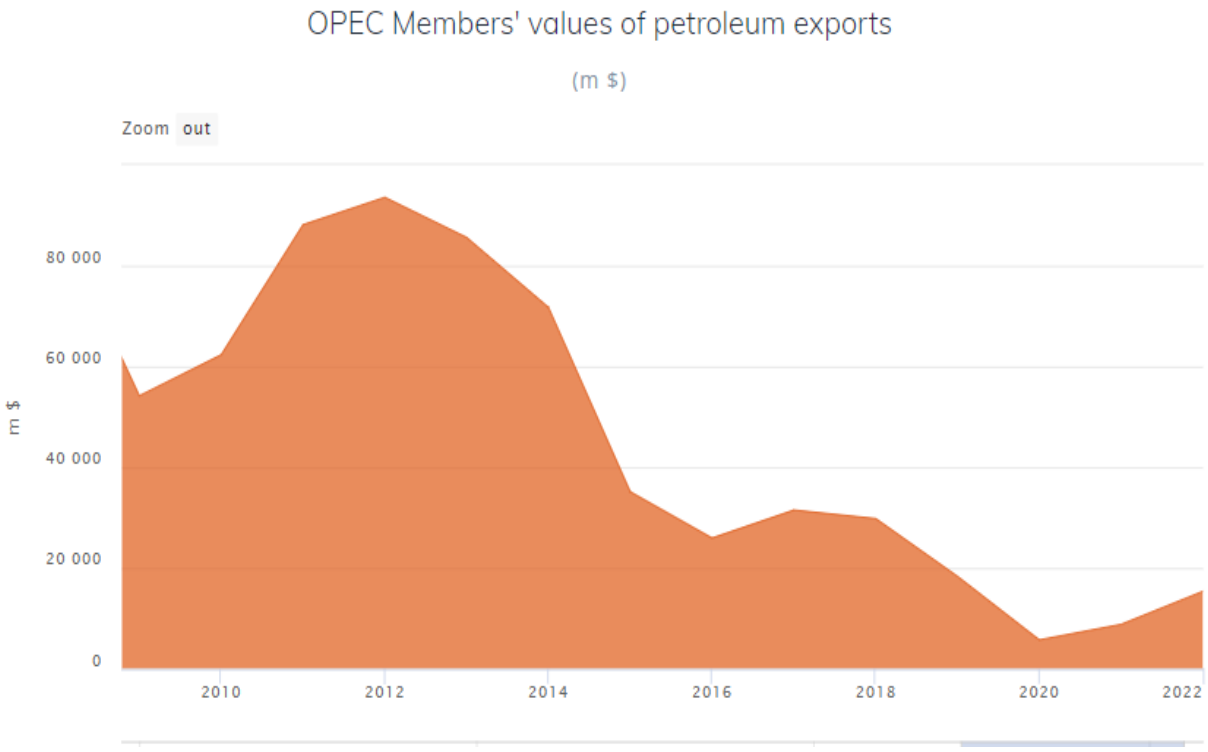


Figure 41: (Venezuela's share of oil revenues 2010-2022).

Source: OPEC ASB

Venezuela's crude oil production has declined rapidly to historically low levels. Since 2017, when the United States first imposed sanctions on crude oil exports, the country's crude oil production (including condensates) has decreased by more than one million barrels per day (b/d). Foreign partners have continued to cut activities in the oil sector due to reduced capital expenditures by state-owned oil company PDVSA, coupled with increased U.S. sanctions, resulting in an increase in crude oil production losses (US EIA "Venezuela Analysis", 2020).

2. Reducing Carbon emissions and Adapting to Energy Transitions from Fossil Fuel Energy Sources to Renewables in OPEC Countries.

As we can clearly see in the previous chapter, oil and gas (fossil fuels) are crucial to the sustenance of the economic activities of OPEC countries, so transitioning to low carbon emission systems either as sources of energy or as revenue presents a significant challenge.

In the energy transition vision, fossil fuel-based systems of energy production and consumption, such as oil, natural gas, and coal, will be replaced by renewable sources such as wind, solar, biomass, hydro, and green hydrogen (S & P Global, 'What Is Energy Transition' 2020)

The term "energy transition" can be interpreted in a broader sense. It refers to creating a world where everyone has access to reliable, affordable energy. It is essential that no one is left behind, regardless of their socioeconomic status.

Along with their commitment to the long-term stability of the oil market, OPEC and its member countries are closely involved in inclusive approaches to addressing a wide range of global concerns, such as sustainable development, environmental initiatives and climate change, and eradication of energy poverty (opec.org)

All of the 12 OPEC member countries have signed the Paris Agreement and most have ratified it. OPEC also collaborates with other energy organizations and stakeholders to promote energy efficiency, renewable energy sources, and energy security (opec.org).

In addition, OPEC actively participates in global initiatives to reduce emissions and address climate change (figure 42).

OPEC Member Countries	Paris Agreement Signature	Paris Agreement Ratification	Target
Algeria	✓	✓	Reduce GHG emissions by 7% unconditionally and upwards to 22% conditionally by 2030 compared to BAU
Congo	✓	✓	Unconditionally reduce GHG emissions by 17.09% by 2025 and 21.46% by 2030 compared to BAU scenario. Conditionally, reduce GHG emissions by 32.19% by 2025 and 39.88% by 2030, compared to BAU scenario
Equatorial Guinea	✓	✓	Conditionally reduce GHG emissions by 35% by 2030 and by 50% by 2050, compared to 2019 levels
Gabon	✓	✓	Unconditionally remain carbon neutral beyond 2050. Conditionally, maintain its net removals at a level of 100 million tCO_2eq per year beyond 2050
Iran	✓		Reduce GHG emissions by 4% unconditionally and up to 12% conditionally by 2030 compared to a BAU scenario
Iraq	✓	✓	Reduce GHG emissions by 1–2% unconditionally and up to 15% conditionally by 2030
Kuwait	✓	✓	Reduce GHG emissions by 7.4% by 2035 compared to BAU
Libya	✓		(not available) n.a.
Nigeria	✓	✓	Reduce GHG emissions by 20% unconditionally and 47% conditionally by 2030 compared to BAU
Saudi Arabia	✓	✓	Reduce GHG emissions by 278 $MtCO_2e$ annually by 2030, with 2019 being the baseline year
United Arab Emirates	✓	✓	Reduce GHG emissions by 40% by 2030 compared to BAU
Venezuela	✓	✓	Reduce GHG emissions by 20% by 2030 compared to BAU

Figure 42: (Emission Targets of OPEC Member Countries).

Source: OPEC WOO

2.1 Pathway to Mitigating and Adapting to the Energy Transition

It is estimated that global warming will reach 1.5 degrees Celsius by 2050 unless anthropogenic CO2 emissions are reduced by 2030 and reach zero by 2050, as stated in the Intergovernmental Panel on Climate Change (IPCC) report Global Warming of 1.5 degrees Celsius (Delmonte et al. 'IPCC report', 2018).

A major contributor to global carbon dioxide emissions (CO2) is the energy sector. Consequently, the industry must accelerate its efforts to decarbonize the energy sector by deploying renewable energy technologies and carbon capture technologies on a large scale. It is important that any solutions adopted for a sustainable transition are chosen wisely if the world is to avoid cascade failures (Magnan et al, 2016). Since the energy sector is intertwined with every other area of life, it is imperative that the world chooses its solutions wisely.

In addition to reducing CO2 emissions and greenhouse gases (GHG), societies also demand energy services. While oil and gas companies are excellent at providing fuels that form the foundation for today's energy system, they now have to decide how they can contribute rapidly to climate change solutions as well as ensure energy security (IEA 'Oil & Gas Industry, 2020)

Several oil and gas companies are already participating in the "grand partnership" that the International Energy Agency (IEA) considers vital to combating climate change. It is well known that oil and gas companies are well aware that developing low-carbon technologies is a long-term investment in their prosperity that is in their best interest and is an investment in their long-term growth (IEA 'Oil & Gas Industry, 2020).

It is important for all parts of the industry to consider how to respond, but no single strategy exists that is suitable for everyone. Similarly, although attention is often focused on some of the largest integrated oil and gas companies, which play a significant role in industry practices and direction, the industry is actually much larger.

Under the auspices of the United Nations (UN), periodic reports by the IPCC have played a vital role in shaping the discussion of climate change worldwide. Several reports are issued by this self-governing network of scientists and researchers each raising the alarm about climate change.

Nevertheless, it added that the changes within the natural climate variability were also broadly consistent with what would be expected. By 2007, in its fourth report, the IPCC was much more categorical in its claim that human behavior contributed to climate change (Parry et al. "IPCC Climate Change report", 2007)

Since the 1950s, many of the changes observed in the climate system have been unprecedented, and recent climate change has had widespread impacts on human and natural systems. The 2007 IPCC report set the stage for what unfolded in later, which subsequently lent impetus to the concept of energy transitions and made climate change a central, global topic (Parry et al. "IPCC Climate Change report", 2007)

2.2 Significance of the Paris Climate Conference (COP 21) in the Energy Transition

The Paris Climate Conference, otherwise known as United Nations (UN) **'Conference of the Parties (COP) 21'**, took place in 2015, paving the way for a more concrete and rational pathway to reducing GHG in the world. The organizers of COP 21 were determined that it would be decisive after the chaotic COP 20 held in Copenhagen in 2009. It was in Beijing a year previously, in 2014, that the essential formula for avoiding another Copenhagen was outlined. Back then, the US and China were competing over one third of global greenhouse gas emissions. By restricting their own energy use and thus slowing their own development, China and other developing nations were asking why they should 'pay' for all the emissions that developed nations have pumped into the atmosphere for centuries (figure 42).

As part of their joint commitment in November 2014, Presidents Barack Obama and Xi Jinping announced that, though with different timelines, their two countries would adopt significant measures to reduce emissions. In 2025, the US promised a 25% reduction in CO2 emissions compared to 2005, primarily due to the use of natural gas to generate electricity, whereas China's carbon emissions would continue to rise but peak by 2030 (US National Archives "U.S.-China Joint Announcement on Climate Change", 2014)

A total of 195 countries and the European Union (EU) attended the Paris conference. They had adopted, however, not a treaty, but a compact intended to take action aimed at preventing temperatures from rising to 2° Celsius degrees above pre-industrial levels this century, but hopefully no more than 1.5° Celsius degrees. (European Commission "Historic Climate Deal in Paris: EU Leads Global Efforts," 2015)

It was agreed that each country would come up with its own 'Nationally Determined Contributions' (NDCs), based on its own conditions, laws, regulations, and choices. These NDCs would not be binding. In spite of the fact that these NDCs would not be compulsory, they would be powerful declarations of policy and compelling global consensus.

According to the landmark Paris agreement signed in 2015, nations commit to keeping global temperature rises to "well below" 2°C, and to "pursuing efforts" to limit temperature increases to 1.5°C. The treaty enshrines those goals. However, in order to achieve these goals, countries also agreed on non-binding NDCs that they would meet to reduce or, in the case of developing countries, to curb the growth of greenhouse gas emissions in the near term, usually by 2030.

To ensure that developing countries (including OPEC countries) meet their climate targets and accelerate the energy transition, developed countries also committed to providing $100 billion in aid each year to them. Due to this longstanding responsibility regarding climate finance, the majority of funding has been provided through loans, increasing the burden of debt for developing countries. In Glasgow, the United Kingdom hosted COP26, where developed countries confirmed they would reach this target by 2022 or 2023, with a climate finance rate of about $100 billion over the next five years. As part of the Paris Agreement, developed nations

are reaffirmed of their obligation to contribute, while other Parties are encouraged to make voluntary contributions as well. As well as mobilizing climate finance from a variety of sources, instruments, and channels, developed countries should acknowledge the significant role that public funds play through a variety of actions, such as supporting country-driven strategies, as well as taking into account developing countries' priorities and needs. An increase in climate finance should represent a progression beyond previous efforts (UNFCC ‘climate finance’, 2022).

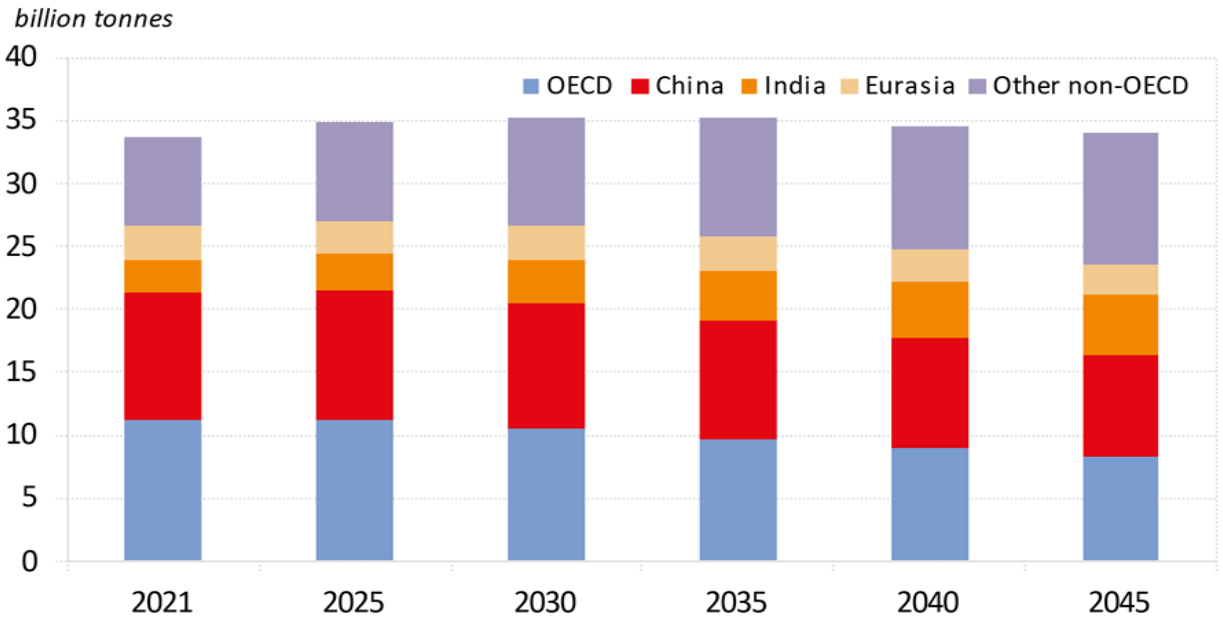


Figure 43: (Energy-related annual CO2 emissions by region, 2021-2045)

Source: OPEC WOO

By mid-century, fossil fuel combustion, agriculture and animal husbandry, and certain industrial processes that create methane must almost completely cease emitting greenhouse gases. Climate change negotiations are centered on NDCs, and achieving long-term emission reductions is also crucial.

2.3 Financing the Energy Transition (Climate Finance)

Generally speaking, climate finance refers to a variety of private, public, and alternative sources of financing aimed at addressing climate change mitigation and adaptation. Countries with greater financial resources are urged to provide financial assistance to those with fewer resources and greater vulnerability under the Kyoto Protocol, and Paris Agreement. Investing in mitigation requires large-scale investments to significantly reduce emissions, so climate finance is needed.

Increasingly, climate change is being influenced by financing and energy investment.

The importance of climate finance for adaptation cannot be overstated, as significant funds are required for climate adaptation and mitigation. The United Nations Framework Convention on Climate Change (UNFCCC) requires developed country parties to provide financial resources to assist developing country parties with implementing its objectives in accordance with the principle of "common but differentiated responsibility and respective capability" outlined in the Convention.

Understanding and assessing the financial needs of developing countries as well as how to mobilize these financial resources are important for all governments and stakeholders. A balance should also be struck between adaptations and mitigations in the provision of resources. Providing financial resources to developing countries to facilitate climate finance was one of the goals of the UNFCCC's financial mechanism. According to the Convention, financial mechanisms can be entrusted to existing international entities. The financial mechanism also serves the Kyoto protocol and Paris Agreement (UNFCCC ‘climate finance’, 2022).

Upon the entry into force of the Convention in 1994, the Global Environment Facility (GEF) has operated the financial mechanism. The Green Climate Fund (GCF) was established at Conference of the Parties (COP) 16 in 2010, and was also designated as an operating entity of the financial mechanism in 2011(UNFCCC ‘climate finance’, 2022).

It is the responsibility of the COP to determine the financial mechanism's policies, program priorities and eligibility criteria, which are governed by the financial mechanism. Additionally,

the Parties have established two special funds under the Kyoto Protocol, the Special Climate Change Fund (SCCF) and the Least Developed Countries Fund (LDCF), both managed by the GEF as well as the Adaptation Fund (AF) established in 2001 under the Kyoto Protocol, in addition to providing guidance to both the GEF and the GCF (UNFCCC 'climate finance', 2022).

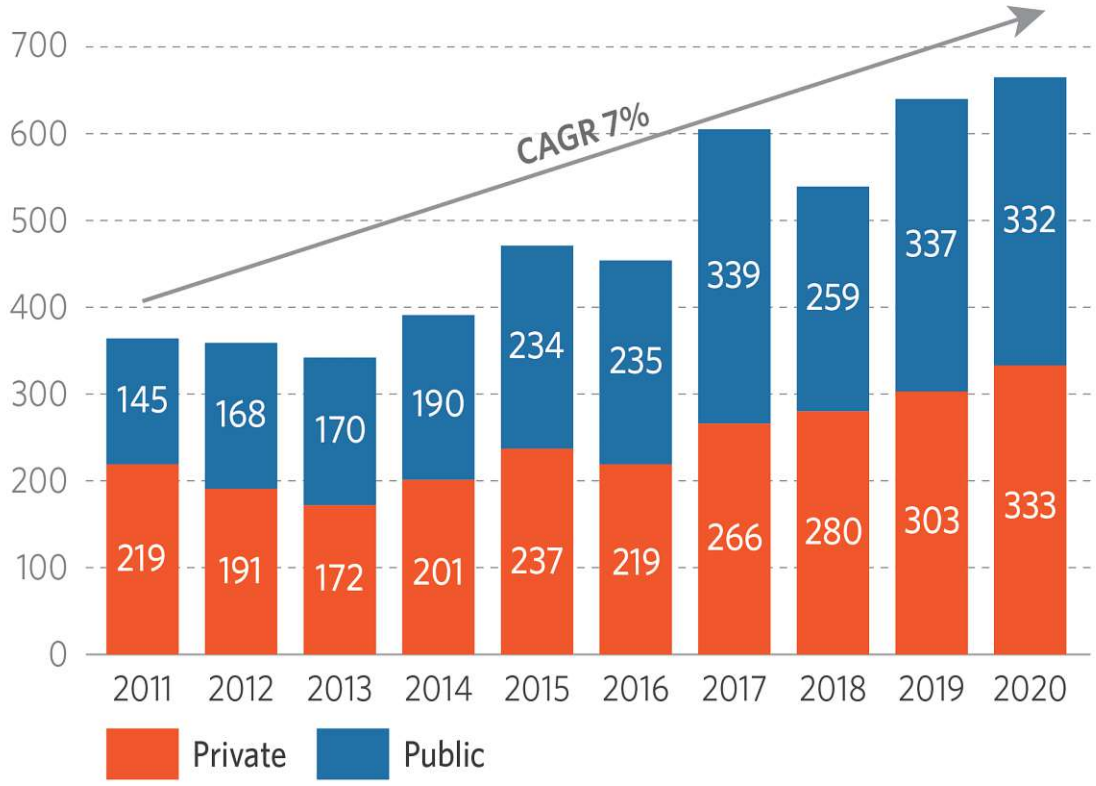


Figure 44: Climate Finance by public and private sources in 2011-2020 (USD bn)

Source: Naran et al, Climate Policy Initiative, 2022

Climate finance commitments are estimated to have doubled between 2011 and 2020, reaching USD 4.8 trillion, according to a climate policy initiative (CPI) analysis. Despite the cumulative average annual growth rate of 7% in climate finance, the current levels of investment are not on track to meet the 1.5C global warming scenario (Naran et al, 'landscape of climate finance', CPI, 2022).

3. Analysis of data on the innovative climate change policies and their implementation in OPEC countries

Understanding the drivers of the energy transition in OPEC countries is crucial for several reasons. Furthermore, analyzing the energy transition in OPEC countries can provide insights into the impact of the transition on local communities and economies. In this chapter intended and declared policies that are driving change across their energy systems were collected and outlined country by country as will be seen below.

OPEC Countries are making significant strides towards reducing greenhouse gas emissions (GHGs). The fact that all OPEC Member Countries are signatories to the Paris Agreement and actively participate in climate governance is an indication that this is a serious commitment.

As a result of their efforts, member countries are becoming leaders in the transformation of energy systems in an inclusive and responsible manner at the regional and global levels. A growing number of renewable energy sources, including solar, wind, nuclear, and clean hydrogen, are being invested in. As well, efforts to replace traditional biomass with modern energy sources and agricultural residues are being made.

Although OPEC Member Countries have a significant number of climate related policies, this thesis understands the indispensable role of fossil fuels in their economies. There are many technologies available, including carbon capture utilization and storage (CCUS) units, enhanced oil recovery (EOR) using CO2, direct air capture (DAC), emission reduction strategies that reduce the intensity of carbon in upstream, midstream, and downstream practices, and the mitigation of gas flaring. As a result, this study emphasizes the significance of such technologies in the development of sustainable transport and industrial infrastructure.

Hence, a circular carbon economy (CCE) is envisaged as the future energy landscape, ensuring clean, affordable and universal access to energy while reducing and adapting hydrocarbon emissions.

It is also important to note that OPEC Member Countries adopt a broad spectrum of climate policies. It is intended that this section of the study discusses the innovative energy policies been implemented within the sectors of power generation, industry, and transportation in OPEC countries

To this end, each OPEC Member Country climate policies will be analyzed in a dedicated section with focus on the below sectors:

- Power Generation
- Industry
- Transportation

3.1 Algeria

In spite of contributing minimally to global greenhouse gas emissions historically, Algeria is a developing country with innovative climate governance policies. Recently, Algeria submitted its Voluntary National Reviews (VNRs). As a result of the Paris Agreement, the country plans to reduce GHG emissions by 7-22% by 2030. With conditional measures, including financial, technological, and capacity development support externally, emissions can be reduced by 7% nationwide, but up to 22% with conditional measures (IEA 'NDC's Algeria', 2024).

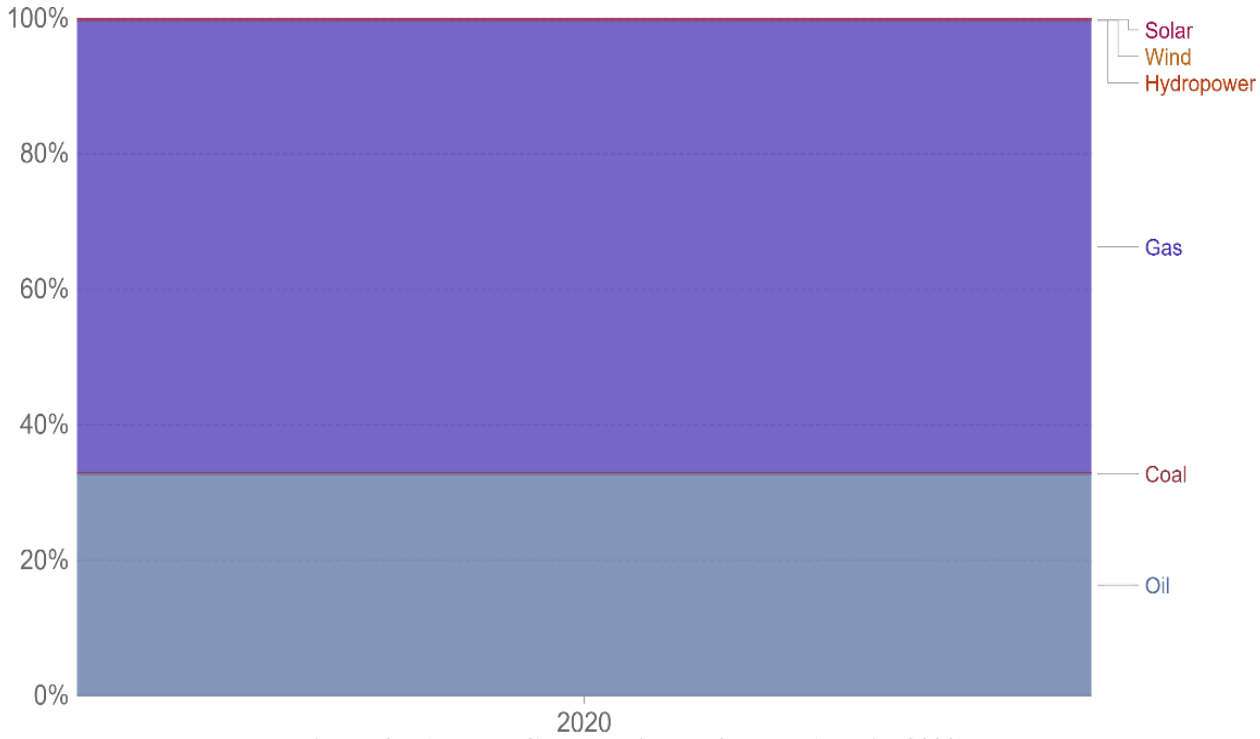


Figure 45: (Energy Consumption by Source, Algeria, 2020)

Source: https://www.climatewatchdata.org/countries/DZA?end_year=2020&start_year=1990

As illustrated in (Figure 44), In Algeria, fossil fuels are still a dominant part of the energy mix, with oil contributing 32.7% of the energy mix and gas, a comparatively cleaner fossil fuel, accounting for 66.9%. Nevertheless, coal has seen a significant decline, contributing only 0.23% to the energy mix, a significant decline from what it used to be. Solar energy, which currently makes up 0.28% of the mix, represents a promising development that is expected to pave the way for further projects involving renewable energy sources in the future.

3.1.1 Power Generation

It has just been announced that Algeria intends to integrate renewable energy into its energy mix by the year 2030. By 2030, the country intends to significantly increase the deployment of photovoltaic, wind, solar thermal, cogeneration, biomass, and geothermal energy, as well as cogeneration and biomass. As a result of this strategic plan, a target of 27% of electricity that is generated nationally will be achieved (IEA 'Efficiency Development Plan 2015-2030', 2015).

Furthermore, Algeria is planning to increase its usage of liquefied petroleum and natural gas as fuels from 2021 to 2030. To ensure these goals are met, the Algerian government established the High Energy Council in 2022 (IEA 'Energy Council', 2023).

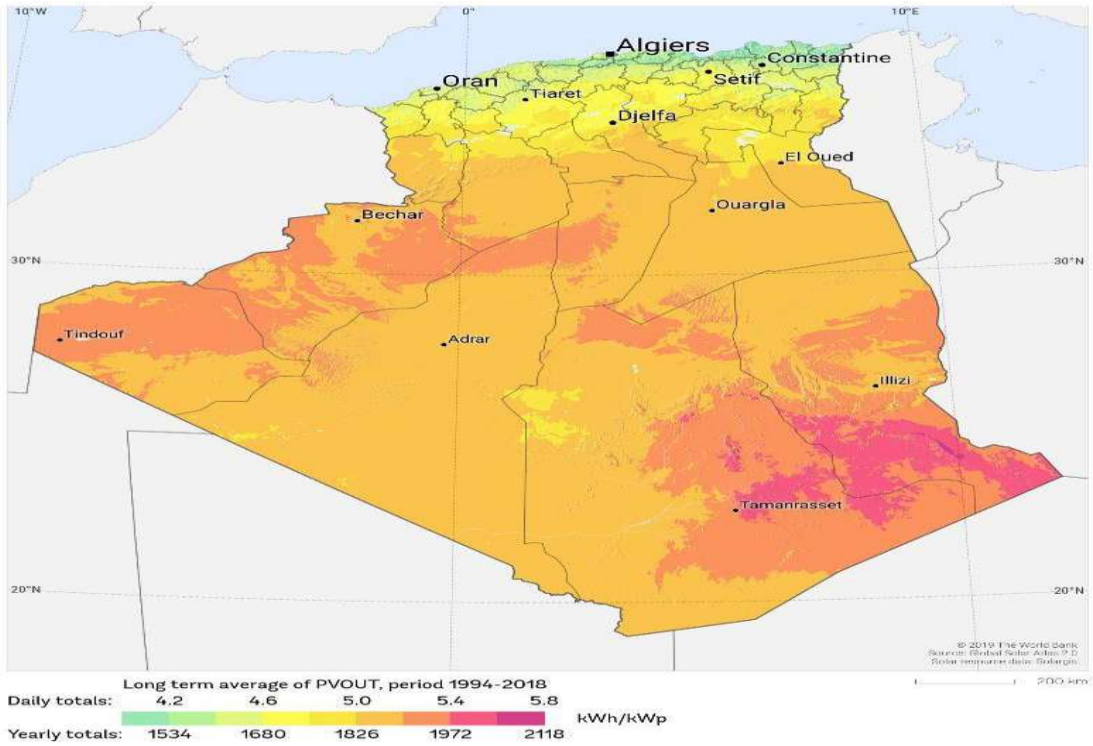


Figure 46: (Photovoltaic Electricity Potential, Algeria)

Source: World Bank Group and ESMAP 2023

As the largest country in Africa, Algeria has a strong solar potential that is estimated to exceed five billion gigawatt hours per year. This makes it one of the world's most abundant solar

regions. As seen in (Figure 45), Algeria intends to take advantage of its geography, particularly near its borders, and envisions a significant increase in solar power capacity, aiming to achieve 13,575 MW of solar power from the current 448 MW of off-grid solar power (IEA 'Development Plan 2015-2030', 2015).

One of the most notable projects is the Beni Ounif Project, which is due to be operational by 2024 and will be managed by Shaems and METRE. Additionally, Sonelgaz, the state power firm, recently closed a tender for a comprehensive 2GW solar PV facility comprising 15 solar farms, each with a capacity of 80 to 220 MW (Enerdata 'Algeria solar project', 2022) . Additionally, Algeria's National Solar Energy Corporation announced that it would open tenders for a further 3GW project in November and a further 1GW project in September (International Trade Administration 'Algeria-Renewable Energy', 2023).

3.1.2 Industry

As part of its efforts to reduce industrial greenhouse gas emissions, Algeria has made significant progress. Although Algeria's industrial emissions account for less than 5% of the country's total emissions, fugitive emissions from its industrial operations and oil production contribute significantly to the country's overall carbon footprint. Several policies and legislation have been implemented in Algeria to curb the practice of flaring in order to address this issue.

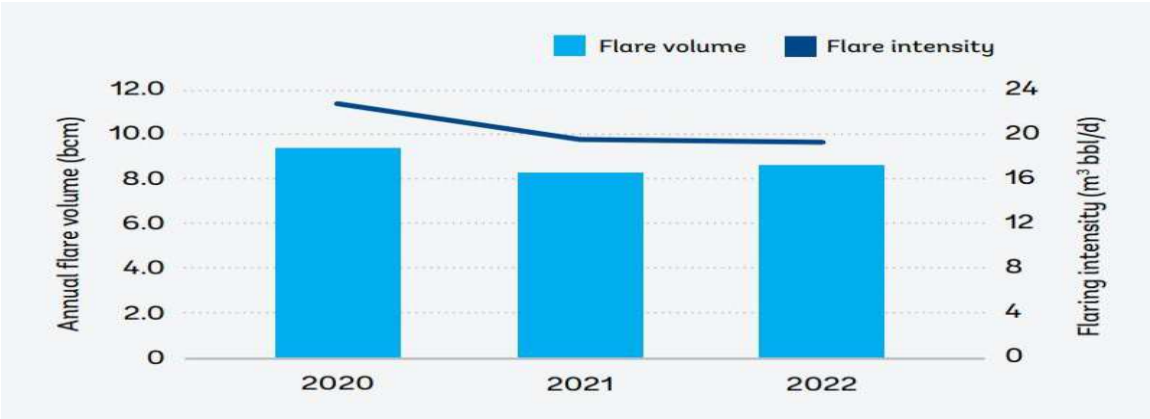


Figure 47: (Flare volume and intensity Algeria)

Source: NOAA, Payne Institute and Colorado School of Mines, EIA, GGFR

Among the many measures taken to reduce flare volumes and intensity is Law No. 19-13, which was enacted in 2019 and has already resulted in a decrease in flare volume and intensity since it has been implemented, prohibiting the routine flaring and venting of natural gas and imposing taxes on the number of flares and vents. As part of the law, Algeria's regulatory agencies, including the National Agency for the Development of Hydrocarbon Resources (ALNAFT) and the Hydrocarbons Regulatory Authority (ARH), are given responsibilities for monitoring flaring practices and for imposing fines for violations (IEA 'Law 19-13 Governing Hydrocarbons', 2022).

3.1.3 Transportation

Due to Algeria's reliance on road transport, which consumes approximately 93.9% of the country's energy, GHG emissions have been significantly influenced by the transportation sector. Petroleum products are primarily used to fuel this sector. Additionally, 62.1% of vehicles in the fleet are older than 10 years as of 2020, contributing to this issue. Private cars make up 63% of these vehicles, and contribute significantly to this problem (Saif & Ammar, 2021: 33-49).

By 2030, Algeria is expected to gradually generalize electric cars in the country due to its recognition of the need to mitigate the environmental consequences of road transport. In order to facilitate the adoption of electric vehicles, Algeria plans to acquire 5,000 electric vehicles as a starting point. To further encourage electric vehicle adoption, Sonatrach, the country's state-owned oil company, plans to build 1,000 electric vehicle charging stations by 2024.

The country has also invested in expanding its rail network since 2000, along with its shift towards electric vehicles. A series of investments have resulted in the total length of rail reaching 4,200 km in 2017, 6,500 km in 2021, and 12,500 km in 2030. Specifically, this extension aims to improve connectivity between the country's productive zones and export hubs, thus stimulating the economy. Although the pandemic has resulted in some delays, these projects are still expected to be completed by 2030, marking a significant step towards a more sustainable transportation system in Algeria (Oxford Business Group 'Algeria focuses on transport' 2018).

3.2 Congo

Congo ratified the Paris Agreement in 2017 after signing it on April 22, 2016. It submitted its INDC in 2015, followed by its first NDC in 2017, followed by an update in 2020. Congo has committed to reducing greenhouse gas emissions by 17.09% by 2025 and 21.46 % by 2030 in comparison to the Business as Usual scenario. Congo has pledged to reduce greenhouse gas emissions by 32.19% by 2025 and 39.88% by 2030 as opposed to a BAU scenario.

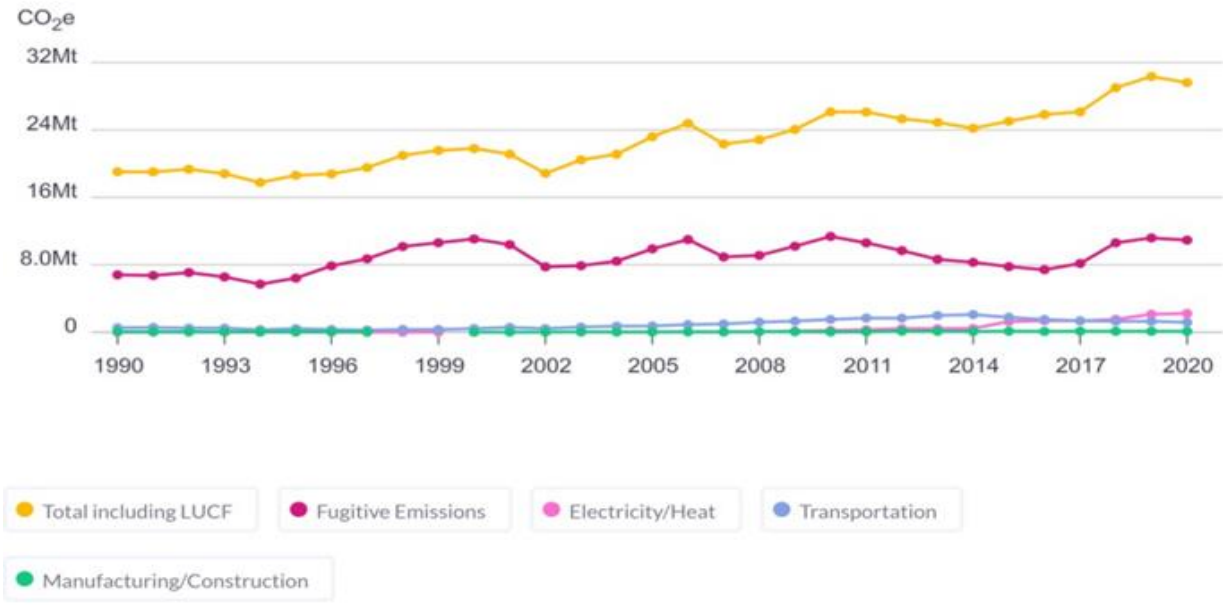


Figure 48: (Historical GHG emissions by sector, Congo, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023) Available online at: https://www.climatewatchdata.org/ghg-emissions

As of 2020, Congo's GHG emissions totaled 29.63 MTCO2e, making up just 0.06% of global emissions. Based on a sectoral analysis (Figure 48), fugitive emissions made up 10.9 MTCO2e, transportation 1.2 MTCO2e, electricity and heat 2.2 MTCO2e, and manufacturing and construction 0.1 MTCO2e. Total emissions are directly influenced by fugitive emission trends. Investing in clean fossil fuels within Congo will result in a significant reduction in the country's emission footprint.

3.2.1 Power Generation

With plans to introduce 600 MW of solar power to the grid by 2025 and 625 MW by 2030, Congo is exploring renewable energy by leveraging its abundant solar potential. Also, the country is focusing on off-grid solar power solutions with the aim of adding 125 MW by 2025 and 200 MW by 2030.

Congo also plans to increase wind power capacity to 3 megawatts by 2025 and 10 megawatts by 2030. While the numbers may seem small, they represent significant progress considering the country had no wind capacity as of 2022.

As part of its continued development, Congo will build on its current capacity of 214 MW in 2022 by adding 5 MW of off-grid small hydropower capacity by 2025 and doubling that to 10 MW by 2030.

A further energy policy element is the development of cleaner biomass feedstock to generate 12 MW of electricity by 2030. This policy also encompasses energy efficiency, with a 10% reduction in wasteful consumption.

3.2.2 Industry

As an alternative to the use of heavy fuel oils, Congo plans to integrate 100TJ of natural gas each year by 2025 and 2030.

It is still common for Congo to flare gas. The year 2022 saw approximately 1,819 million cubic meters of flare volume (World Bank, 'Gas Flaring,' 2022). However, Congo is trying to address this issue. In 2025, the NDC will target a reduction of two millions cubic meters of flare volume a day.

3.2.3 Transportation

In spite of Congo's relatively low transportation emissions, climate mitigation policies within this sector are relatively limited. It is the intent of the NDC to incorporate 8,000 electric vehicles into its national road network by 2030, but the national development plan also sets targets for that sector. Furthermore, there is a plan to introduce 2,000 18-meter electric buses by 2025, followed by 10,000 in 2030.

3.3 Equatorial Guinea

In 2016, Equatorial Guinea signed the Paris Agreement on April 22nd, 2016, two years later, and ratified it on 30th October 2018. In 2015, Equatorial Guinea submitted its INDC, which explained its initial plans to combat climate change globally. In 2018, Equatorial Guinea submitted its first NDC and revised it in 2022.

The country has also established a national climate change policy, which aims to reduce the country's emissions and ensure its adaptation and resilience to the impacts of climate change. The government is also working to implement a number of projects to reduce emissions and promote renewable energy (US Department of State 'Equatorial Guinea', 2023).

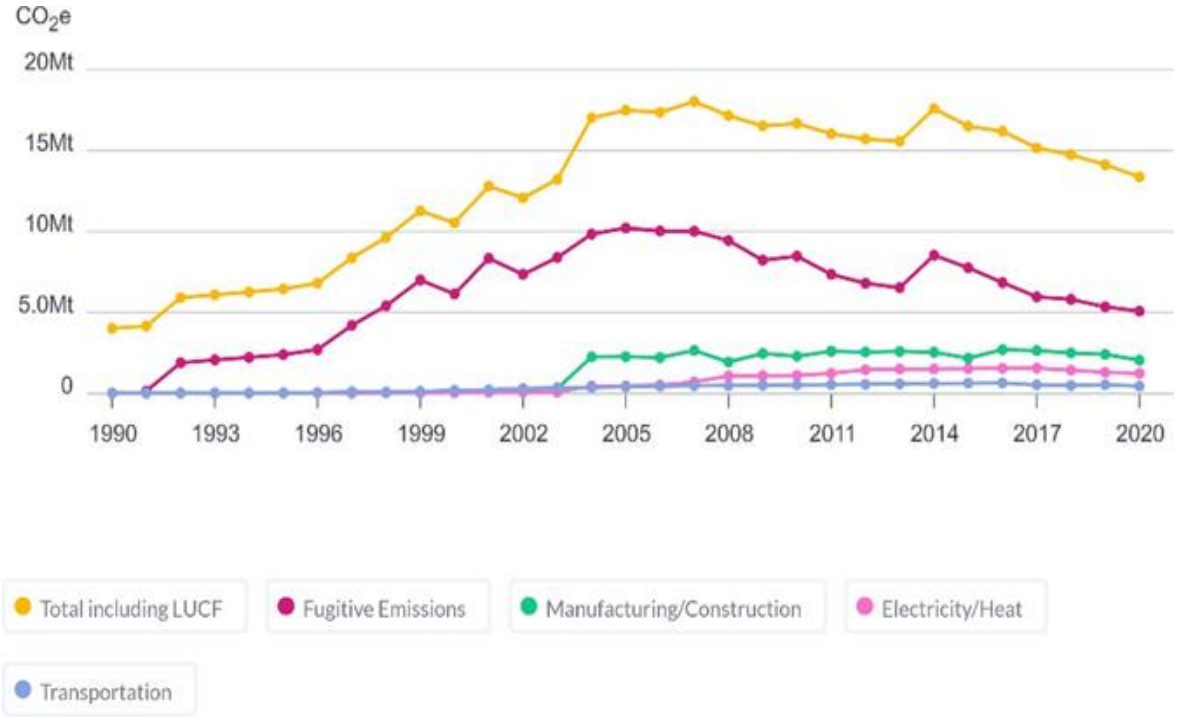


Figure 49: (Historical GHG emissions by sector, Equatorial Guinea, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions

As shown in (Figure 49), Equatorial Guinea's emissions total 13.38 MTCO2e, which account for only 0.03% of global emissions. Manufacturing and construction accounted for 2.1 MTCO2e of

emissions, electricity and heat for 1.2 MTCO2e, and transportation for 0.4 MTCO2e. Fugitive emissions totaled 5.1 MTCO2e, the largest contribution to emissions. In Equatorial Guinea, advanced technologies have led to drastic reductions in fugitive emissions since 2014, bringing total emissions back to 2003's 13.2 MTCO2e.

3.3.1 Power Generation

In order to begin the energy transformation process, Equatorial Guinea has adopted an Energy Law and developed a National Strategy for the Regulation of Renewable Energy. Several key laws will be implemented in the country by 2030, and two more by 2050, according to the country's clear timeline.

Also, the country plans to utilize the Wele River's hydropower potential. Equatorial Guinea plans to install a new hydroelectric power plant by 2030 on the Wele River with a renewable energy capacity of 205 MW, with plans to expand the capacity to 332 MW. This goal will cost an estimated a total of 365 million dollars (Enerdata 'Equatorial Guinea sets more ambitious...', 2022).

As part of its efforts to power the island of Bioko and the mainland regions of Bicomo, Equatorial Guinea is also refurbishing the aging hydroelectric plants in Musola and Riaba. A total of 4.3 MW of hydroelectric capacity will be installed by 2030, ensuring a reliable supply of power for the entire island of Bioko, at a cost of about $20 million (UNDP ' Sustainable Energy for All', 2016).

Additionally, Equatorial Guinea plans to use renewable energy to power its remote islands, including Annobon and Corsico. By 2030, the country hopes to have five megawatts of electrical generation on Annobon, estimated to cost approximately $10 million.

3.3.2 Industry

As part of its environmental commitment, Equatorial Guinea aims to incorporate cleaner heavy fuel oils into its industrial practices by 2030. The country also aims to use 100% renewable energy for its industrial sector by 2050.

As part of its efforts to limit flaring, Equatori Guinea enacted strict regulations in 2006 which limited flaring to necessities and enforced penalties on those who violated them (IEA 'Hydrocarbon Law 08/2006' 2020). Despite these measures, around 219 million m3 of gas will be flared in 2022.

Through the enforcing and strengthening of hydrocarbon laws and regulations, Equatorial Guinea intends to intensify its efforts in order to deal with this issue. Two new laws will be implemented by Equatorial Guinea to regulate hydrocarbons in order to minimize flared hydrocarbons' impact on the environment.

3.3.3 Transportation

A set of targets has been set for incorporating electric buses into Equatorial Guinea's transportation system. A total of 100 electric buses and eight charging stations are planned for Equatorial Guinea by 2030, with the number of charging stations expected to double by 2050. In addition, Equatorial Guinea has implemented strict import regulations to ensure that vehicles are of a certain quality and age. Vehicle imports are limited to those older than seven years after a presidential decree adopted international standards for vehicle emissions.

Additionally, Equatorial Guinea has demonstrated its commitment to transparency in transportation. It has promised to publish annual reports that will provide an in-depth look at the carbon footprint of the sector. These reports will also include an action plan to mitigate greenhouse gas emissions in the aviation, land and maritime sectors.

3.4 Gabon

In November 2016, the Gabon ratified the Paris Agreement, which had been signed on April 22, 2016. Gabon submitted its INDC in 2015, its first NDC in 2016, and its second NDC in 2022, as well as a VNR to the Harmonized Low Carbon Development Framework in 2022.

As part of its carbon-neutral commitment, Gabon has committed to remain carbon-neutral up to and beyond 2050. In addition, Gabon has committed to maintain its net absorption of carbon at a minimum of 100 MTCO2e per year beyond 2050 as part of this commitment (Enerdata ‘Gabon commits to carbon neutral’, 2022)

Gabon has signed several international agreements on climate change, including the Paris Agreement and the Kyoto Protocol. It has also established its own National Strategy on Climate Change to ensure that its commitment to carbon neutrality is achieved (CCAC, 'Gabon', 2020).

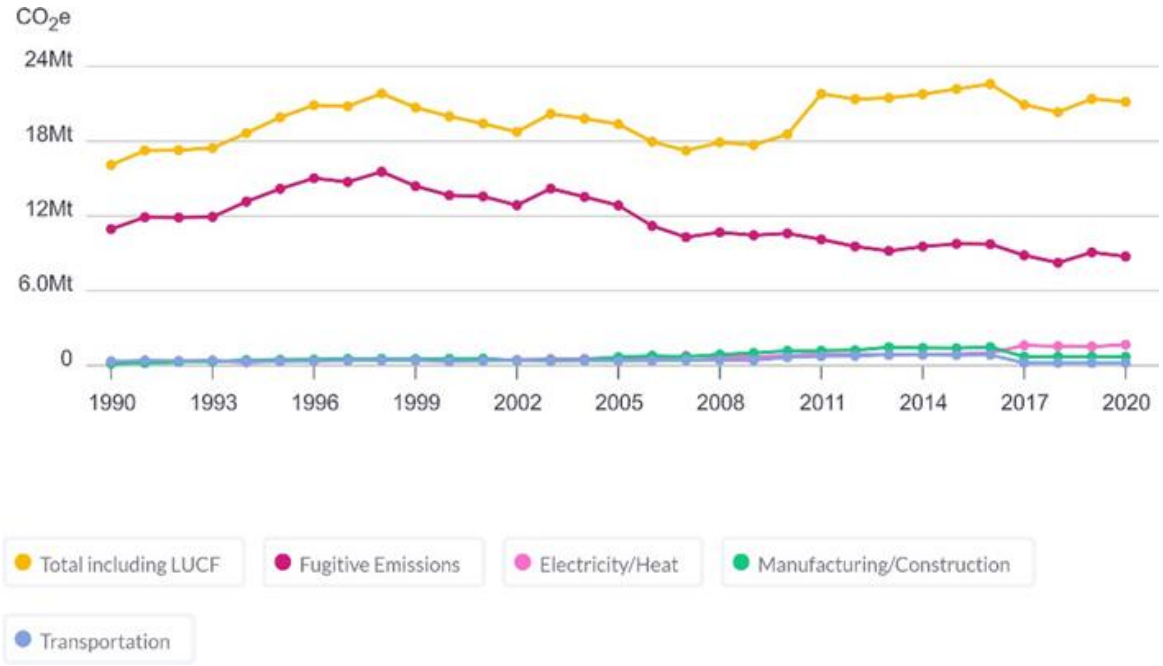


Figure 50: (Historical GHG emissions by sector, Gabon, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions

In 2020, Gabon accounted for 0.04% of global emissions with 21.16 MTCO2e. (Figure 50) breaks down these emissions by sector, showing that fugitive emissions contributed 8.75 MTCO2e, transportation 0.3 MTCO2e, electricity and heat 1.6 MTCO2e, and manufacturing and construction 0.69 MTCO2e. Even though fugitive emissions decreased and other sectors slightly increased, total emissions drastically increased in Gabon in 2011, suggesting that external factors are affecting energy related practices.

3.4.1 Power Generation

As part of Gabon's National Development Plan, 115 megawatts of solar power are expected to be installed by 2030, along with a hybrid mini-grid (solar/diesel). The country has set a goal of expanding its hydropower capacity to 260 megawatts by 2030 and to 630 megawatts by 2050.

In addition, the NDC points out that by 2025, hydropower will account for 80% of all electricity produced in the country, followed by gas and renewable energy. It is estimated that the financial requirements for these endeavors will be approximately $4.3 million by 2025. The necessary infrastructure must be in place in order for the NDC to be implemented successfully. This investment is necessary. Further, it is necessary to ensure that the hydropower sector is modernized and upgraded, as well as managed sustainably.

3.4.2 Industry

There has been a significant effort to improve the electricity grid in Gabon so that manufacturing processes can be more energy efficient and industrial intensity can be reduced. Furthermore, the country is gradually replacing oil-fired power plants with natural gas-powered plants. It is important to note, however, that despite the implementation of Law 002/2019, which regulates the hydrocarbon sector in Gabon and seeks to reduce gas flaring, approximately 1,402 m3 of gas were flared in 2022 (IEA 'Law No 002/2019 Regulating Hydrocarbons', 2022).

As a result, the government has decided to reaffirm its commitment to zero-flaring in its National Development Plan, which has prompted it to affirm its desires to remove flaring altogether.

It is estimated that 91.81% of Gabon's population will have electricity and 89.7% will have access to clean fuels and cooking technologies by 2021, indicating a minimal level of energy poverty. A major contributing factor to this shift has been the increasing capacity for renewable energy sources (Ritchie et al, 'Gabon: Energy Country Profile', 2022).

3.5 Iran

Despite signing the Paris Agreement in April 2016 and yet to ratify it, Iran continues to be committed to reducing greenhouse gas emissions as well as adapting to climate change. The Iranian government has set forth a condition that sanctions need to be lifted before it is fully able to enact and ratify the Paris Agreement's obligations.

The Iranian government submitted its Intended Nationally Determined Contribution (INDC) in November 2015, which although it is not a binding document, does outline Iran's goal of reducing greenhouse gas emissions, so the document serves as an indication of Iranian environmental policy. As of now, Iran's mitigation target is aimed at reducing greenhouse gas emissions by 4% by 2030 compared to a 'business-as-usual' scenario.

As part of the conditional mitigation target, Iran has set out an ambitious goal of reducing GHG emissions by 12% when compared to a 'business-as-usual' scenario. Towards the achievement of this target, sanctions have to be lifted, international resources like financial support and technology transfer must be available, carbon credits have to be exchanged, access to bilateral and multilateral implementation mechanisms must be available, and capacity must be built.

Given the multiple challenges that the country faces, it is commendable that the country is committed to global efforts to mitigate greenhouse gas emissions. Its ambitions for reducing GHG emissions have been set, but international cooperation and support are required to reach these goals.

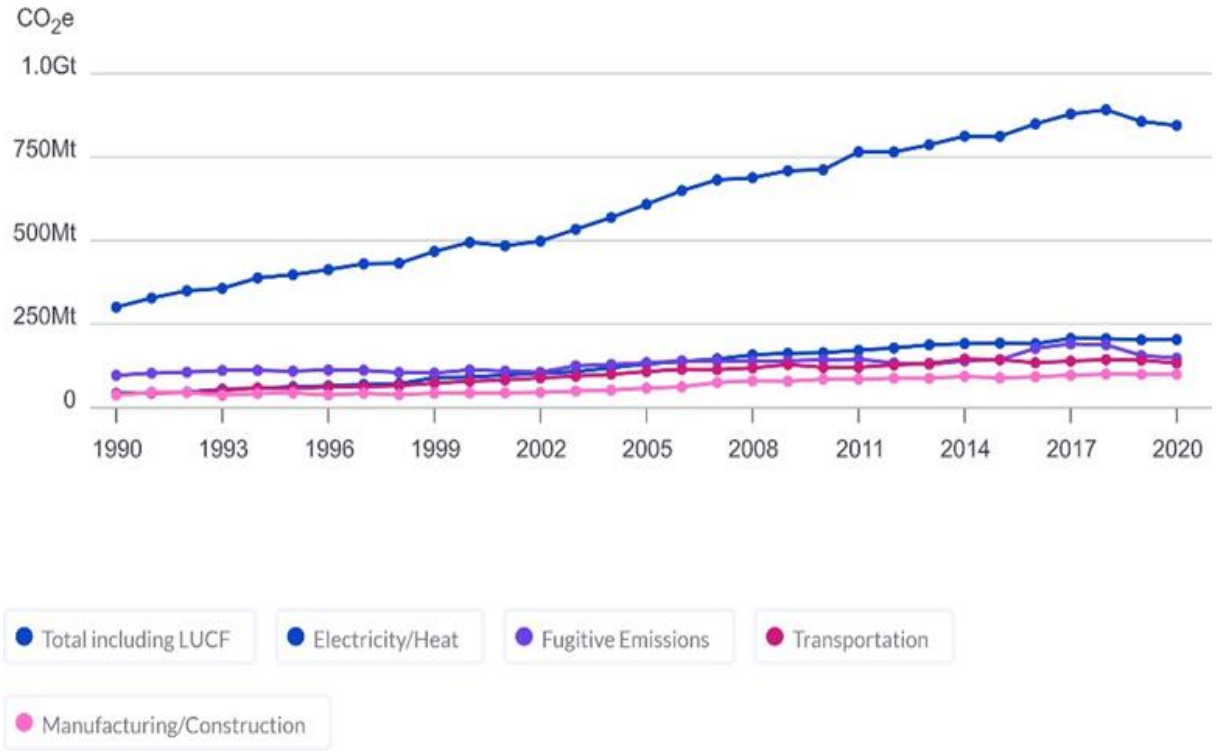


Figure 51: (Historical GHG emissions by sector, Iran, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions

According to (Figure 51), Iran's greenhouse gas emissions will total 844.7 MtCO2e in 2020, representing 1.8% of global greenhouse gas emissions. In order to address climate change effectively, Iran must adopt robust policies targeting the sectors that are responsible for the largest amount of emissions. Around 24% of Iran's total emissions came from the electricity and heat sector, which produced 203.31 MtCO2e.

In addition, the transportation sector contributed about 15.7% of total emissions, totaling 132.7 MtCO2e. In the industry subsection, fugitive emissions and manufacturing/construction accounts for around 29.2% of total emissions, while fugitive emissions account for 147.9 MtCO2e and 99.2 MtCO2e, respectively. To achieve Iran's GHG reduction targets, it will be crucial for the country to focus on power generation, transport, and industry.

3.5.1 Power Generation

As a part of its sixty-five-year development plan, Iran had previously set the target of integrating 5 GW of solar and wind energy into its electricity mix by 2021. However, only 0.7 GW had been installed by 2020. This was primarily due to the cancellation of key projects hindered by a lack of funding, which had significantly impeded the country's ability to progress in this area.

There is a considerable amount of hydropower in Iran, which is expected to reach 13 GW by 2020, which could serve its entire electricity demand. Due to climatic factors such as precipitation and drought, several hydropower development projects have been retracted. There was an alarming 11.9 GW gap between peak supply and demand due to hydropower fluctuations during the summer (Al-Maleki "MEES- Iran Blackouts", 2022).

Due to this, a policy has been implemented in the country aimed at increasing renewable energy capacity by 1 gigawatt each year. As an additional measure, the country announced on April 11, 2023 the development of 10 gigawatts of renewable energy through two initiatives. It is expected that these projects will be operational by 2025. By implementing these policies, Iran will compensate for its capacity losses, facilitate its transition to renewable energy sources, and strengthen its energy security (Al-Maleki "MEES- Iran Dreams" 2022).

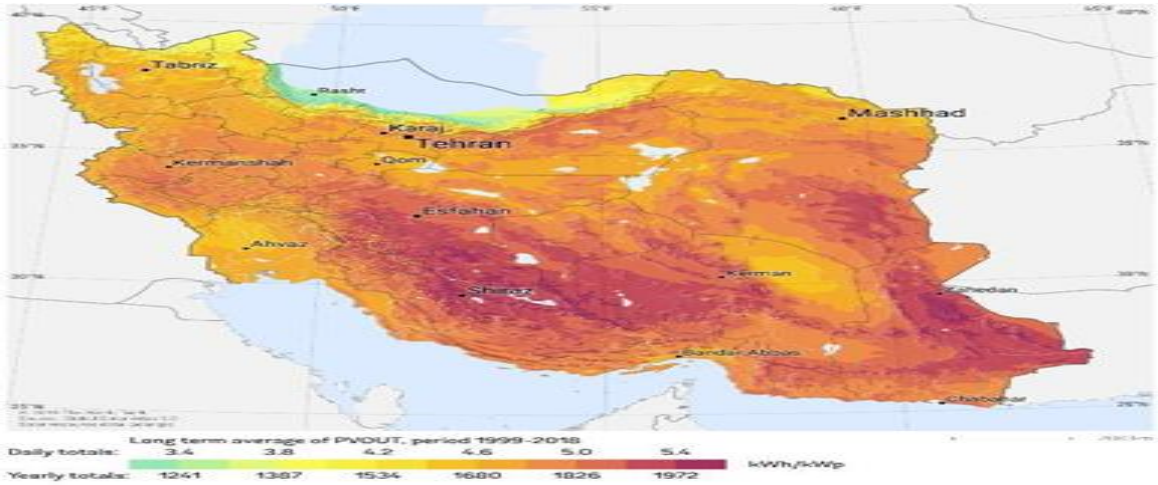


Figure 52: (Photovoltaic Electricity Potential, Iran)

Source: World Bank Group and ESMAP 2023

A vast amount of solar energy can be tapped by Iran as it lies within the global solar radiation belt (Figure 52). As of 2021, the country had managed to generate only 900 MW of electricity from solar energy sources, leaving much room for improvement. With solar power installations ranging from 4 to 10 megawatts, Kerman, Yazd, and Fars have the highest concentration of solar power plants. In recent years, Tehran, Hamedan, and Isfahan have also adopted solar energy, establishing plants with respective capacities of 37.57 MW, 31.4 MW, and 13.45 MW (Makkiabadi et al, 2021).

In June 2020, Iran's Renewable Energy & Energy Efficiency Organization (SATBA) announced a tender for the development of four GW of solar power plants in an effort to further develop its solar power potential. In order to increase solar energy production capacity significantly in the country, this tender aims to attract domestic and international investors. Since July 2023, however, only 1.8 GW have been issued, with 2.2 GW expected to be offered later this year. This development suggests that Iran is moving steadily towards solar energy (Howey 'Iran Refocuses' 2023).

Apart from the SATBA initiatives, the Iranian government has also adopted several policies to encourage the growth of solar energy. A number of incentives have been introduced to encourage solar panel installation, including feed-in tariffs, tax exemptions, and waivers of import duties for solar equipment and components (IEA 'Iran feed-in Tariff', 2018).

The Bushehr Nuclear Power Plant, approximately 12 km south of Bushehr, is Iran's only nuclear power plant. It has a capacity of 1GW and will be expanded with two additional reactors in the near future. Although Iran has been working on expanding nuclear energy capabilities since the 1970s, access to nuclear technologies has been limited. Although Iran continues to face challenges with its energy source diversification, it views nuclear energy as one of its future endeavors (NTI 'BNPP', 2023).

3.5.2 Industry

A comprehensive emission mitigation strategy for Iran's industrial processes was outlined in their third National Communication released in 2017. Even though the country hasn't yet explicitly expressed interest in using renewable energy sources in their industrial processes, they have shown a willingness to use natural gas as a feedstock and to use "20 percent of the electricity consumed by ministries, institutes, government sectors, and public non-governmental organizations" as renewable energy sources (IEA 'Supplying 20% Electricity', 2018).

As part of Iran's overall emission reduction strategy, gas flaring will be reduced by 90%, with the goal of eliminating it altogether by 2025. Approximately 10-19% of total emissions came from flaring in 2017. This indicates that reducing gas flaring could significantly reduce emissions overall (Gabbatiss 'Carbon Brief- Iran', 2020).

Because Iranian barrels emit high amounts of greenhouse gas emissions, reducing flaring will result in a reduction in their barrel footprint, especially for its upstream practices from the Marun field. To ensure these strategies are effective at reducing industrial emissions, careful planning, international support, and consistent monitoring will be necessary.

A major part of the country's ambitious emission reduction plans involves integrating Carbon Capture and Storage (CCS) units into industrialized regions. The Iranian government maintains, however, that the success of this policy depends on international assistance and finance.

3.5.3 Transportation

It is estimated that almost 90% of Iranians use road transportation for transportation, but this reliance on road transportation has a significant economic and environmental cost. Climate change indirectly impacts the transportation sector significantly. As a result, Iran must address transportation emissions as it provides economic and environmental benefits.

One of Iran's strategies for reducing emissions from its transportation sector, which was outlined in its Third Communication, was promoting public transportation. In order to promote citizens' use of sustainable modes of transportation, Iran plans to increase the capacity of its passenger rail systems from 17.4 billion passenger kilometers to 34.2 billion passenger kilometers by 2024. By 2024, Iran plans to increase freight rail capacity by 75.8 ton kilometers.

The country is also introducing 27,000 compressed natural gas (CNG) powered buses and 500,000 long-range CNG powered taxis for cleaner public transportation. In addition to retiring older, more polluting vehicles, Iran plans to replace 140,000 oil-fueled taxis and 17,000 oil-powered buses with cleaner vehicles. A total of 400,000 old gasoline-powered motorcycles in Iran will be replaced with electric bikes by 2025. In order to cut emissions from private vehicles, Iran is tightening its emission regulations. It plans to prohibit vehicles that do not meet Euro IV emission standards from being registered (Gabbatiss ‘Carbon Brief-Iran’, 2020).

3.6 Iraq

With its ratification of the Paris Agreement on November 1, 2021, Iraq has become more active in global climate governance. It also submitted revised NDCs in October 2021, along with a VNR in July 2021, outlining its climate objectives. By 2030, the country intends to reduce greenhouse gas emissions by 1-2% unconditionally, to demonstrate its commitment to climate change mitigation. A conditional goal of 15% reduction in emissions by 2030 has also been set by Iraq, which requires international assistance (UNDP 'Iraq NDCs', 2021).

In order to achieve Iraq's conditional emissions reduction target, international collaboration and assistance are required, emphasizing the importance of considering how development and climate action are connected in the local context of the country. This could include providing financial support for renewable energy and energy efficiency projects, as well as technical assistance to help the country increase its capacity for adaptation and resilience. Additionally, international collaboration can help Iraq to develop and strengthen its policies, programs and legal frameworks to support climate action.

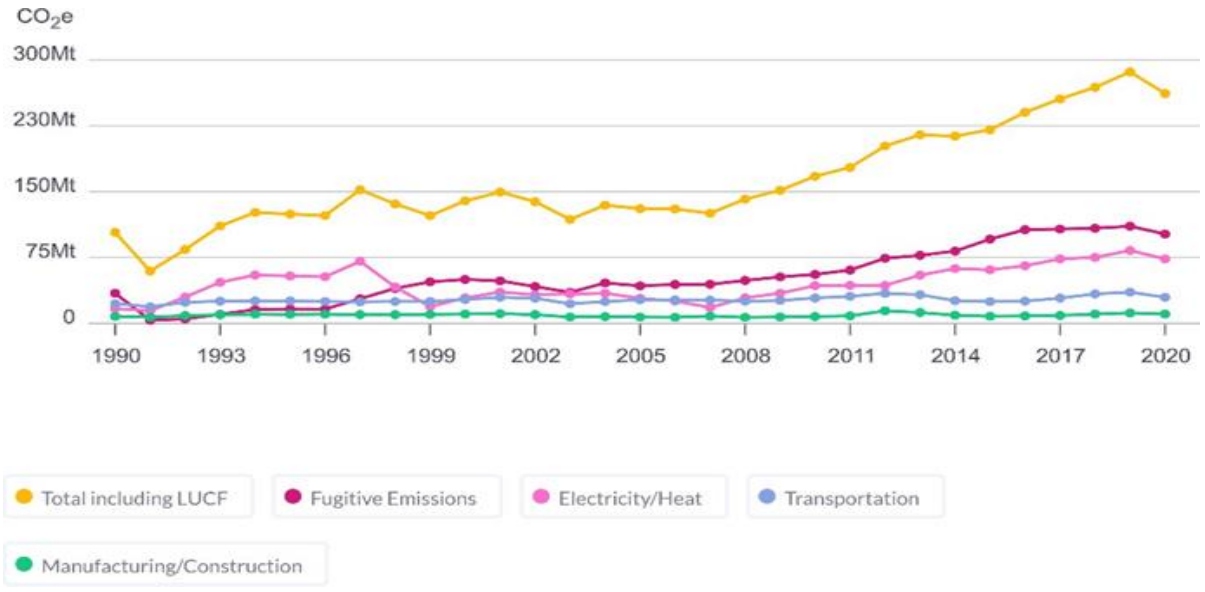


Figure 53: (Historical GHG emissions by sector, Iraq, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions

Iraq accounted for 0.65% of global greenhouse gas emissions in 2018 when it reached its peak of 286.5 MtCO2e. By 2020, Iraq has reduced its emissions to 261.8 MtCO2e. As a result of an analysis of the sectoral contributions to these emissions (figure 53), it is apparent that the electricity and heat sectors accounted for 73.3 MtCO2e, or approximately 28%. With 29.5 million tonnes of greenhouse gas emissions, the transportation sector contributed around 11%, while manufacturing and construction contributed 10.5 million tonnes, or 4%. As well as fugitive emissions, fugitive emissions from the oil and gas industry contributed 101.6 million tonnes of CO2.

3.6.1 Power Generation

The Iraqi government prioritizes efforts to reduce greenhouse gas emissions from its power sector in accordance with the commitments of developed countries to provide financial aid, technology transfers, and capacity building assistance. As part of Iraq's overall energy policy, a gradual shift towards a more environmentally sustainable model is being taken, as LPG and dry gas are expected to replace oil at heavy power plants in order to reduce. As part of their energy mix by 2030, the Iraqi Ministry of Oil has set a target of incorporating 33% of clean energy into their energy mix (Enerdata ‘Iraq Energy’, 2023). This shift has been welcomed by the international community, as it reduces the country's emissions and helps to combat climate change. Iraq is also investing in renewable energy sources such as solar and wind, to further diversify their energy mix.

A $10 billion collaboration with France's Total Energies, the Gas Growth Integrated Project (GGIP), has been announced to assist Iraq in achieving this goal (IEA ‘GGIP’, 2023). The project is part of a $27 billion deal with Total Energies (Nazeh et al ‘Iraq oil, gas & renewables deal’, Reuters 2023). As part of GGIP, flared gas in southern Iraq will be captured and used while Iraq's natural resources are optimized and an electricity supply is secured. With the help of flaring recapture technology, GGIP will provide gas to power generation plants and electricity to Basrah. In addition to improving Iraq's electricity supply and energy self-sufficiency, GGIP will reduce the climate impact of gas flaring in southern Iraq once it is completed.

Iraq can also export gas products to new markets as a result, diversifying its energy exports. GGIP is an essential step towards achieving a sustainable and climate-friendly energy mix in Iraq's power sector.

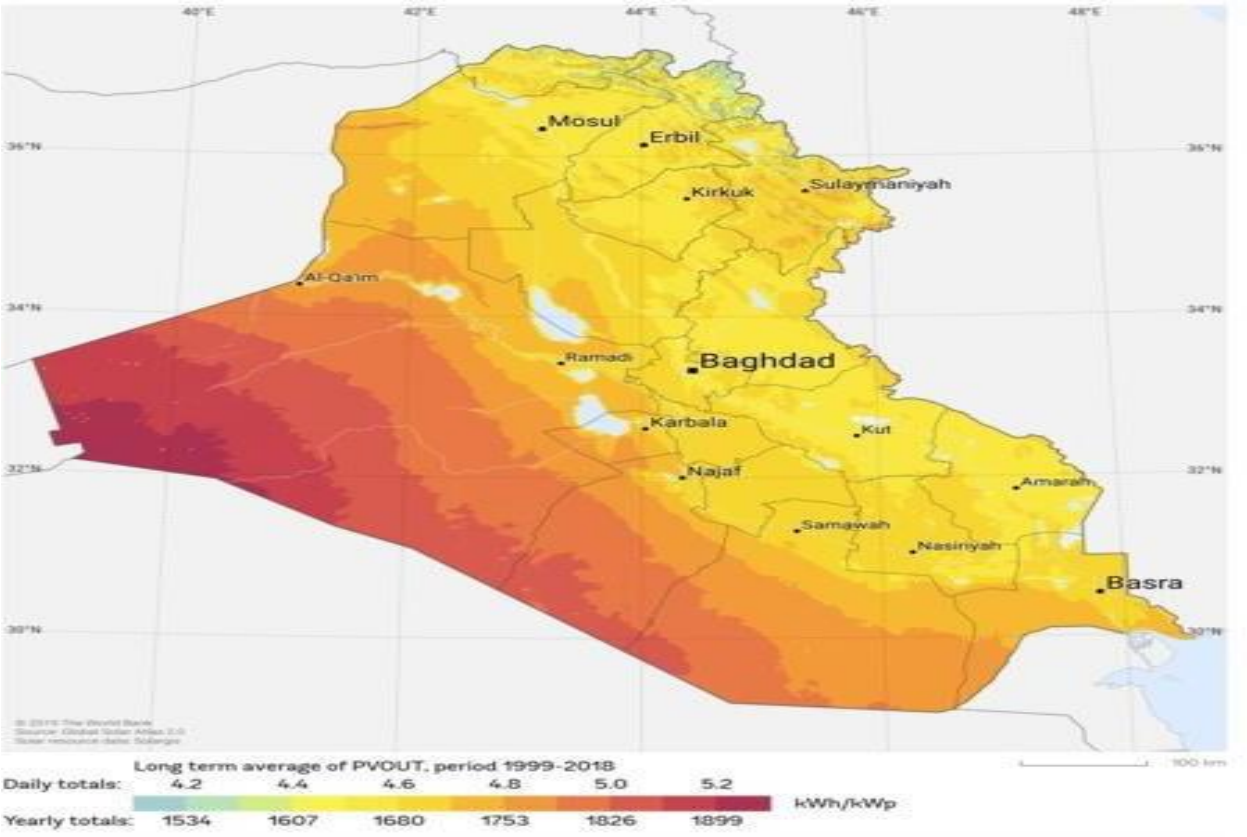


Figure 54: (Photovoltaic Electricity Potential, Iraq)

Source: World Bank Group and ESMAP 2023

Renewable energy technologies, particularly solar energy, are a major part of Iraq's renewable energy strategy. Its geographical location makes it an ideal place for solar power to be deployed, since western Iraq has a high PV potential and abundant radiation, as shown in (Figure 53). In 2021, Iraq announced seven solar projects as part of its renewable energy expansion plan, including the 225 MW Iskandariya PV plant, the 300 MW Karbala plant, the 30 MW Sawa-1 plant, and the 50 MW Sawa-2, Khidir, Al-Ramla, and Jissan plants (Al-Maleki 'Iraq solar projects', 2021). Contractual issues, however, have caused delays in these projects.

While Iraq faces a number of challenges, it remains committed to completing some of these solar projects by 2025. In accordance with its power generation strategy, renewable energy is a crucial part, and its cabinet recently approved two significant solar projects on June 2nd 2023 (Al-Maleki 'Iraq solar projects', 2023) to further demonstrate its determination.

3.6.2 Industry

In Iraq, fugitive emissions, particularly those originating from the oil and gas industries, significantly impact the country's greenhouse gas footprint. According to IEA, 9% of global methane emissions originated from the oil and gas industry in 2019. According to the IEA, a meaningful policy measure could prevent 32% of Iraq's greenhouse gas emissions, pursuant to the latest methane tracker report published on 21st February 2023 (IEA 'methane tracker', 2023). As part of a worldwide initiative, Iraq has signed the Global Methane Pledge, which aims to reduce methane emissions by at least 30% by 2030 (UNEP 'Iraq Methane Pollution', 2022).

The Iraqi government plans to set up CCS and CCUS units in areas where industrial activity is concentrated to capture heat and gas emissions from industrial furnaces. Also, Iraq is funding postgraduate research aimed at reducing greenhouse gas emissions from its industrial practices, emphasizing its commitment to cultivating local expertise and innovation in clean industrial practices.

The success of Iraq in reducing emissions from its industrial sector, however, will be largely dependent on international support, as the country has little experience with implementing low-emission technologies. It will be imperative that Iraq collaborates and builds capacity with international partners in order to achieve its ambitious targets for reducing greenhouse gas emissions.

3.6.3 Transportation

Among its NDC, Iraq has identified a lack of supportive laws, legislation, and projects to promote environmentally friendly and sustainable transportation. Iraq has noted that it lacks a strong understanding of how to develop transportation in an environmentally friendly way, which is a critical challenge as the country attempts to reduce GHG emissions from the transportation sector. In order to address this issue, the country plans to fund and support postgraduate students working on cleaner transportation research. Academic research is a strategic investment, since it will help develop a knowledge base that can be utilized to guide future transportation policies.

Through the development and implementation of mass public transportation systems, including high-speed electric trains, the Iraqi government hopes to reduce traffic congestion, improve living standards, and reduce greenhouse gas emissions. Iraq's cabinet has demonstrated its intention to encourage private investment in public transportation systems by releasing tenders for upcoming projects, acknowledging their role in achieving these goals.

Figure 55: (Proposed Development Road Project, Iraq)

Source: KHL Group

Iraq's transportation plans included the $17 billion Route for Development Project was announced in 2023 (Figure 55). The project will build 1,200 km of railways and highways, resulting in significant improvements in road and transport efficiency across the country. Furthermore, the project is expected to stimulate economic growth, highlighting sustainable transportation's multifaceted benefits. Furthermore, the project will create jobs and opportunities for economic development, as well as reduce traffic congestion and emissions, improving the environment.

In addition to a commitment to environmental protection, the country has a broader climate governance strategy. In order to be successful, these initiatives must be effectively implemented and backed up by robust regulations. In addition, the government should provide incentives for people to use environmentally friendly transportation, such as subsidies, tax breaks, or other financial or non-financial assistance. To support these initiatives, the government should ensure the necessary infrastructure and resources are available.

3.7 Kuwait

Towards achieving sustainable energy goals aligned with global efforts to mitigate climate change, Kuwait has progressed its strategy. Kuwait ratified the Paris Agreement on April 23rd, 2018, demonstrating its commitment to global climate governance. The country submitted its first NDC in that same year, followed by an updated version in October 2021 and another in May 2023. By 2035, Kuwait plans to reduce emissions by 7.4% when compared to the base case scenario through unconditional measures (EPA 'NDC State of Kuwait, 2021). In addition to these measures, Kuwait intends to transition to a circular carbon economy and follow its four pillars: reduce, reuse, recycle, and remove. Kuwait has set the goal of reaching net zero emissions by 2060 and net zero in oil and gas by 2050 in order to achieve net zero emissions.

It is clear from these commitments that Kuwait remains committed to sustainable energy practices and to combating climate change on a global scale. Kuwait also invests in renewable energy sources such as solar and wind power. The government is also investing in the research and development of new technologies that can help the country achieve its climate goals (US EIA 'Kuwait Analysis', 2023).

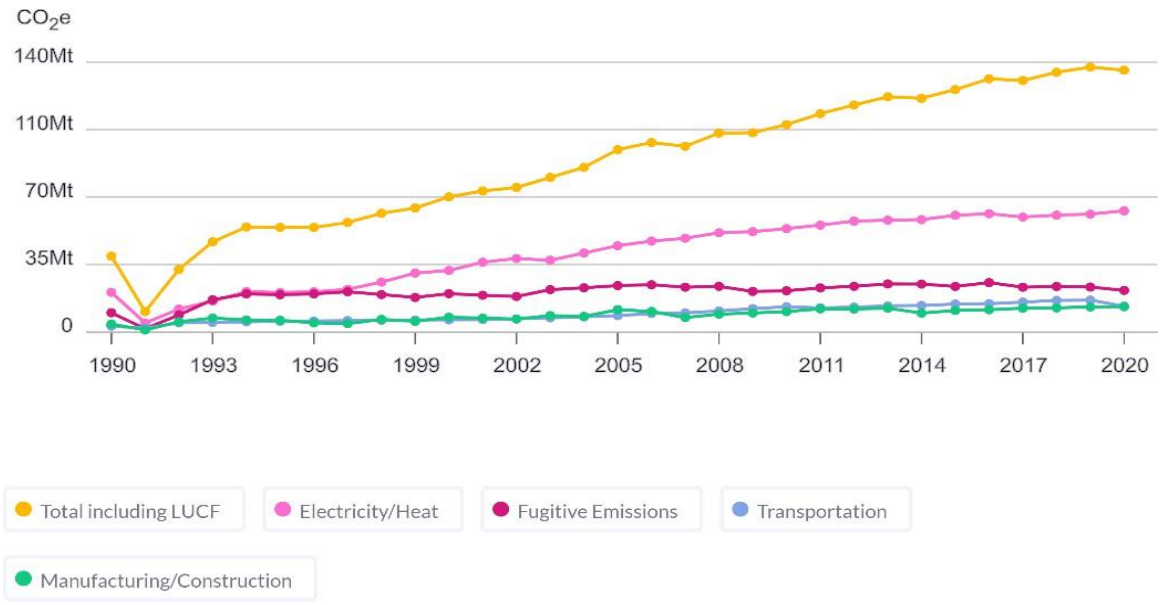


Figure 56: (Historical GHG emissions by sector, Kuwait, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). *Available online at: https://www.climatewatchdata.org/ghg-emissions*

Approximately 0.27 % of global emissions are estimated to have been generated by Kuwait in 2020 (Figure 56). Looking closely at the data, it becomes clear that specific sectors of Kuwait's economy contributed more to the country's emissions than others. Kuwait's electricity and heat sector produced 62.8 MtCO2e or 46.2% of Kuwait's total emissions in 2020, which is about the same number as its total emissions. At 21.5 MTCO2e, or about 15% of total emissions, fugitive emissions were the second largest contributors. A total of 15.5 Mt CO2e was released by the transportation sector, making up for 9.9% of Kuwait's total GHG emissions. It should be noted that the manufacturing and construction sector contributed the largest amount of CO2 emissions, with an amount of 13.1Mt CO2e, or around 9.6%.

3.7.1 Power Generation

As part of Kuwait's 2030 energy mix, renewable energy is expected to increase by 15% from 1% to 15% by 2030. Through a collaboration between the Ministry of Electricity, Water, and Renewable Energy and Kuwait Institute for Scientific Research, the Shaqaya Complex for Renewable Energy was founded in 2018, which made the first steps towards achieving this goal possible. In the same year, the complex's first phase was completed, adding 70 MW to the national grid. In the second and third phases of the project, scheduled for completion by 2025, 4,000 MW of renewable energy will be generated, expanding the country's use of renewable energy. It demonstrates Kuwait's commitment to a sustainable energy future through the development of CSP, PV, and wind energy (NCSD 'Kuwait VNR', 2023).

The project also fosters economic growth by creating jobs and new industries. Furthermore, it helps to reduce the country's carbon footprint, helping to mitigate the effects of climate change

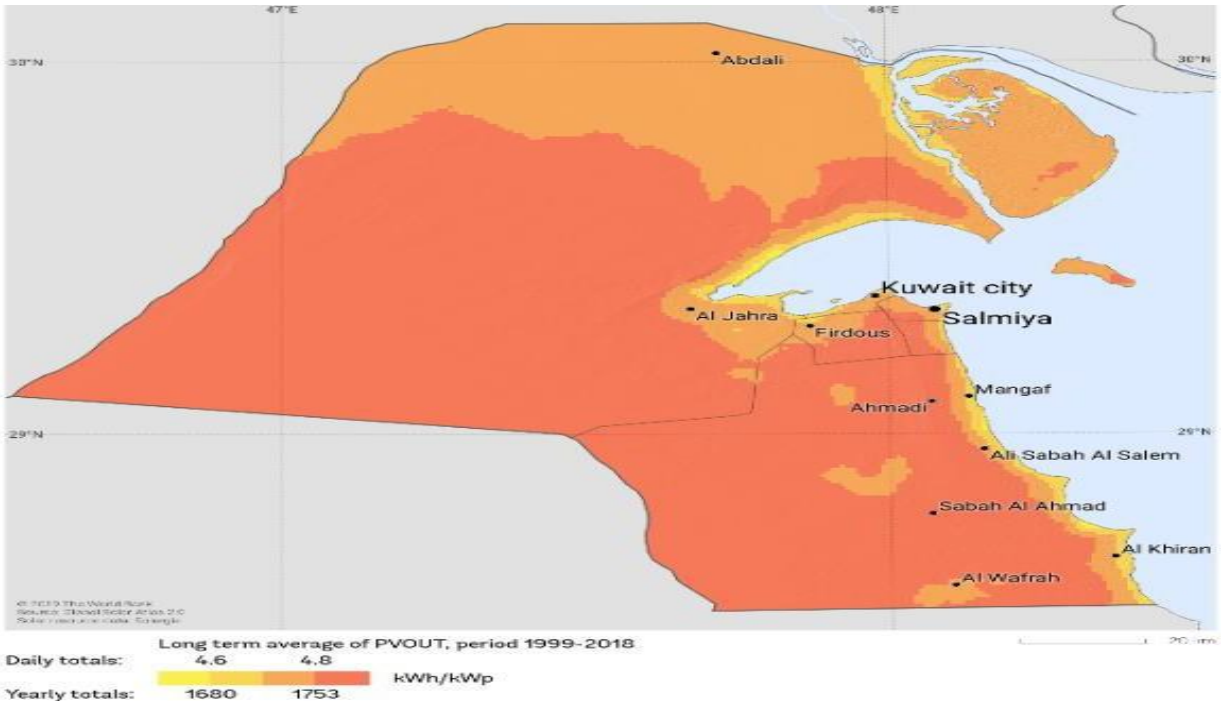


Figure 57: (Photovoltaic Electricity Potential, Kuwait)

Source: World Bank Group and ESMAP 2023

Due to its location and climate, Kuwait is well suited to harness solar energy. With its vast desert landscapes and abundant sunshine (Figure 57), Kuwait has already made significant strides in this direction with its Sidrah 500 Project. Kuwait has already made considerable progress in this area. Over the next two decades, this project is expected to save around 500,000 barrels of oil because it will generate 10 MW of power (KOC 'Sidrah Project', 2016), the country's first large-scale PV project. Kuwait's Sidrah 500 Project is a step forward in integrating renewable resources into its energy mix, marking a shift in its energy strategy.

As part of the second phase of the Shaqaya Complex for Renewable Energy, Kuwait is also implementing the Al-Dibdibah Solar Project, which represents Kuwait's ambition to expand its solar capacity. With a production capacity of 1.5 GW (KNPC 'Al-Dibdibah solar project', 2019), this project contributes significantly to Kuwait's renewable energy goals. As a result, Kuwait's commitment to solar energy will be further strengthened by the fact that this project will rely entirely on PV panels.

3.7.2 Industry

The Kuwaiti industrial sector is also undergoing significant changes to reduce emissions and transition to sustainable practices, a goal that will be achieved by 2024 (Kuwait vision '2035'). It will provide policymakers with essential information for formulating measures that can enhance air quality by providing them with essential data. By 2025, the Ministry of Electricity and Water plans to replace 600,000 traditional electricity meters with smart meters to enhance industrial and residential energy efficiency (NCSD '2nd Kuwait VNR', 2023).

A waste-to-energy plant, which is expected to be operational by 2024, is also being built in Kuwait to utilize its industrial waste. This plant will generate 650 GWh of electricity, contributing to Kuwait's energy matrix while effectively managing industrial waste. Kuwait is committed to sustainability in its industrial sector, and these efforts will pave the way for a more sustainable future. The plant will also be a source of job opportunities, as it will require highly skilled engineers, technicians, and operators. This initiative will also help to reduce the environmental impact of industrial waste, as it will be converted into renewable energy.

Kuwait's high reliance on petroleum products for exports, 84%, makes reducing emissions from the oil and gas industry crucial to achieving the country's 2035 environmental goals and net-zero target. The Kuwait Oil Company has already made significant progress in reducing gas flaring during crude oil extraction, resulting in an annual emission reduction of 220,000 TCO2 in 2019 and 351,000 TCO2 in 2020 (NCSD '2nd Kuwait VNR', 2023).

The Kuwait Institute for Scientific Research (KISR) is also exploring the potential of renewable technologies to decrease the carbon intensity of Kuwait's oil sector even further having already being one of the lowest in the world. One such exploration involves the deployment of PV systems to meet the operational energy requirements of its oil industry (Carnegie 'Assessing global oils', 2015).

3.7.3 Transportation

Almost ten percent of Kuwait's total greenhouse gas emissions are accounted for by the transportation sector in 2020. Kuwait faces a challenge to reduce their emissions from the transportation sector since public transportation usage has declined from 10 percent to 6 percent between 2010 and 2019. The amount of car ownership in Kuwait has also increased by 35% over the same time period (State of Kuwait 'KNDP 2020-2025', 2022).

Figure 58: (Public Reliance on Transportation, % over 10 years, Kuwait)

Source: The 4th Kuwait Master Plan, 2019

Kuwait has invested heavily in sustainable and eco-friendly transportation solutions in order to address this issue. Over the past decade, approximately 80% of the population has commuted by car (Figure 58). In this case, the $7 billion metro project will, even with some delays, reduce the number of cars on the road, ultimately lowering greenhouse gas emissions (New Kuwait 'KNDP 2020-2025', 2022) by a significant amount. Additionally, Kuwait is implementing initiatives to promote EVs on its roads.

The Kuwait Ports Authority recently announced plans to establish an EV city that will facilitate the access of electric vehicle manufacturers to the Middle Eastern market via its ports. By establishing EV hubs in the region, GHG emissions will be reduced.

In addition, Kuwaiti government policy measures include installing charging stations in new buildings and residential areas as a way to promote the adoption of electric vehicles.

3.8 Libya

In August 2016, Libya signed the Paris Agreement, and a VNR was sent to the High-Level Political Forum (HLPF) in 2020. Libya has a goal of reducing emissions intensity by 25% by 2030. According to this VNR, Libya's emissions in 2020 were 75.37 MTCO2e, which accounted for 0.25 percent of global emissions. In order to achieve this, the country has established a range of measures, including investments in renewable energy sources, energy efficiency improvements, and incentives for sustainable transportation (Elias & Victor, 'Energy Transitions', 2005).

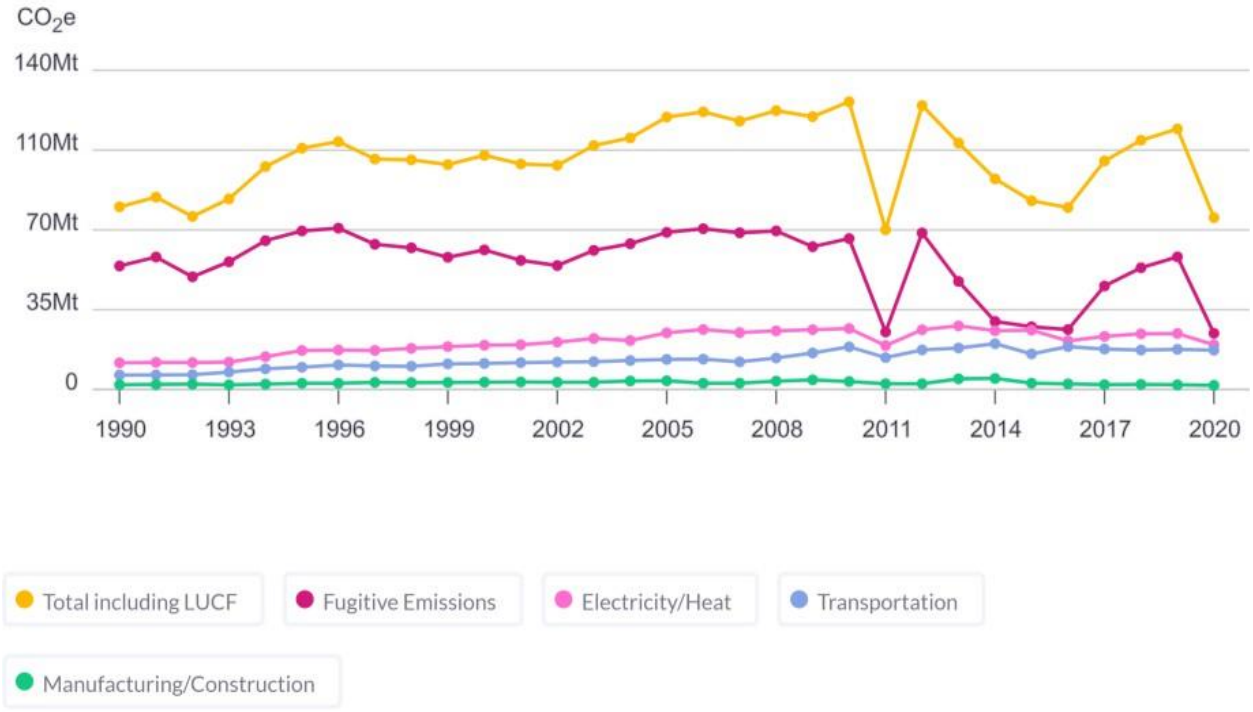


Figure 59: (Historical GHG emissions by sector, Libya, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions

The (figure 59) demonstrates that fugitive emissions account for a significant portion of Libya's total emissions, which highlights the importance of incorporating cleaner hydrocarbon technologies. A total of 17.23 MTCO2e was generated by transportation, while 19.6 MTCO2e was generated by electricity and heat production. Manufacturing and construction contributed 1.82 MTCO2e less.

3.8.1 Power Generation

It is expected that by 2030, the Libyan Ministry of Planning will be able to meet 22% of its electricity needs through a national renewable energy strategy. Between 2025 and 2027, 100 MW of solar power and 700 MW of wind power will be installed. In addition, a strategic expansion plan is outlined in the policy, with 400 MW of solar power and 850 MW of wind power expected to be installed by 2030 (Libya Energy, ‘ Harnessing the desert sun’, 2023).

The country intends to fund education in renewable energy development. Libya's strategic plan also identifies the need for a transition to natural gas as an alternative to other fossil fuels in order to eradicate pollution. The plan also emphasizes the need for investment in renewable energy sources, as well as increasing energy efficiency and diversifying energy sources. Additionally, the country plans to create a regulatory framework to incentivize renewable energy investment (Azubike & Gatiesh 'The intricate goal of energy security', 2024).

There is an energy shortage in Libya. According to the World Bank, only 70.2% of Libyans have electricity access (World Bank 'Access to electricity - Libya', 2021). Despite this, the custodian agencies that monitor global access to clean fuels and cooking technologies do not provide Libya with information regarding progress. Libya, however, subsidizes energy to ensure universal electricity access. Libya's gas infrastructure is predominately responsible for the increase in electricity access after 2018, following a steep decline between 2013 and 2018. This underscores the importance of fossil fuel investments for the eradication of energy poverty.

3.9 Nigeria

Considering the fact that Nigeria is the biggest economy in Africa and is expected to become the third largest population country by 2050, it plays a significant role in addressing global climate change. A strategic climate-related energy policy has been proposed by the country in an effort to balance environmental sustainability with increasing energy demand.

Nigeria submitted its VNR in June 2020 to the HLFP, which demonstrated the country's commitment to sustainable development goals as well as its Long Term Low Emission Development Strategy (LT-LEDS). Nigeria's long-term strategy for the period 2050–2070 was released in November 2021 and sets forth an ambitious goal of reaching net-zero emissions by 2060, which outlines the country's long-term goals.

As Nigeria takes a strategic approach to its energy goals, it must realize its full potential as it pursues sustainable energy development through the fulfillment of its obligations in terms of external involvement in financing, technological development, and technology transfer, as well as capacity building with the help of developed countries. These external involvements should be based on the principle of mutual benefit, and they should also include measures to ensure the equitable distribution of benefits.

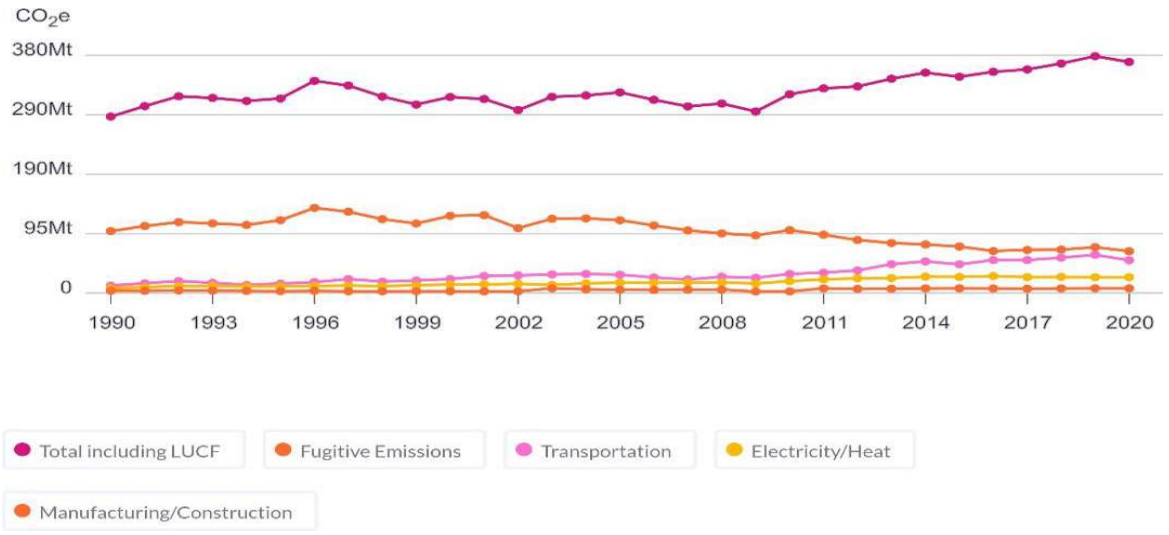


Figure 60: (Historical GHG emissions by sector, Nigeria, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions

As a result of Nigeria's GHG emissions, which totaled 369.4 MTCO2e in 2020, 0.71% of global emissions. In Nigeria, electricity and heat production account for about 25.5% of Nigeria's total greenhouse gas emissions, or about 6.9% of the total emissions. The total amount of transportation-related emissions was 52.6 MTCO2e, which represents 14.2% of total emissions. It is estimated that fugitive emissions originating from oil production and flaring contributed about 67 MTCO2e to the national greenhouse gas emissions, a figure that is approximately 18.1%. The manufacturing and construction industry, on the other hand, contributed 2.1% of total emissions, with 7.8 MTCO2e (figure 60). This is significant because the emissions from these three sectors are almost entirely responsible for the amount of carbon dioxide in the atmosphere. It is therefore essential to reduce these emissions in order to mitigate the effects of climate change.

3.9.1 Power Generation

The Nigerian government aims to generate 30% of its electricity from renewable sources by 2030. As Nigeria aims to reduce the use of diesel and gasoline generators by the end of this decade, integrating renewable energy is a crucial step in its energy transition strategy. In addition to improving energy efficiency standards, Nigeria seeks to mitigate unnecessary emissions. Among the primary targets is reducing grid transmission and distribution losses to 8% of final consumption by 2030, a significant reduction from the 15% reported in 2018 (Federal Republic of Nigeria 'Nigeria's 1st NDC', 2021).

In order to meet Nigeria's renewable energy goals, the NDC recognizes solar energy as the most promising resource. Located in the heart of the tropical region, Nigeria enjoys abundant sunshine and solar radiation, which makes it an ideal candidate for solar energy. Nigeria has an annual solar energy resource that is 27 times higher than its total fossil fuel resources, so the NDC recommends that 10 GW of solar capacity be installed by 2030. As part of the Energy Transition Plan (ETP), 197 GW of solar capacity is expected to be incorporated by 2060 (Federal Republic of Nigeria 'Energy Transition Plan', 2022).

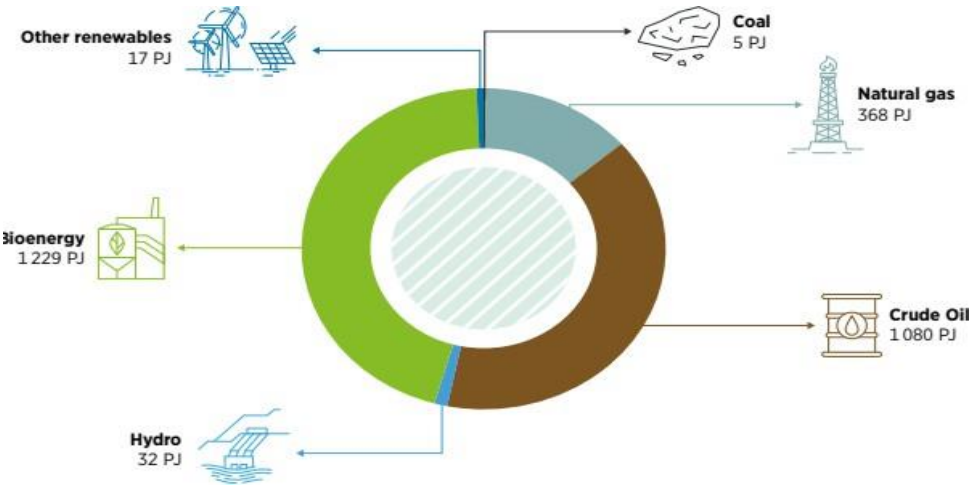


Figure 61: (Primary Energy Supply, Nigeria, 2015)

Source: IRENA

According to (IRENA 'Nigeria Energy RoadMap', 2023), Nigeria has only 37 MW of on-grid solar capacity in 2022 despite these targets and geographical advantages. Although announcements concerning new solar farms have been limited, Nigeria recently commissioned its biggest on-grid solar farm in Kano State on January 20, 2023, boasting a capacity of 10 MW.

Nigeria's energy landscape is dominated by bioenergy, with traditional biomass, primarily fuelwood and charcoal, supplying 1229 PJ of primary energy in 2015 (Figure 61). The use of traditional biomass energy sources may have health and environmental implications, so Nigeria's National Gas Expansion Program has been launched to switch from traditional biofuels to LPG (IEA 'Economic Sustainability Plan', 2022).

There is, however, a significant amount of clean biomass potential in Nigeria, especially agricultural residues, which may be used as fuel for power generation. The country's agricultural residue potential is estimated at 145.62 MT annually. By 2030, the country aims to integrate 1.1 GW of biomass into its energy mix, and by 2050, six GW (Federal Republic of Nigeria 'Energy Transition Plan', 2022).

3.9.2 Industry

A major characteristic of Nigeria's industrial sector is its underdevelopment and outdated technology. By 2050, this sector will transition to a low-emission, energy-efficient model that takes advantage of international financial support, technology transfer, capacity building, and global circular economy opportunities. Nigeria's industrial sector emissions could increase from 4.2 MTCO2e to 14.8 MTCO2e by 2030 without energy efficiency mandates. In order to significantly reduce industrial emissions by 2030, the national goal is to decrease energy intensity by 2.5% per year across all sectors (Federal Republic of Nigeria 'Nigeria's 1st NDC', 2021). However, this is a conditional target contingent on international support.

It is estimated that cement and fertilizer production technologies are inefficient, requiring more energy than necessary, contributing to high energy demand. Therefore, Nigeria plans to eliminate wet processes that use high amounts of energy in the cement industry by 2050 (IRENA 'Nigeria Energy RoadMap', 2023). In order to embrace alternative energy sources, Nigeria plans to use hydrogen in ammonia production. By 2030, the goal is to increase hydrogen consumption to 33% for use in ammonia blends, and after 2050, the goal is to increase hydrogen usage to 100% for use in high-temperature heating. (Federal Republic of Nigeria 'Energy Transition Plan', 2022).

3.9.3 Transportation

Between 2010 and 2035, Nigeria's transportation sector is expected to face a critical challenge as fuel consumption will rise by 680%. The increase in vehicle kilometers is driven by a fivefold increase in total vehicle kilometers, an increase in commercial vehicles and a rise in manufacturing. As a result of rising incomes, and growing service sectors, the sector is seeing an expansion in recent years, which makes heavy diesel-fueled vehicles more appealing, further enhancing the appeal of this sector (IRENA 'Nigeria Energy RoadMap', 2023).

It is important to note, however, that Nigeria has a comprehensive plan to create a transport system that is efficient, affordable, integrated, and intermodal, which is outlined in its National Development Plan. Nigeria intends to reduce GHG emissions by about 4MtCO2e annually by 2030. However, if no policies are imposed, the projected rise in emissions is expected to exceed 25 times this value. According to Nigeria's long-term transportation plan, which is outlined in the LT-LEDCS, by 2050 it would like to have a national transportation system that provides affordable transportation options to all citizens. It is imperative that no more than 50% of all journeys are made by vehicles, at least 40% are made by public transportation, such as trains or Bus Rapid Transit (BRT), and at least 10% of all journeys are made by active means, such as cycling or walking (Mali et al, 'Challenges in the Penetration of Electric Vehicles in Developing Countries', 2022).

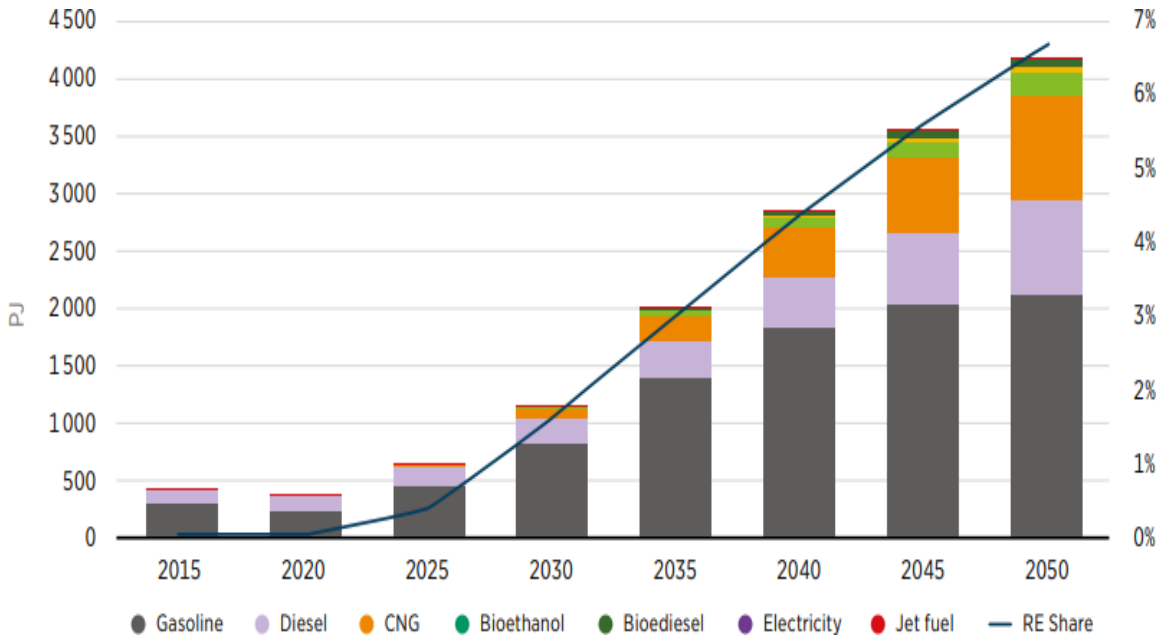


Figure 62: (Final energy consumption for the transport sector under current and planned policies, Nigeria)

Source: IRENA

Currently, gasoline and diesel vehicles dominate Nigeria's transport sector, contributing to 98% of its total energy consumption. Due to increased income levels and the subsequent rise in the purchase of private vehicles, energy demand in the sector is projected to grow significantly from 418 PJ in 2015 to 4172 PJ as seen in (figure 62). To counter these challenges, Nigeria is making strides to limit the use of diesel and gasoline and promote cleaner energy solutions. The Nigerian Gas Expansion Program is a key initiative that seeks to enhance the distribution of CNG. The adoption of this fuel source could potentially reduce the use of diesel and gasoline to 90% of the transport sector in 2030 and 70% by 2050, with the integration of CNG, first-generation biofuels, and EVs (IRENA 'Nigeria Energy RoadMap', 2023).

3.10 Saudi Arabia

As part of its commitment to sustainable governance, Saudi Arabia ratified the Paris Agreement on November 3, 2016. In November 2015, it published an INDC that has since been updated in October 2021. With 2019 as a baseline year, they propose reducing and avoiding GHG emissions by 278 MtCO2e annually by 2030. Saudi Arabia has set this goal without any conditional measures. The Saudi Green Initiative illustrates Saudi Arabia's commitment to sustainability. The initiative aims to achieve net-zero carbon emissions by 2060.

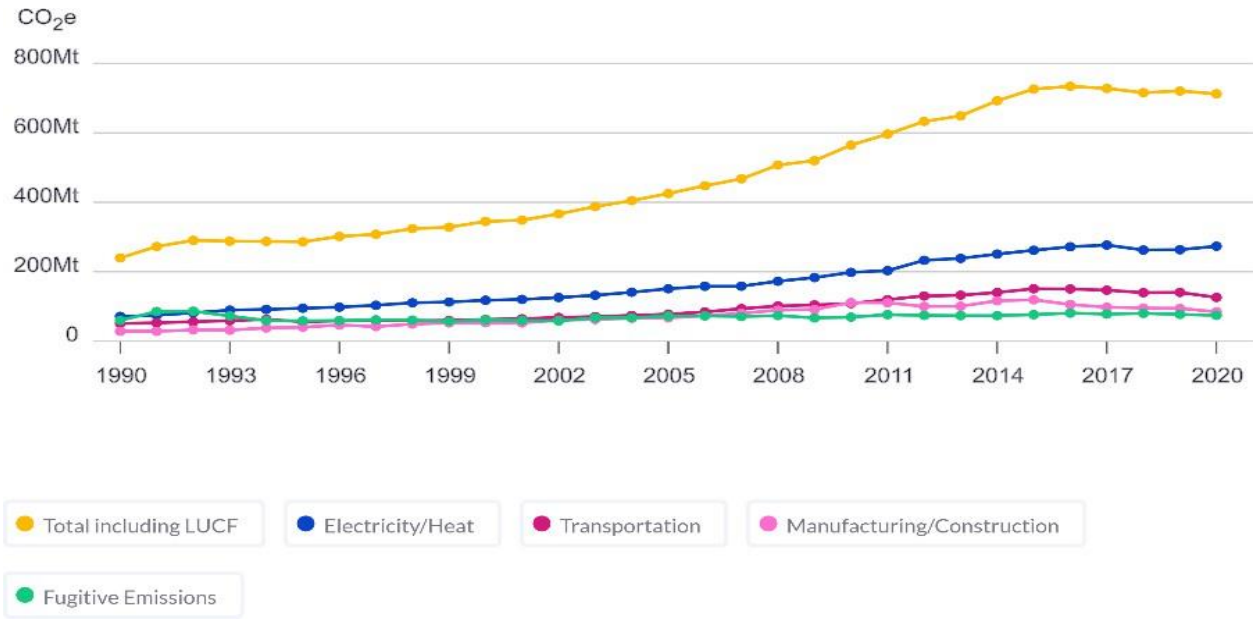


Figure 63: (Historical GHG emissions by sector, Saudi Arabia, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions

Saudi Arabia has been an integral part of OPEC's initiative in promoting responsible consumer-producer dialogue surrounding climate policy and has been instrumental in the global energy landscape. The Kingdom is committed to making concreted efforts to reduce its emissions footprint and diversify its energy mix.

(Figure 63) identifies that in Saudi Arabia, the electricity and heat sector are the most significant contributor, accounting for a total of 273.38 MtCO2e. This is followed closely by the transport and industry sectors, which contribute 125.81 MtCO2e and 84.21 MtCO2e, respectively. These three sectors collectively accounted for 84.5% of the total emissions in 2020, making them the country's primary sources of GHG. Saudi Arabia is making strides towards reducing its GHG emissions by diversification strategies and engaging with climate governance, however, a review of its energy mix in 2021 reveals a reliance on fossil fuel for energy consumption.

3.10.1 Saudi Circular Carbon Economy Initiative Framework

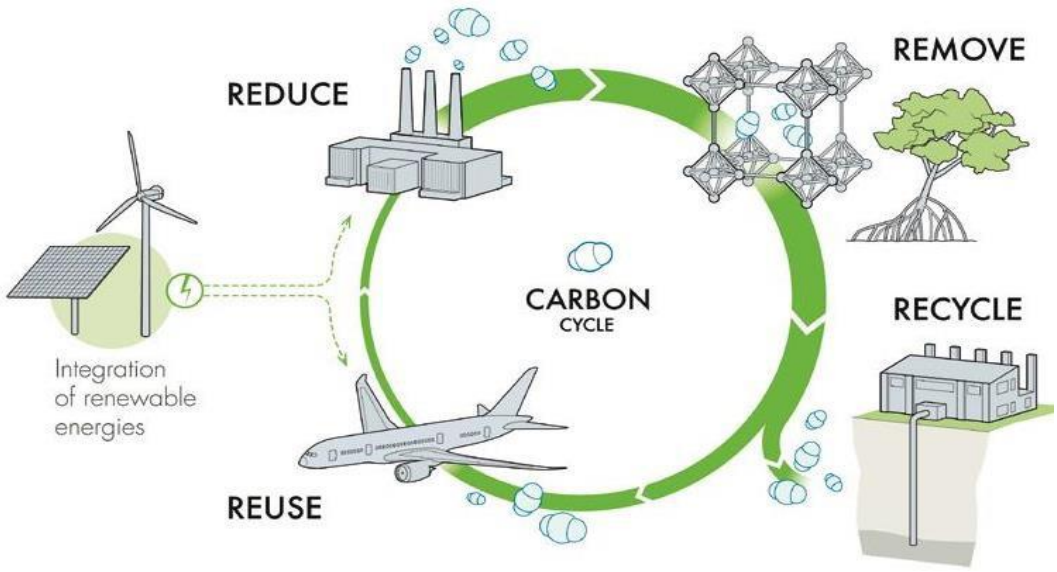


Figure 64: (Saudi Arabia Circular Carbon Economy Program)

Source: King Abdullah University of Science and Technology

Among the cornerstones of the Saudi Green Initiative is the Circular Carbon Economy (CCE) Programme. The 4 Rs, as shown in (Figure 64), will be used to transition Saudi Arabia into a carbon neutral state by implementing the principles of Reduce, Remove, Recycle and Reuse.

Investing in the CCE programme is a result of Aramco's two primary climate targets, which are found in their latest sustainability report for 2022. In order to achieve net zero carbon emissions

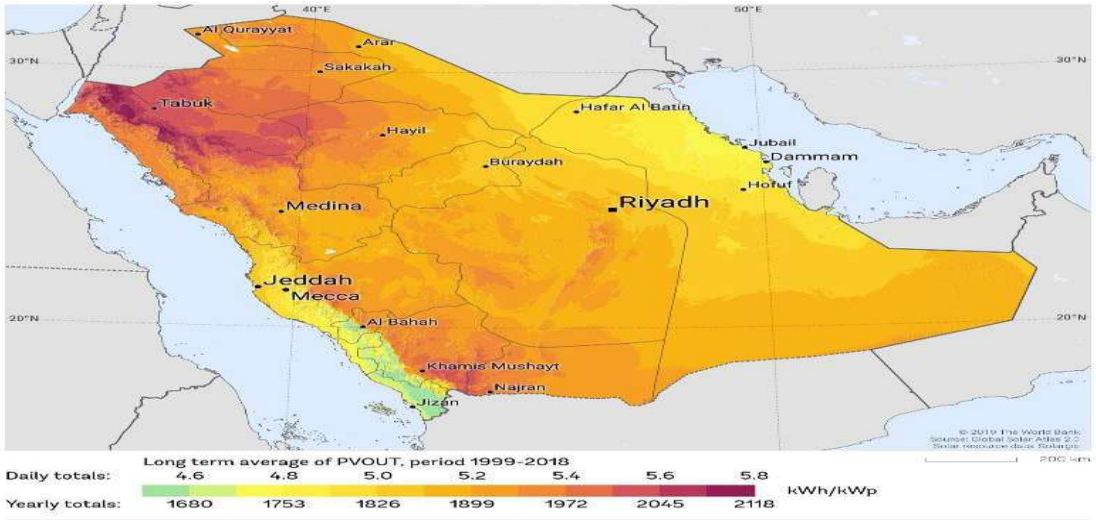
for Scope 1 and Scope 2 by 2050, CO2 emissions must be reduced by 52 MMtCO2e annually by 2035 (Aramco 'Innovating for Sustainability', 2022).

Saudi Arabia aims to achieve these goals and transform from a traditional linear carbon economy to a circular one through two modes of solutions of carbon management. The first is through afforestation where Saudi Arabia funded 33 afforestation programs such as pledging to plant 100 million native trees by 2030 to mitigate 45 MtCO2 emissions (Saudi Green Initiatives 'Saudi & Middle East', 2023).

3.10.2 Power Generation

Through the National Renewable Energy Program (NERP), Saudi Arabia aims to develop clean hydrogen, solar, and wind projects in the region. As part of its diversification strategy, Saudi Arabia plans to integrate 50 percent of renewable energy into its portfolio by 2030, displacing over a million barrels of oil per day. The framework includes policies and regulations to encourage and invest in the private sector to support research and development and renewable energy employment.

Figure 65: (Photovoltaic Electricity Potential, Saudi Arabia)



Source: World Bank Group and ESMAP 2023

As a result of Saudi Arabia's geographical location and abundant solar radiation, solar energy has the potential to be developed as a key energy source. The Sakaka Solar Power Project, which is fully operational, provides power to more than 45,000 households. The project has a production capacity of 300 MW (Saudi Arabia 'Saudi National Review', 2023).

A total of 840 MW of solar PV capacity is planned to be integrated into Saudi Arabia's grid through 10 new renewable energy projects including Shuaibah and Jeddah (Ministry of Energy Saudi Arabia 'Renewable Projects', 2021).

Additionally, the Dumat Al Jadal project was completed and is in operation. It is the Kingdom's first of many wind farms and the largest in the Middle East with a capacity of 400 MW. Figures presented by Masdar, a member of the consortium of companies commissioned to develop renewable energy in Saudi Arabia, indicate that the wind farm is capable of displacing 1 MtCO2e annually (Masdar ' Dumat wind farm', 2021).

3.10.3 Industry

Since the effectiveness of the SGI program and its circular carbon economy program is heavily reliant on CCUS investment and capacity increases, Yanbu and Jubail City were established as CCS hubs in the Kingdom. It is planned that the CCS in Jubail, which is a joint project between Saudi Aramco, SLB, and Linde, will capture a total of 9 million tons of greenhouse gases by 2027 by capturing emissions from three of Aramco's gas plants and other downstream industrial facilities (ARAMCO 'Carbon Capture & Storage, 2024). With a capacity of 44 MtCO2 by 2035, the hubs were strategically placed in these two cities as these two regions account for a large portion of GHG emissions because of the concentration of petrochemical, steel, and other heavy industries within this region.

Additionally, Saudi Arabia aims to transition from solely being a major petroleum producer to becoming a leading producer of clean hydrogen, which carries immense promise as a sustainable energy source.

3.10.4 Transportation

A vital component of Saudi Arabia's climate goals is the railway projects that it is implementing. It is important for the Kingdom to encourage public transport in order to achieve its 2030 and 2060 climate targets. The Saudi Land Bridge project aims to connect the Red Sea with the Gulf by bridging the country into a global logistics hub. The Haramain High-Speed Rail, for example, aims to reduce the travel time between the holy cities and Jeddah for passengers, and the North-South Line, for example, is aimed at reducing the dependency on road transportation, potentially resulting in a significant reduction in greenhouse gas emissions as a result. In order to establish 9,900 kilometers of new railway lines by 2040, Saudi Arabia has invested $97.4 billion in its railway projects. (Oxford Business Group 'Saudi Arabia', 2020).

By encouraging the use of electric vehicles in Saudi Arabia, the Public Investment Fund (PIF) has invested and created Saudi Arabia's first electric vehicle company (CEER) in an effort to reduce greenhouse gas emissions from its transportation sector. The Saudi Arabian government is aiming to attract more than $150 million in foreign direct investment by using these vehicles, as outlined in its VNR. Saudi Arabia intends to target the Saudi market and the MENA market through these vehicles. According to a study conducted by KAPSARC (Elshurafa & Peerbocus, 'Electric Vehicle Deployment', 2020), 100,000 EVs would result in a net reduction in carbon emissions of 0.36% on average when compared to the same number of internal combustion engine vehicles (ICEVs).

3.11 United Arab Emirates (UAE)

In releasing its third update of its second NDC on July 11, 2023, the UAE demonstrated a commitment to tackling climate change challenges. By taking unconditional measures, the UAE reaffirmed their ambition to achieve net zero by 2050.

UAE greenhouse gas emissions stand at 225 MtCO2e in 2019, which they are committed to reducing. UAE initially hoped to reduce emissions by 31% by 2030. Their recent updated NDC highlights their ambitious goal of reducing emissions by 40% by 2030, an increase of 19% from their original target. They are committed to climate action, as demonstrated by their ratification of the Paris Agreement.

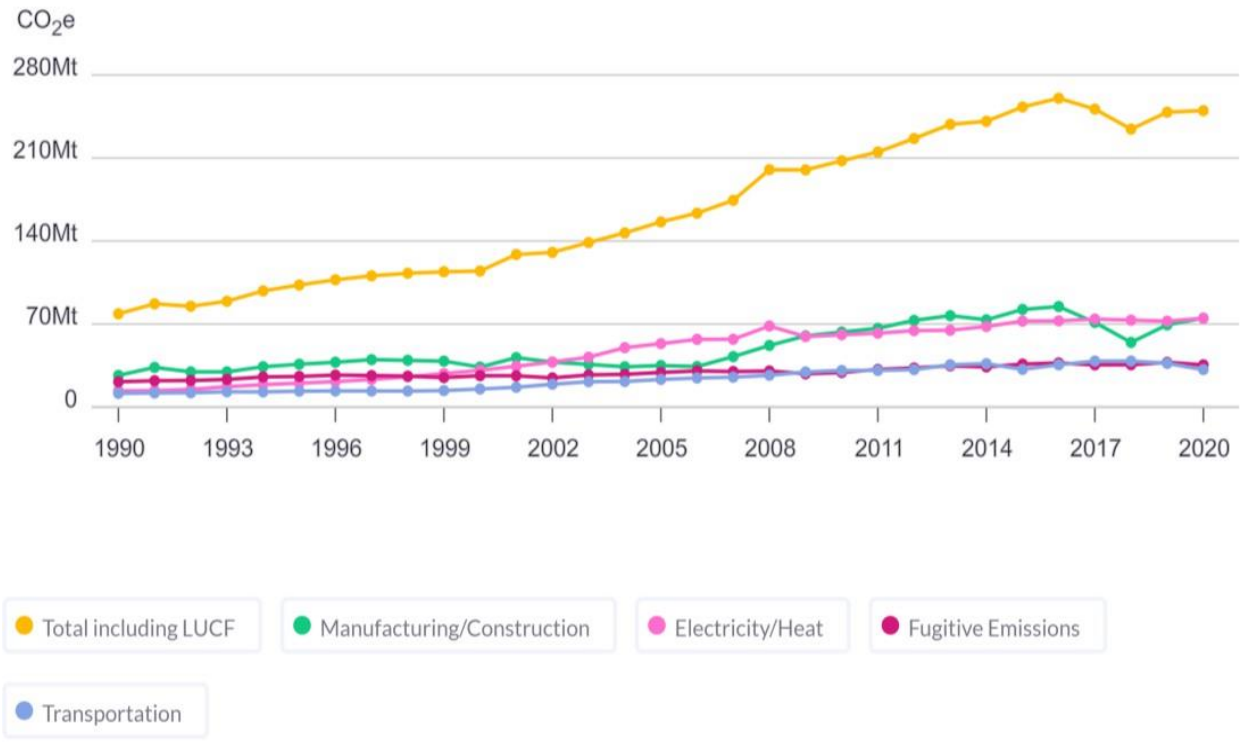


Figure 66: (Historical GHG emissions by sector, UAE, 1990-2020,

Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions

In recent years, the UAE has taken significant steps toward reorienting its energy policy, particularly in the electricity and heat sectors. As of 2020, the sector accounts for 74.7 MTCO2e of the UAE's total greenhouse gas emissions (Figure 66). This figure underlines the importance of diversifying the UAE's energy systems. In response to this, the UAE has initiated the Net Zero Strategic Initiative. This initiative seeks to reduce gas usage in power generation by 30% by 2030, as compared to the levels of 2019.

3.11.1 Power Generation

UAE has set a goal of 51% reduction in power grid emissions from 2019 as the base year. It is important to note that this target is based on an estimated significant increase in energy demand over the same period. As a means of achieving this goal, the country has developed an energy mix that is diversified, focused on solar photovoltaics, and incorporated nuclear power developments. It is estimated that the UAE will produce 19.8 GW of clean energy through this development strategy, which aligns with the UAE's 2030 energy target of integrating 30% of clean energy into the mix by 2031, and 50% by 2050.

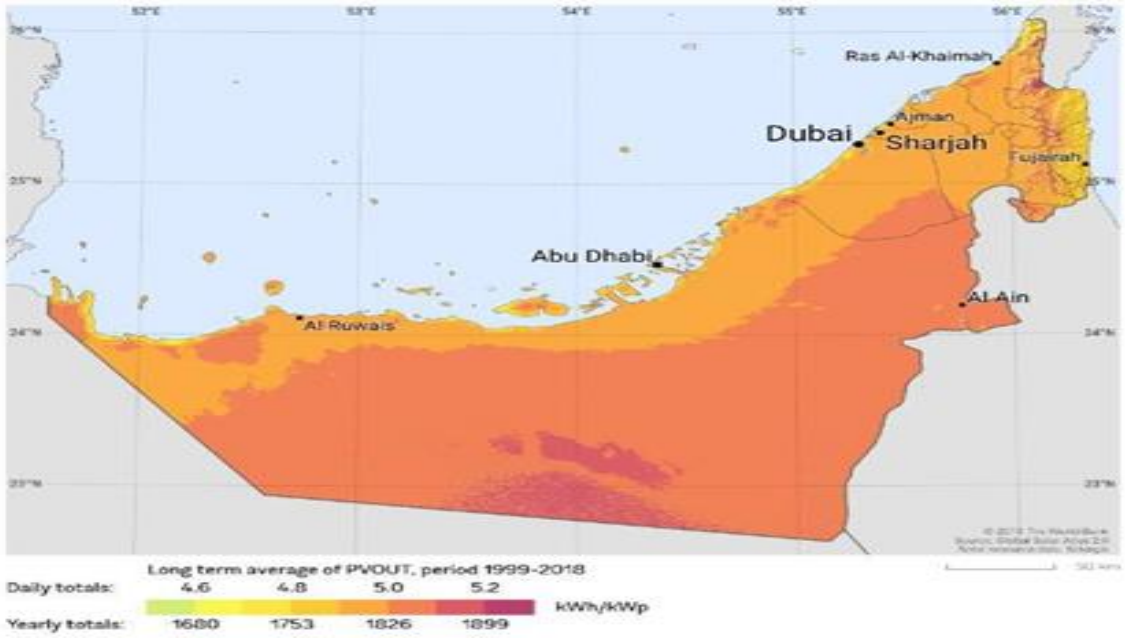


Figure 67: (Photovoltaic Electricity Potential, UAE)

Source: World Bank Group and ESMAP 2023

A number of developments have been made in the field of solar energy in the UAE through the use of its favorable climate and geographical location, which offer a significant potential for harnessing solar power (Figure 67).

Three solar power plants are currently operating in the country, including the EWEC Al Dharfra plant of 2 GW and the EWEC Noor Abu Dhabi plant of 1.2 GW. In addition to the 1.75 GW being built at DEWA Mohammed Bin Rashid Al Maktoum Solar Park, 1.5 GW is currently under contract at EWEC Al Ajban. Mohammed bin Rashid Al Maktoum Solar Park will be the largest project ever in terms of reducing over 6.5 MT CO2 every year. (EWEC, 'Announces Partners to Develop', 2020)

Furthermore, the country's leading renewable energy company, Masdar, has committed to invest an additional $8 billion in solar energy by 2030, demonstrating its serious commitment to rapidly developing solar energy.

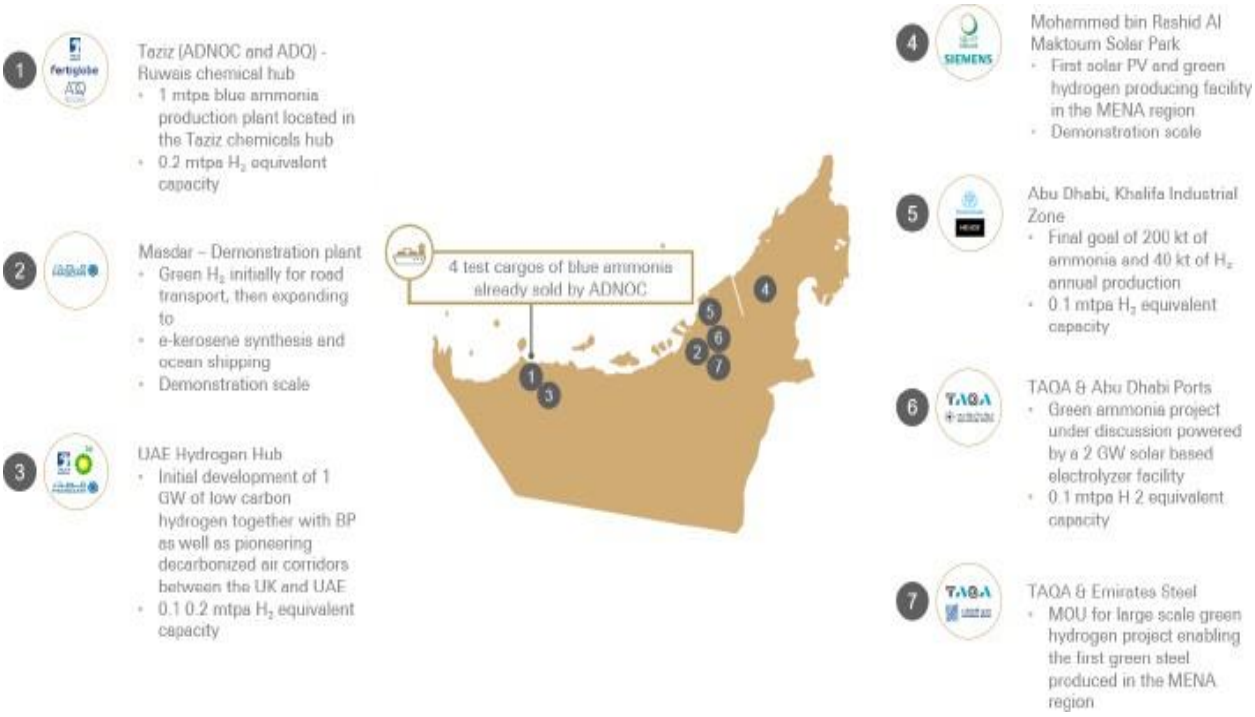


Figure 68: (Planned hydrogen projects, the UAE)

Source: Third Update of Second Nationally Determined Contribution for the UAE

As part of its strategic vision, UAE wants to become a global leader in clean hydrogen production and have set a goal of acquiring 25% of the global market. Due to its natural advantage with access to water and natural gas, the country has invested substantial capital and time into seven projects to expand its blue and green hydrogen capabilities, as shown in (Figure 68).

It is planned that Abu Dhabi National Energy Company (TAQA), Mubadala, and ADNOC will produce 1MT of green hydrogen by 2030. Masdar has constructed a green hydrogen plant with a capacity of 20 kilograms per hour at the Mohammed bin Rashid Al Maktoum Solar Park. With the help of ENGIE, the company plans to expand this initiative by investing $5 billion in hydrogen plants across the country. The company will also construct a green hydrogen facility capable of producing green ammonia by 2025.

3.11.2 Industry

Using strategies to reduce emissions from metal production, the UAE has developed strategies to transition to sustainable energy practices. By 2050, Emirates Global Aluminum (EGA), the UAE's largest industrial entity outside oil and gas, plans to achieve zero emissions. The company has already sourced 100% of grid electricity by 2021 from renewable sources, demonstrating its commitment to sustainability. Thus, the GHG emissions for EGA's metal products are 35% lower than the global average. Furthermore, the emission of perfluorocarbons (PFCs) stands 91% below the average global figure, which demonstrates EGA's sustainability strategy's effectiveness (EGA, '2022 Sustainability Report', 2022).

Among the key players in the UAE's industrial sector, Emirates Steel, has integrated the Al Reyadah CCUS facility into its operations, which will enable the company to capture carbon dioxide emissions during the steel manufacturing process in order to reduce its carbon footprint. In addition to developing the first green steel plant in the MENA, Emirates Steel has invested in green hydrogen technology. As a result of these innovative developments, the company believes that by 2030, scope 1 and 2 emissions will be reduced by 40%. Through its proactive approach to metal production, the UAE demonstrates its commitment to energy sustainability in its industrial sector by demonstrating its commitment to climate-conscious metal production.

Through these initiatives, the UAE is committed to achieving low-emission industrial systems while maintaining a climate-conscious energy policy.

3.11.3 Transportation

An important measure taken by the UAE to promote energy sustainability in transportation is the National Smart Mobility Strategy, which is a set of policies and regulations that aims to enhance safety, sustainability, efficiency, and reliability in transportation. Additionally, the government eliminated subsidies that correlated gasoline and diesel prices with international markets, imposed new fuel standards requiring diesels to contain 10 parts per million sulfur, as well as Euro V standards, and mandated that all new vehicles meet Euro IV performance standards, with a gradual transition to Euro V and Euro VI planned.

UAE has introduced a policy package to encourage the use of battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) that includes grants for capital expenditures (CapEx), free parking in Dubai, and other road privileges including dedicated lanes, lower registration fees, and reduced tolls. In addition to these incentives, the government intends to impose policy restrictions on the use of Internal Combustion Vehicles (ICVs) in order to encourage their phase-out. The Road and Transport Authority of Dubai announced that all taxis will be hybrid, electric or hydrogen-powered by 2027. Abu Dhabi has also recently introduced Battery Electric Vehicles (BEVs) and Fuel Cell Electric Vehicles (FCEVs) to its fleet.

As part of the UAE's effort to reduce greenhouse gas emissions and revolutionize freight transport, the UAE is developing a 1,200 km freight rail network (figure 69). This network has been in operation since January 2016, and is scheduled to extend to over 605 km in 2023. With this network, freight is carried by trains equivalent to 300 trucks, thereby reducing carbon emissions dramatically.

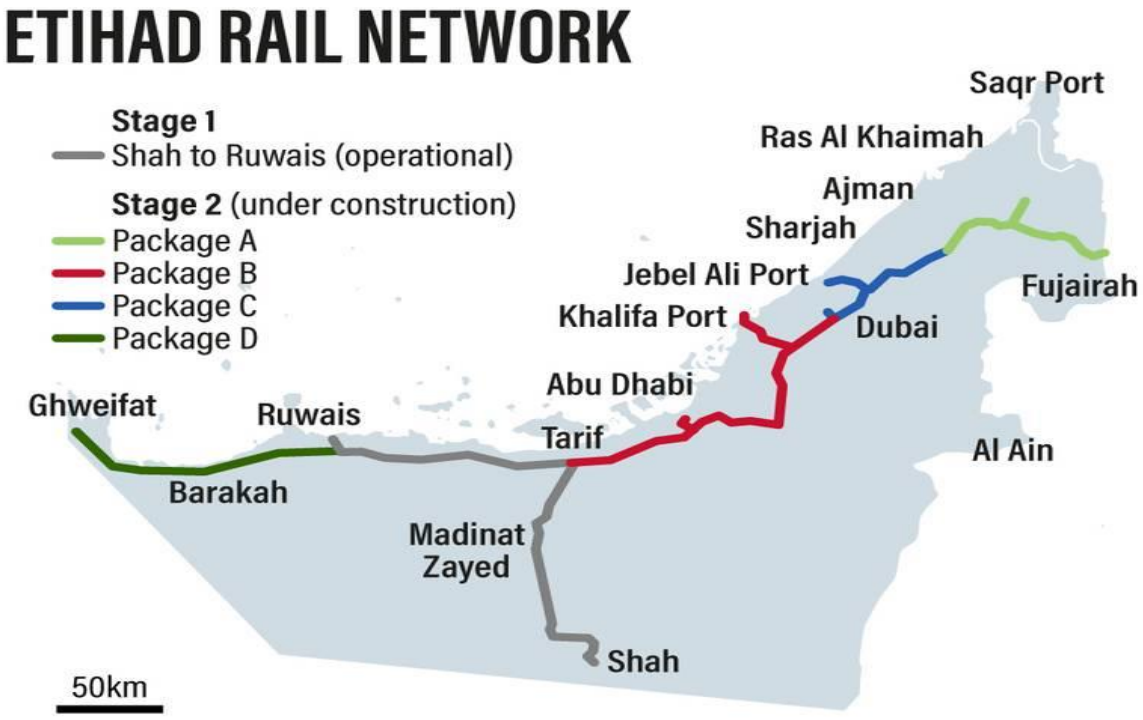


Figure 69: (Etihad 1,200km Rail Project, the UAE)

Source: National News, UAE.

3.12 Venezuela

Having signed the Paris Agreement in April 2016, Venezuela has submitted a VNR to the HLPF as of 2017. Its commitment to environmental action was reflected in the Venezuelan National Development Plan, which was submitted in 2018 and revised in November 2021. Venezuela's NDC targets do not contain national unconditional measures, unlike BAU scenarios. Instead, they have set a conditional target of 20% reductions by 2030 in GHG emissions.

Adaptation and mitigation methods are both part of the approach, but adaptation has been given priority. The success of Venezuela's climate-related energy policies is largely due to international cooperation, which includes developed countries providing financing, technology transfer, and capacity building in return for Venezuela's commitments. A largely collaborative effort will be required to achieve Venezuela's NDC goals due to the environmental repercussions and stagnation of climate policies that have been caused as a result of unilateral coercive measures.

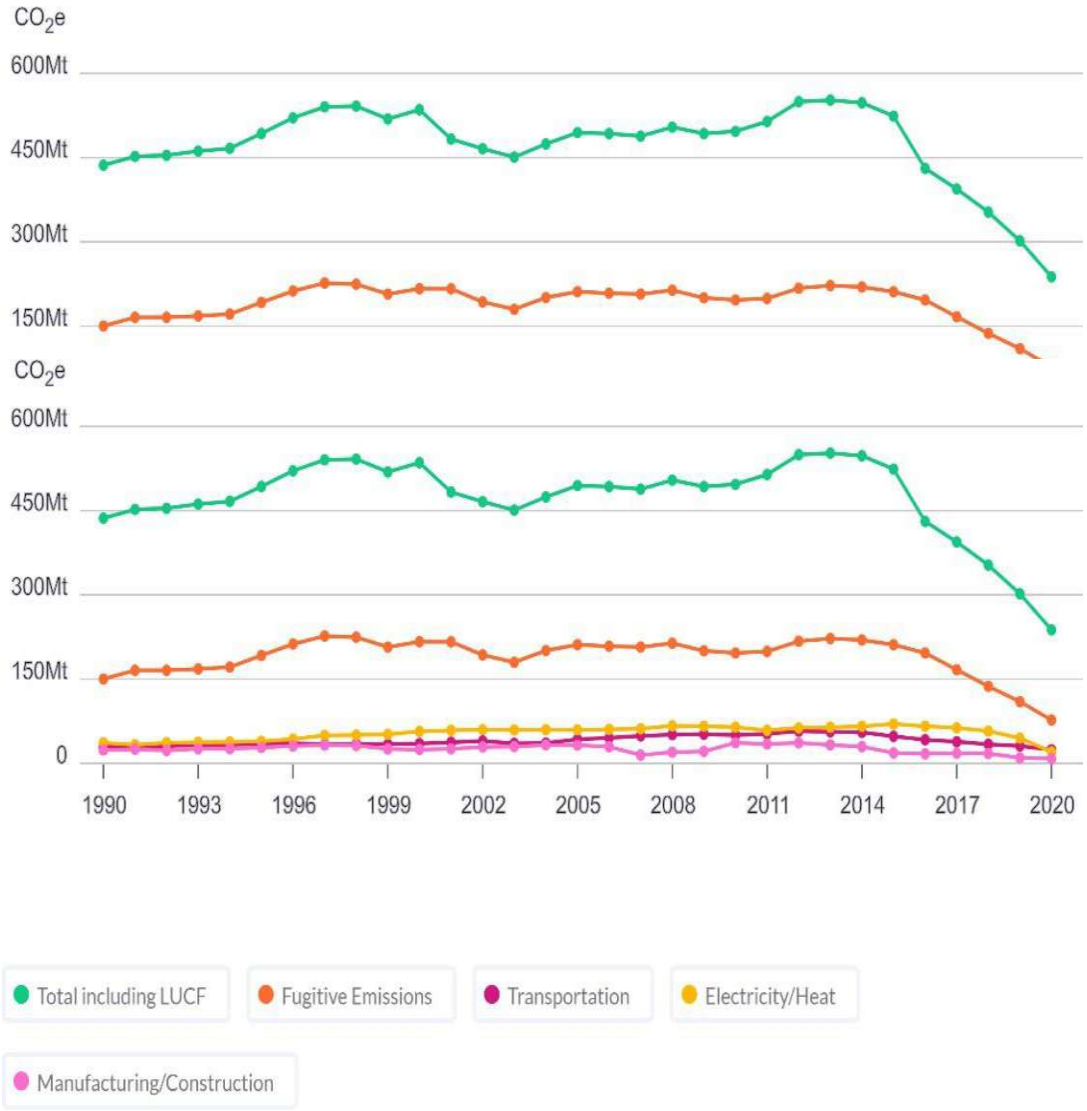


Figure 70: (Historical GHG emissions by sector, Venezuela, 1990-2020,*Source: Climate Watch Historical GHG Emissions (1990-2020), 2023). Available online at: https://www.climatewatchdata.org/ghg-emissions*

3.12.1 Power Generation

In Venezuela, hydropower accounts for 79.7% of electricity generation. Approximately 96% of the remaining energy is derived from thermoelectric power plants powered by natural gas, diesel, and fuel oil. The extensive use of hydropower in Venezuela is a positive step towards renewable energy, but the National Development Committee highlights the adverse effects of climate change on its reservoirs and rivers, leading to severe droughts. According to (IRENA, 'Venezuela energy profile', 2023) 84% of Venezuela's renewable energy comes from hydro and marine energy

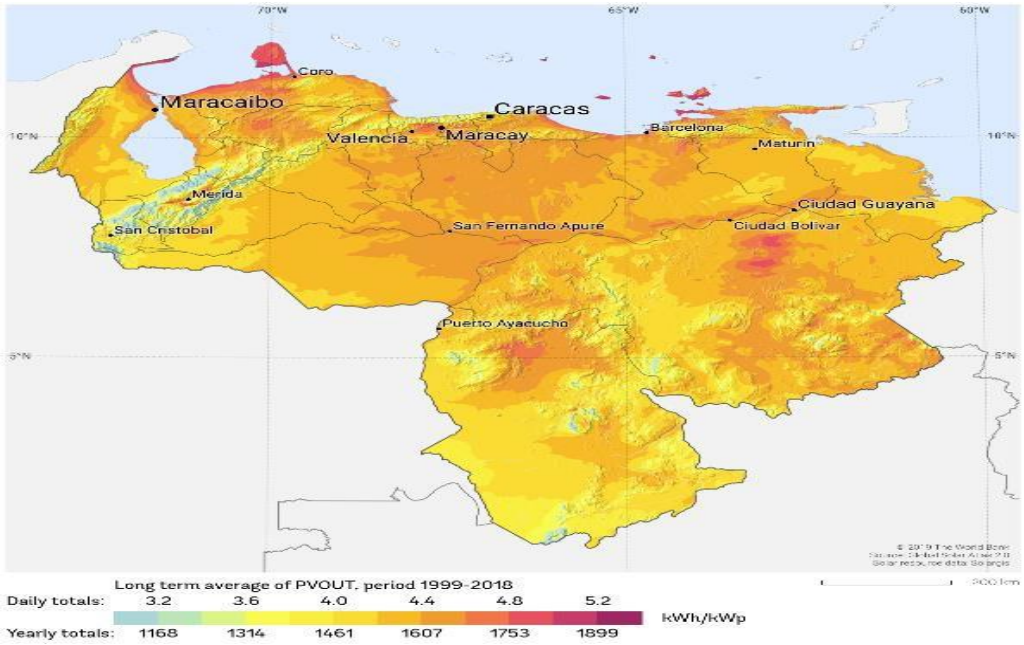


Figure 71: (Photovoltaic Electricity Potential, Venezuela)

Source: World Bank Group and ESMAP 2023

To overcome the challenges faced by hydropower, alternative renewable sources are being explored in Venezuela in order to meet its peak demand of about 12.4 GW in 2021. As most of Venezuela's landmass is capable of producing solar energy, it has a good chance of harnessing it, with a particular high yield (figure 71) in its northwestern region of just under 5.2 kWh/Kwp per day. The annual electricity consumption is 1899 kWh/KWp (Dialogo 'Could Solar Help', 2023).

3.12.2 Industry

It has been difficult for Venezuela to reduce energy-related emissions from the industrial sector. However, the NDC mentions the necessity to address fugitive emissions that result from oil and gas production. There is a serious problem with gas flares in Venezuela, which are a major concern for the country. In Venezuela, gas flaring contributes not just to environmental pollution, but also to the waste of valuable resources. By reducing gas flares, not only would emissions be reduced, but natural gas could also be harnessed for economic development. (World Bank 'GGFD - Venezuela', 2022).

Among the main reasons Venezuela flares is the lack of investment and safety measures. The state-owned oil company, Petróleos de Venezuela, S.A. (PDVSA), lacks the necessary technology to capture and process its gas, thus it resorts to flaring to capture and process it. Significant investment will be required to resolve this issue (Venezuela 'Actualizacion de la Contribucion', 2021).

The ultimate objective is to reduce greenhouse gas emissions by the oil industry by approximately 75% through fugitive emissions. However, in order to achieve this goal, developed countries must fulfill their Paris Agreement obligations and provide international support and financing. It emphasizes the need for global cooperation in fighting climate change and the interconnectedness of environmental responsibility.

3.12.3 Transportation

The Venezuelan public transportation system has been working hard to improve over the past few years. There are several metro stations, such as Metro de Caracas, Metro Maracaibo, Metro Valencia, Metro Los Teques, and Metro Cables. The city has also expanded its bus system by completing various projects, such as Trolebús Mérida, Trolebús Caracas, TransMaracay, TransBarca, TransCarabobo, TransFalcón, and TransAnzoátegui. Venezuela aims to make its transportation system more efficient and environmentally friendly as part of the NDC (Smilde & Hernaiz, 'Venezuela's Public Transportation', 2018).

Additionally, the country is exploring the integration of modern technologies into the transportation system with the intention of converting them to electricity. The policy is expected to reduce nitrogen oxide emissions by 0.5 to 0.25 g/kWh. Buses will be powered by electric and diesel engines, and the fleet standard will be upgraded from Euro III to Euro VI when renewed.

As part of Venezuela's effort to promote cleaner transportation, the Chinese company Yutong has also commissioned a bus plant. The Yutong Bus plant has the capacity to produce 3500 buses per year. These buses are Euro V compliant, so they can cut emissions by 40%. (China Daily 'Venezuela to Open Chinese Yutong Bus', 2015).

4. Findings and Conclusion

4.1 Findings

The objective of this thesis was to investigate and research the implications of climate change policies on OPEC countries, as well as the innovative solutions that OPEC countries are implementing to adapt to the proposed future energy system. Though many of these innovations have been around for years, their scalability in terms of deployment has been quite slow for a variety of reasons.

In addition to differences in trends to oil production and consumption within the OPEC countries, efforts to eradicate energy poverty, and diversified revenue sources are some of the identified challenges uncovered by the author in the course of this study. OPEC countries solely

depend upon oil sales revenues to fund their respective budgets, which has lacked the stability necessary to allow policy makers to forecast and plan long-term budgets.

With the spread of Covid-19 pandemic, which virtually halted economic activity across the globe, and the ongoing war in Ukraine, another unexpected challenge associated with geopolitics was revealed.

Although some of the bottlenecks highlighted in the thesis are major challenges for OPEC, this should rather serve as a motivation for balancing current realities within the energy sector, while being aware of the fact that they must implement necessary changes in a timely manner.

Using a substantial quantity of literature sources, materials, and analyzing some of the significant declarations made by OPEC countries about diversifying their revenue sources and energy systems, the following are some of the key findings from the thesis study.

- The results highlight the critical innovative policies OPEC countries are adopting to reduce GHG emissions and diversify their energy sources, particularly those derived from fossil fuels, to further reduce GHG emissions and secure future revenue streams.
- The OPEC countries rely heavily on revenues from crude oil sales to fund their respective budgetary (financial) obligations. With much discussion and the on-going implementation of policies by oil consuming nations to shift away from oil source energy systems to renewable energy sources will undoubtedly create a bottleneck for the OPEC countries who rely heavily on oil revenues (Omaye et al, 'Energy Consumption, Economic Growth and Energy Transition', 2022).
- The financial cost of transitioning away from fossil fuels to renewable energy sources is huge and the transition can only be achieved if the pledges on financing made in the Paris Agreement are sufficiently met.
- Implementing the necessary change in the energy systems of this OPEC countries is lopsided, for example Saudi Arabia has much more resources (financial, human resource,

technological) at its disposal to effect these change compared to let's say the Republic of Gabon.

- The study also found that energy consumption, economic growth, and greenhouse gas (GHG) emissions, also known as CO2 emissions, are all related to OPEC countries' energy consumption.

4.2 Conclusion

Since the signing of the historic Paris Agreement, all OPEC Member Countries have demonstrated commitment to climate governance. This includes exploring and adopting innovative policies that facilitate change in their energy systems. This is illustrated by their unanimous engagement with the UNFCCC and emissions reduction pledges. This study investigated the climate policies of these countries focusing intently on three pivotal sectors: the power generation sector, the industrial sector, and transportation. Despite the importance of integrating renewables into their energy matrix for achieving emission reduction targets, the study noted oil's vital role in protecting their economic and energy security (Omri, 'CO2 Emissions, Energy Consumption and Economic Growth Nexus..', 2013).

Furthermore, the author of this thesis found that the economic and social implications of OPEC Members' decisions on oil prices and production levels, as well as their influence on global energy markets and geopolitics, have been sufficiently researched and analyzed. However the environmental impacts of oil use continue to present challenges to OPEC countries. The issue of its implications for the environment is often ignored by some these oil producing countries.

Understanding the energy transition is essential to a successful adaptation strategy, as it determines how fast the transition will happen, which will affect business model adaptation and investment strategies. It is also critical to know what technologies will eventually win out (Solar, Wind, Biomass, Hydro, and Green Hydrogen), and what the final energy mix will be once the transition has been completed

Today, fossil fuel technology is the most efficient and economical way to power most transports, heavy industries, and domestic needs. From an economic and technological perspective, fossil fuel energy is undoubtedly going to be an integral part of an eventual energy mix. If oil producing countries fail to adapt to the new context, they will be exposed to economic and geopolitical losses, especially those that are more dependent on energy markets with higher decarbonization commitments, like the European Union (Niu et al, 'The Transition to Clean Energy and the External Balance of Goods…', 2023)

Concluding, OPEC countries need to think about several factors to implement effective strategies to maintain their economic influence and role. Some of these factors are:

- The emergence of decarbonization policies around the world affects oil and gas demand globally.
- The pace at which the global transition to renewables is unfolding at different rates in different parts of the globe.
- It is imperative for oil export portfolios to be diversified to secure sustainable growth.
- In a constrained oil market, producers often experience a high level of competition due to the high level of supply.
- Some OPEC producers have low production costs and low carbon intensity in comparison with others.

List of Abbreviations

ALNAFT - National Agency for the Development of Hydrocarbon Resources

ASB – Annual Statistical Bulletin

ARH - Hydrocarbons Regulatory Authority

BAU - Business As Usual

BRT - Bus Rapid Transit

CCE - Circular Carbon Economy

CCS - Carbon Capture and Storage

CCUS - Carbon Capture, Utilization, and Storage

CEER - Saudi Arabia's first electric vehicle company

CNG - Compressed Natural Gas

CO2 - Carbon dioxide

KW - Kilowatt

Kwp - Kilowatt peak

KWh - Kilowatt-hour

OPEC – Organization of the Petroleum Exporting Countries

IRENA - International Renewable Energy Agency

IEA - International Energy Agency

OECD – Organization for economic Cooperation and Development

GHG – Green House Gases

HLFP – High Level Political Forum

VNR – Voluntary National Review

NDC – Nationally Determined contribution

INDC – Intended Nationally Determined Contribution

PFC - Perfluorocarbon

PIF - Public Investment Fund

PJ - Petajoule

PV – Photovoltaic

tCO2e - Tons of carbon dioxide equivalent

TWh - Terawatt-hour

W – Watt

UNFCCC - United Nations Framework Convention on Climate Change

BEV - Battery Electric Vehicles

ICV - Internal Combustion Engines

FCEV - Fuel Cell Electric Vehicles

CapEx – Capital Expenditure

MENA – Middle East and North Africa

Emirates Global Aluminum (EGA)

WOO – World Oil Outlook

PDVSA Petróleos de Venezuela, S.A.

List of figures

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