

# Energy Industry in Egypt



## General State of the Economy

Egypt, officially the Arab Republic of Egypt, is located on two continents – one part of the country is in the north-east of Africa and the other is on the Sinai Peninsula in Asia. The country has a long border with Libya in the west, in the south it borders Sudan, and in the north-east Israel. The north of the country has access to the Mediterranean Sea and the Red Sea is in the east. Both of these seas are connected to the Suez Canal. In terms of the size of the territory, Egypt is 31<sup>st</sup> in the world, and ac-

ording to the population density, the country is 118<sup>th</sup> [1,2].

The total length of the country's coastline is 2 450 km [3]. According to 2020 statistics, the country is home to around 108 million people [3].

Six out of ten indices characterizing the economic situation in the country are at the bottom part of the diagram shown in Figure 1.

Between 2005 and 2014, the country experienced rapid growth in GDP at purchasing power parity, but then it dropped, amounting to \$1.223 trillion in 2020 [3,4]. For



Sources:

1. GDP (purchasing power parity), 2020 est. / The World Factbook/Library/Central Intelligence Agency \*228
2. GDP - per capita (PPP), 2020 / The World Factbook/Library/Central Intelligence Agency \*229
3. Inflation rate (consumer prices), 2019 est. / The World Factbook/Library/Central Intelligence Agency \*228
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6. High-technology exports (current US\$) 2019-2020 / United Nations, Comtrade database through the WITS platform / License: CCBY-4.0 / Data \*134
7. 2021 Index of Economic Freedom / International Economies / The Heritage Foundation \*178
8. Reserves of foreign exchange and gold, 2017 est. / The World Factbook / Library / Central Intelligence Agency \*195
9. Annual average GDP growth in %, for the last 10 years (2011-2020) / World Bank national accounts data, and OECD National Accounts data files / License: CC BY-4.0 \*206
10. Public debt (% of GDP), 2017 est. / The World Factbook / Library / Central Intelligence Agency (from smallest to largest) \*210

\* Total number of countries participating in ranking

Figure 1. Economic indices of Egypt

this indicator, Egypt is 20<sup>th</sup> in the world, behind Saudi Arabia and Canada, but ahead of Nigeria and Pakistan [3].

According to GDP at purchasing power parity per capita, Egypt shows a figure below world average –\$12 00 in 2020 [3]. The inflation rate in 2019 was 9.3% compared to 29.6% in 2017 [3]. The basis of Egypt's exports are crude oil and oil products. The dominant economic partners are the United Arab Emirates and Italy.

According to the Global Competitiveness Report, presented by the World Economic Forum in 2019, Egypt is 93<sup>rd</sup>, out of an estimated total of 141 countries, behind Tunisia. This rating reflects the effectiveness of the use of the country's own resources for sustainable development. In addition to a number of economic indicators this index also takes into account such variables as education, health, level of innovation, etc.

In the list of countries that export high-tech products in 2019-2020, the country was 62<sup>nd</sup> out of 134 countries.

## Energy resources

Egypt has quite large and diverse reserves of fossil resources (Table 1), but the main resources of the country are oil and gas. These resources are represented by reserves of traditional oil, as well as tight oil and extra heavy oil, natural gas and shale gas.

In terms of tons of oil equivalent, in 2021 proved reser-

ves of conventional hydrocarbons in Egypt were: gas – 77.7%, oil – 21.8%, coal – 0.5% (Fig.5). The unconventional natural resource matrix looks much different: shale gas – 63.5%, oil shale (kerogen) – 21.2%, tight oil – 15.1%, oil sands and extra heavy oil – 0.2% (Fig. 5).

According to the Index of Economic Freedom 2021, which is based on freedom of business, freedom from government action, property protection, and freedom from corruption, Egypt was 130<sup>th</sup> in 2021, out of the 178 countries considered, ahead of Kenya, Zambia and Pakistan. In terms of reserves of foreign exchange and gold Egypt is 47<sup>th</sup> out of 195 countries, ahead of Kuwait and behind Nigeria. According to the indicator for the average GDP growth in percentage over the last 10 years, in 2020 the country was 53<sup>rd</sup> out of 206 countries. In terms of public debt, calculated as a percentage of the country's GDP, Egypt was ranked 188<sup>th</sup> out of 210 countries considered in 2017.

For more information on the Egyptian economy click [here](#).

**Table 1. Fossil energy resources of Egypt**

Resource/ explanations	Crude oil	Natural gas	Coal	Shale Gas*	Tight Oil*	Oil Shale	Extra heavy oil
<b>Value</b>	3.3	1.783	18	100	4.6	5.7	50
<b>Unit</b>	billion bbl	Tcm	million short tonnes	Tcf	billion bbl	million barrel	million barrel
<b>Year</b>	2021	2021	2021	2013	2013	2008	2008
<b>Source</b>	[3]	[3]	[7]	[8]	[8]	[9]	[9]

\*unproved technically recoverable

According to information presented in [3], as of the beginning of 2021, oil reserves in the country amounted to 3.3 billion barrels, and gas reserves were 1.783 Tcm. According to the BP report, from 1997 to 2020, the total proved oil reserves decreased from 3.8 to 3.1 billion barrels, and natural gas reserves grew from 1 Tcm to 2.1 Tcm in 2020 [6]. Coal reserves were estimated at 18 Mst in 2021 [7].

Egypt has small reserves of shale (tight) oil - about 4.6 billion barrels and substantial reserves of shale gas – 100 Tcf, according to 2013 data [8]. The country also has reserves of extra-heavy oil, which at the end of 2008 were estimated at 50 million barrels and oil shale – 5.7 billion barrels [9].

**Table 2. Renewable energy resources of Egypt**

Resource/ explanations	Solar Potential (DNI)*	Wind Potential (50 m)*	Hydro energy Potential**	Bio Potential Agricultural area	Bio Potential Forest Area	Municipal Solid Waste
<b>Value</b>	5.7 - 7.1	6.0 - 7.0	50	4.0	0.0	0.67
<b>Unit</b>	kWh/m <sup>2</sup> /day	m/s	TWh/yr	% of land area	% of land area	Kg/per capita/day
<b>Year</b>	2018	2018	2008	2020	2020	2016
<b>Source</b>	[10]	[11]	[12]	[13]	[14]	[15]

\*for most of the territory of the country

\*\*economically exploitable hydropower potential

Egypt has a significant potential for the development of renewable energy (Table 2).

Due to its favorable geographical location, Egypt has a significant potential for the development of solar energy. The most typical level of direct normal irradiation is 5.7-7.1 kW/m<sup>2</sup>/day, and it can reach the level of over 7.9 kW/m<sup>2</sup>/day on the South Sinai Peninsula [10]. Wind speed in most parts of Egypt is 6.0-7.0 m/s, and in coastal areas, on the South Sinai Peninsula, can reach over 8.5 m/s [11].

The country's economically exploitable hydropower potential is 50 TWh/yr, and small hydropower potential is

estimated to be 51.7 MW in 2016 [12]. There are almost no forested areas in the county is forested with around 4% covered by agricultural land [13,14].

In terms of production of municipal solid waste Egypt reached 0.67 Kg/capita/day in 2016, and by 2025 it can reach the level of 1.8 Kg/capita/day [15].

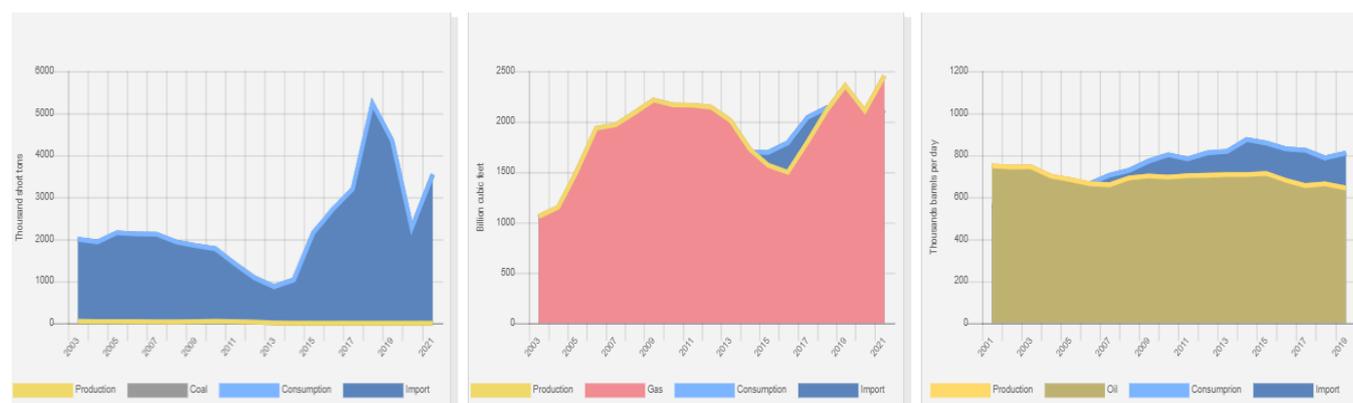
For more information about energy resources in Egypt click [here](#).

## Energy balance

According to BP's report, total primary energy consumption in Egypt in 2021 amounted to 3.79 exajoules, about 58.8% of which was natural gas, 33.8% – oil, 1.3% – coal, 3.7% – hydropower, 2.6% – renewable energy [6]. Egypt is the largest oil producer in Africa outside the OPEC [16]. The production of oil remained stable since 2006, and in 2019 it was 644 thousand barrels/day [17]. In 2021 it was at the level of 608 thousand barrels/day according to [6], and 660 thousand barrels/day according to [3].

The volume of consumption of this resource demonstrated a stable growth (Fig. 2), and in 2019 reached the level of 810 thousand barrels/day, compared to 664 thousand barrels/day in 2006 [17]. According to BP in 2021 this number was 648 thousand barrels/day [6]. As reported in [3], the volume of oil exports from Egypt in 2018 amounted to 204 100 bbl/d.

Internal gas production in 2021 was 2 452 Bcf, demonstrating a increase, compared to the previous year [17]. In 2021, according to [6], gas production amounted to 67.8 billion m<sup>3</sup>, and according to [3] – 64.2 bcm in 2019.

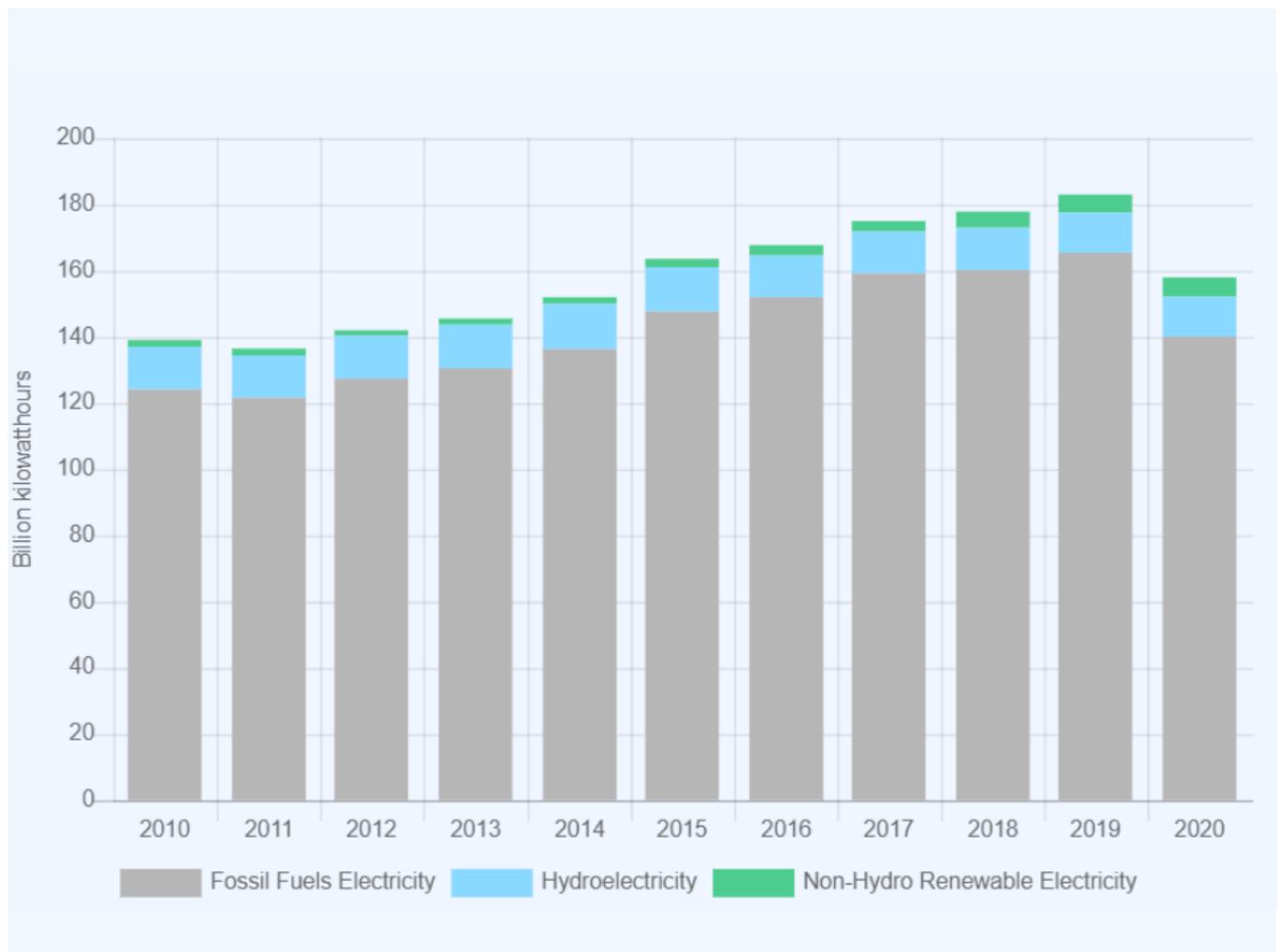


Source: U.S. Energy Information Administration (Dec 2021) / <https://www.eia.gov/>

Figure 2. The production and consumption of fossil fuels in Egypt (coal-left, in the center-gas, oil-left)

Gas consumption in Egypt has been growing since 2001, due to an ever-increasing demand Egypt became a net importer of natural gas in 2015; although the discovery of Zohr and Atoll fields may enable Egypt to become a net exporter in the future [16]. In 2021, the country consumed 2 116 Bcf [17], according to [6] in 2021 it reached the level of 61.9 Bcm. In 2016 Egypt exported 26.3 Bcf of

LNG, the main importers were the Asia Pacific countries, followed by the Middle East and Europe [16]. Coal consumption has been steadily decreasing until 2013, then it grew again and in 2021 reached a level of 3 533 thousand short tons, compared to 867 thousand short tons in 2013 [17]. Historically, Egypt has a high share of fossil fuels in electricity production (Fig. 3).



Source: U.S. Energy Information Administration (Jan 2020) / <https://www.eia.gov/>

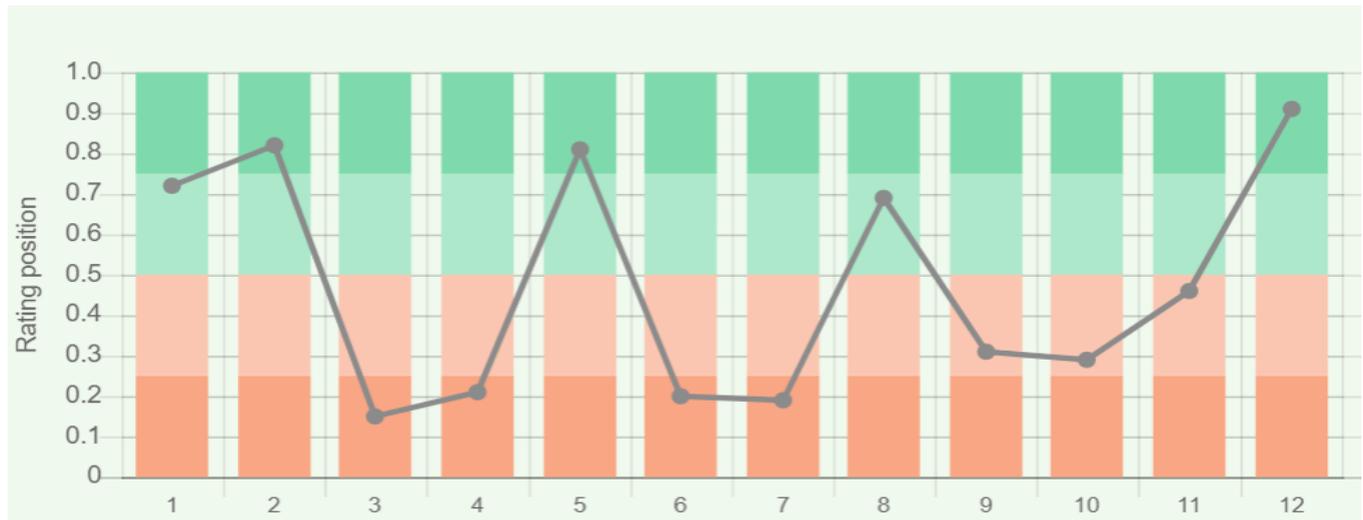
Figure 3. Electricity production in Egypt

In 2020 Egypt produced about 157.97 GWh of electricity, of which 88.7% was by fossil fuels, 7.7% by hydropower, and 3.6% by other renewable sources (Fig. 6). Egypt's position in the comparative diagram of energy index is shown in Fig. 4.

As mentioned previously, Egypt has a potential of traditional fossil resources, which provides a high level of indices associated with crude oil and natural gas. However, the country simultaneously shows extremely low indicators of the production-consumption combination for the-

se resources. At the same time GDP per unit of energy use is above the world average – 19<sup>th</sup> place out of 66 countries considered, while energy consumption per capita is much lower – 57<sup>th</sup> out of 66 countries.

The share of renewable energy in electricity production in Egypt is about 3.6%, and in 2017 the country was 138<sup>th</sup> out of 170 countries selected for consideration. In the Energy Architecture Performance Index 2017, which is based first on the level of economic growth, environmental safety, and energy independence of the



Sources:

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  6. Combination production-consumption for Coal 2019 / International Energy Statistic / Geography / U.S. Energy Information Administration (Nov 2021) \*128
  7. Electricity – from other renewable sources (% of total installed capacity), 2017 est. / The World Factbook / Library / Central Intelligence Agency \*170
  8. GDP per unit of energy use (PPP per unit of oil equivalent), 2020 \*66
  - Primary energy consumption - BP Statistical Review of World Energy 2021/BP/GDP (purchasing power parity) - The World Factbook/Library/Central Intelligence Agency
  9. Energy use (primary energy use of oil equivalent per capita) 2020 \*127
  - Primary energy consumption – BP Statistical Review of World Energy 2021; Population - United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, custom data acquired via website. Retrieved 15 November 2021\*66
  10. The Global Energy Architecture Performance Index Report (EAPI) 2017 / Rankings / Reports / World Economic Forum
  11. Electric power consumption (kWh per capita), 2016 \*217
  - Electricity Consumption - The World Factbook / Library / Central Intelligence Agency; Population - United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, custom data acquired via website. Retrieved 15 November 2021
  12. Combination of electricity production-consumption (kWh)/The World Factbook/Library/Central Intelligence Agency \*216
- \* Total number of countries participating in ranking

Figure 4. Energy indices of Egypt

country, including access to energy, Egypt lost 12 ranking positions over the previous year, and is 90<sup>th</sup> in the world, ahead of Libya.

In terms of electricity consumption per capita, the country is 117<sup>th</sup> in the world, however, for the indicator of combination of electricity production-

consumption, Egypt is 20<sup>th</sup> in the ranked list of 216 countries.

*More information about the energy resources of Egypt can be found [here](#).*

## Energy Infrastructure

The extraction of fossil fuels is carried out mainly in the north and north-east of the country, where the main offshore and continental fields are situated. Energy infrastructure is also concentrated along the coast, in the immediate vicinity of the deposits (Figure 5). More than half of the total volume of oil is extracted from the deposits of the western desert; the rest comes from the Gulf of Suez area, the Eastern Desert, Sinai, and the Mediterranean, the Nile Delta, and Upper Egypt. Western Desert fields produce 58 000 bbl / day and Abu Rudeis fields 85 000 bbl/day [18]. Suez, Belayim, and Western Desert are the main Egyptian oil brands. Western Desert is a light sweet crude oil, but with a high wax concentration [19].

One of the largest gas fields is the Qasr Gas and Condensate Field, A Barell Full estimates the recoverable gas reserves of 2 trillion cubic feet and around 50 million barrels of condensate [20]. Every year there are new gas discoveries in Egypt. As previously mentioned the development of the Yohr and Atoll fields can add another 0.75 Bcf/day to production capacities [16].

Shale gas fields such as Abu Gharadiq, Alamein, Natrun, and Shoushan - Matruh are also in the Western Desert. According to US experts, these deposits contain 100 trillion cubic feet of technically recoverable shale gas [21]. Extraction of heavy oil in Egypt is carried out in the Issaran field, with estimated reserves of 700 million barrels of oil with a density of 10-12 API. In this field modern methods of stimulation are used, for example, the methods of cyclic steam stimulation [22].

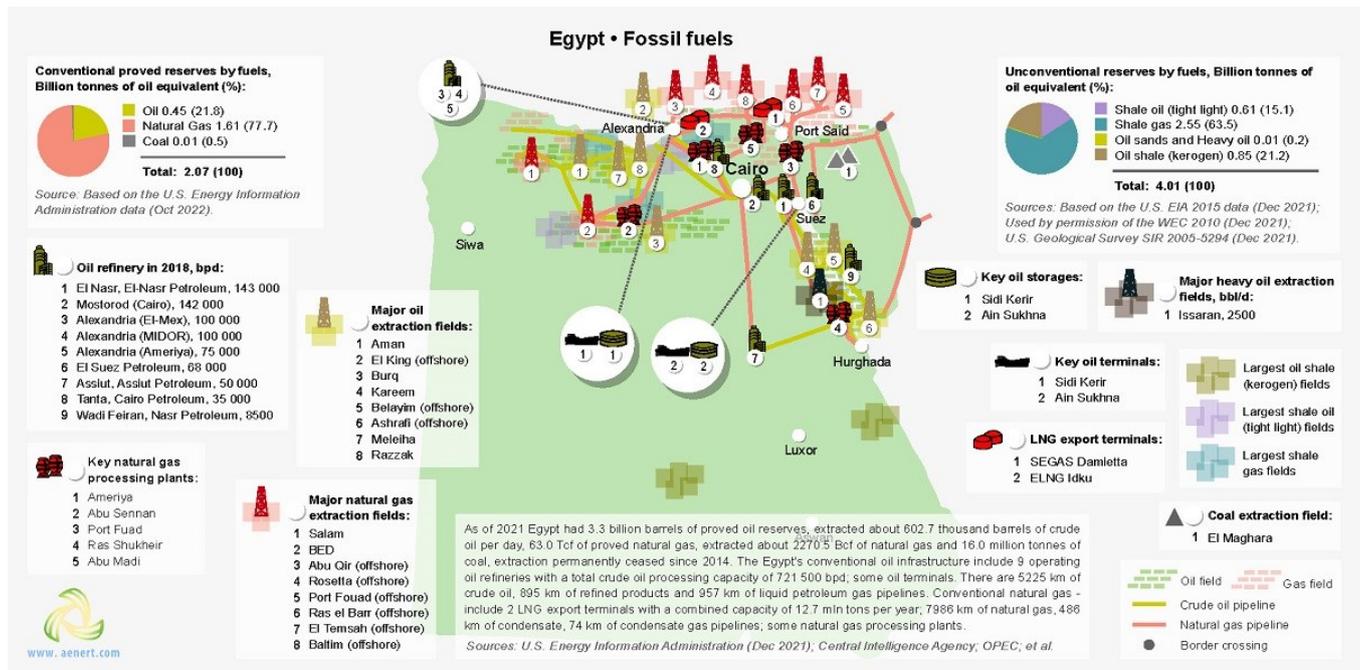


Figure 5. Basic infrastructural facilities of the fossil fuel sector in Egypt

The largest coal mine, El Maghara, contains 21 million tons of coal [23].

Export of gas is carried through the Arab Gas Pipeline (AGP), connecting the Egyptian deposits with Jordan, Syria, and Lebanon [16].

The Suez Canal is one of the main ways of transportation of oil from the Persian Gulf to Europe and the US. The only alternative to the Suez Canal is the SUMED Pipeline, which is 320 km long and has a capacity of 2.34 million barrels / day. In the event of the Suez Canal closing, the transportation of oil from Saudi Arabia to the United States will be through the Cape of Good Hope, thereby increasing the distance by 2,700 miles, and consequently the costs for both parties [16].

The major oil and gas players in the energy market in Egypt are BP, Eni, BG, Apache, and the National Company of Egypt - Egyptian General Petroleum Corporation (EGPC), Egyptian LNG (ELNG) [19]. The main oil terminals are Sidi Kerir and Ain Sukhna, with an oil storage volume of 3.3 million m<sup>3</sup> and 2.95 million m<sup>3</sup>, respectively [24].

As mentioned earlier, power generation is carried out advantageously in Egypt from various fossil fuels, so the country is represented as a gas power plant and a mixed type (Figure 6). One of the largest power plants is the combined power plant complex Kuriemat 1-2-3, with an installed capacity of 2800 MW [25]. Egyptian fossil fuel infrastructure is also represented by Cairo South gas power plant (615 MW) and Walidia oil power plant (624 MW)[26,27].

The refining industry capacity of Egypt (775 000 barrels a day) is one of the largest in Africa (Figure 5). The leading oil refinery is El Nasr has a capacity of 143 000 bpd. Another two plants have a capacity of over 100,000 barrels a day - Alexandria MIDOR Refinery and El-Nasr Refinery [16,28]. The capacity of the refining industry should increase by 85 000 bbl with the opening of a new plant of Egyptian Refining Corporation (ERC) in 2016. Another ambitious project of the plant with a capacity of 300 000 bbl is still in the development phase [19]. Hydropower is the third leading source of power generation in Egypt after oil and gas; in 2017, Egypt produced about 13.3 TW (Fig.6). The country has a number of large hydroelectric power plants with a capacity of more than 50 MW each. Among these is the Aswan High Dam hydroelectric power station with an installed capacity of 2 100 MW is the largest in Egypt. The total installed capacity of hydroelectric power plants is over 2 800 MW [29]. According to data for 2019, the share of hydropower in electricity production from renewable resources was prevalent (73%) (Figure 7).

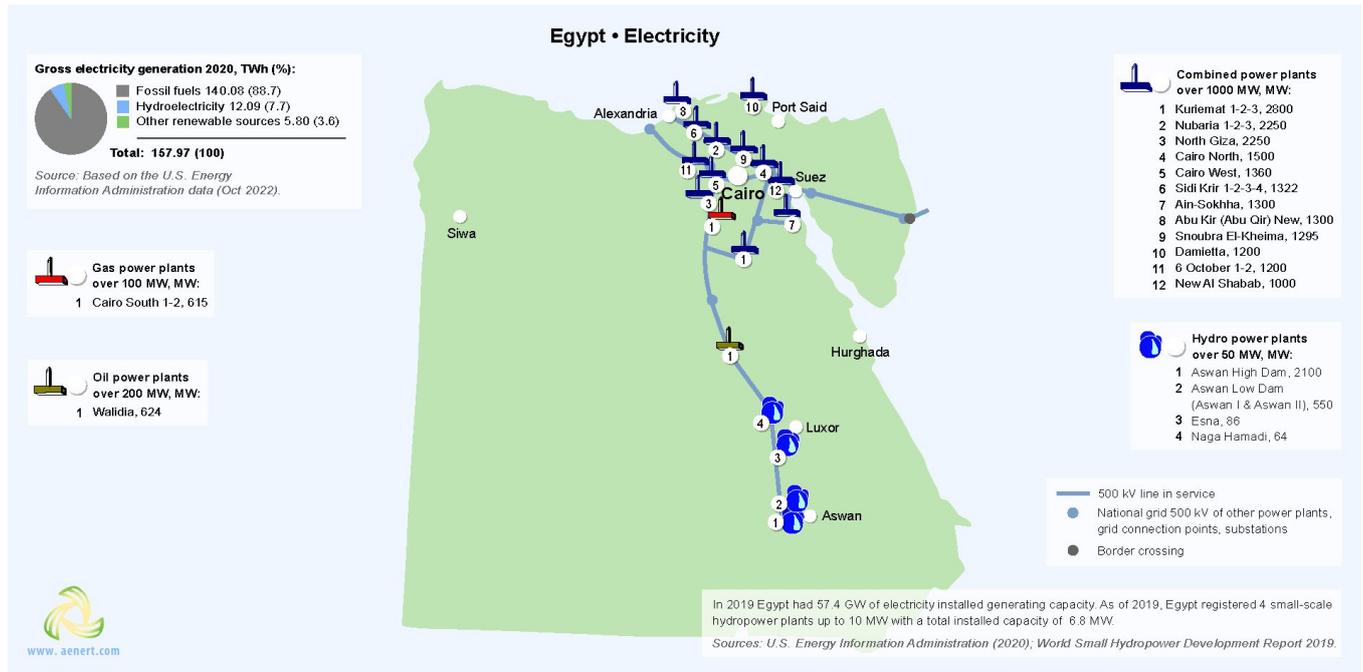


Figure 6. Electricity production in Egypt

In Figure 7, you can see the main facilities of the Egyptian infrastructure for the production of energy from renewable sources.

The total installed capacity of wind power in the last ten years has increased almost four-fold and is 750 MW [30]. One of the biggest stations is Gebel el-Zeit with a capacity of 580MW [31].

Solar energy, with a total installed capacity of 0.77 GW, is playing only a minor role in the production of electricity,

nowadays. The largest station is the combined power plant Kuraymat, with a total capacity of 140 MW, of which 20 MW accounted for concentrated solar power [32].

The priority areas of the energy strategy are to reduce Egypt's dependence on natural gas and its imports, and to attract foreign investment for the development of energy in the region. The Egyptian government plans to increase the share of renewable energy in electricity production

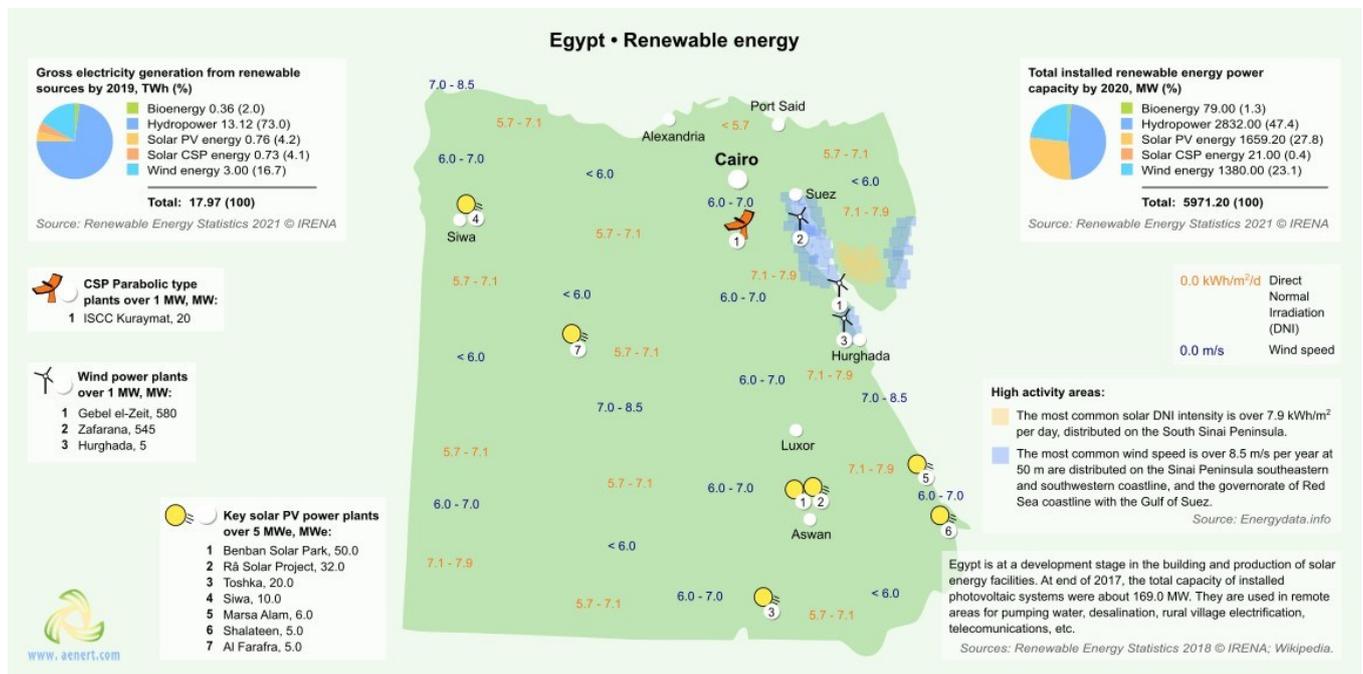


Figure 7. Renewable energy in Egypt

duction to 20%, 12% of which will be developed exclusively by wind turbines. Thus, it is planned to increase the installed renewable energy capacity of 4.3 GW. The largest solar projects will be concentrated in the West Nile regions Benban (Power Plant in Benban -100 MW) and Aswan (Kom Ombo PV - 200 MW), and wind stations, such as the Zafarana, with a capacity of 545 MW, will be built in the region of the Gulf of Suez [33].

According to the forecasts of IRENA, renewables could provide 22% of Egypt's total final energy supply in 2030, up from just 5% overall in 2014. In addition, according to the reports, Egypt could supply more than 50% of its electricity mix from renewables by 2030 [34].

Detailed information about energy infrastructure of Egypt can be found [here](#).

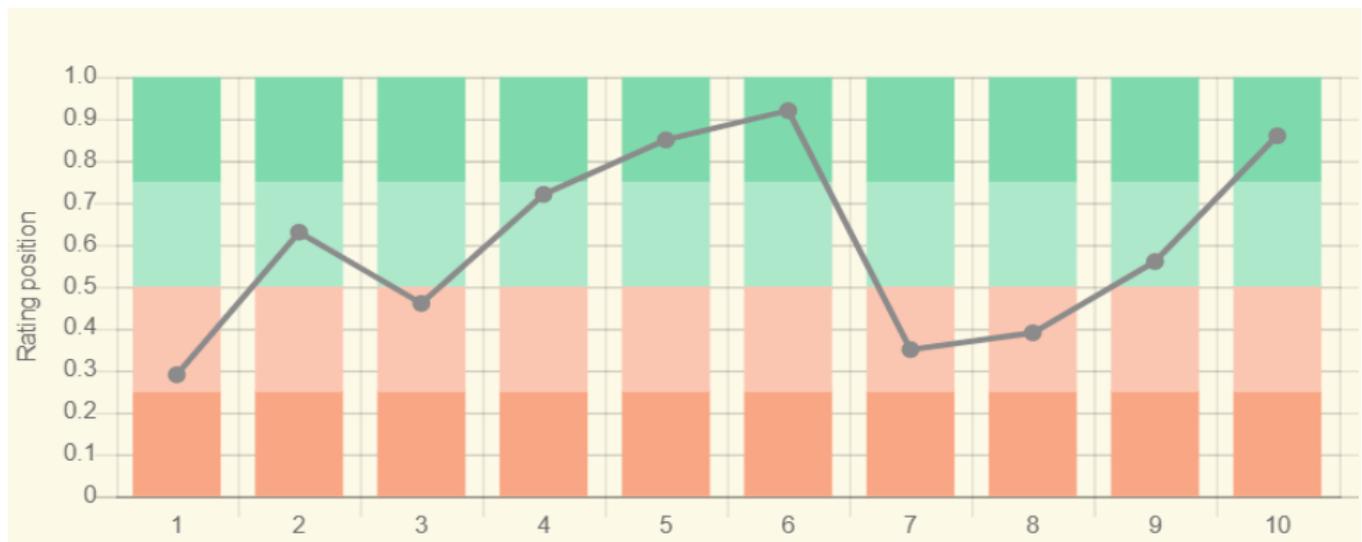
## Education and Innovation

The set of indices reflecting the position of Egypt among other countries in the field of education and innovation can be seen in Figure 8.

In the country ranking in accordance with The Global Innovation Index in 2021, Egypt was 94<sup>th</sup>, ahead of Algeria. According to the number of patents granted to Egyptian residents, both inside the country and abroad, the country ranks 68<sup>th</sup> in the world. Similarly, by the number of patents in force, the country was 59<sup>th</sup> in the world, which largely characterizes the country's patent attractiveness.

Egypt is well positioned when considering the number of publications of specialists in scientific and technological journals – 28<sup>th</sup> place out of 197 countries considered. It is also regarded highly by the Scimago Journal and Country Rank (37<sup>th</sup> place).

In terms of government expenditure on education as a percentage of the country's GDP, the country demonstrates a result close to the world average – 108<sup>th</sup> out of 177 countries selected for consideration. In terms of the amount of government expenditure on research and development as a percentage of GDP, the country is 52<sup>nd</sup> in the world.



Sources:

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\* Total number of countries participating in ranking

Figure 8. The indices of education and innovation in Egypt

The Cairo University and the American University in Cairo are actively involved in the research in the field of associated petroleum gas. The Egyptian Petroleum Research Institute and the Cairo University publish scientific papers in the field of extraction and processing of unconventional oil.

The Egyptian Petroleum Research Institute, Khalda Petroleum Company and the Tanta University are engaged in research in the field of non-traditional oil production, including directional drilling and hydro-cracking.

In the field of synthetic fuel development – the Cairo University and the Suez Canal University, and in the field of coal seam methane – the Zagazig University and the Assiut University.

Research and development in the field of bioenergy is being carried out by the American University in Cairo.

A large number of Egyptian universities conduct research in the field of energy production from renewable sources. The main patent-holder in the field of solar energy is Egypt Nanotechnology Center. Egypt-Japan University of Science and Technology, the Benha University and the National Research Center of Egypt have the largest number of scientific publications in this field.

In the field of wind energy– the Ain Shams University, the Cairo University and the Assiut University.

Detailed information about energy education and research in Egypt is to be found [here](#).

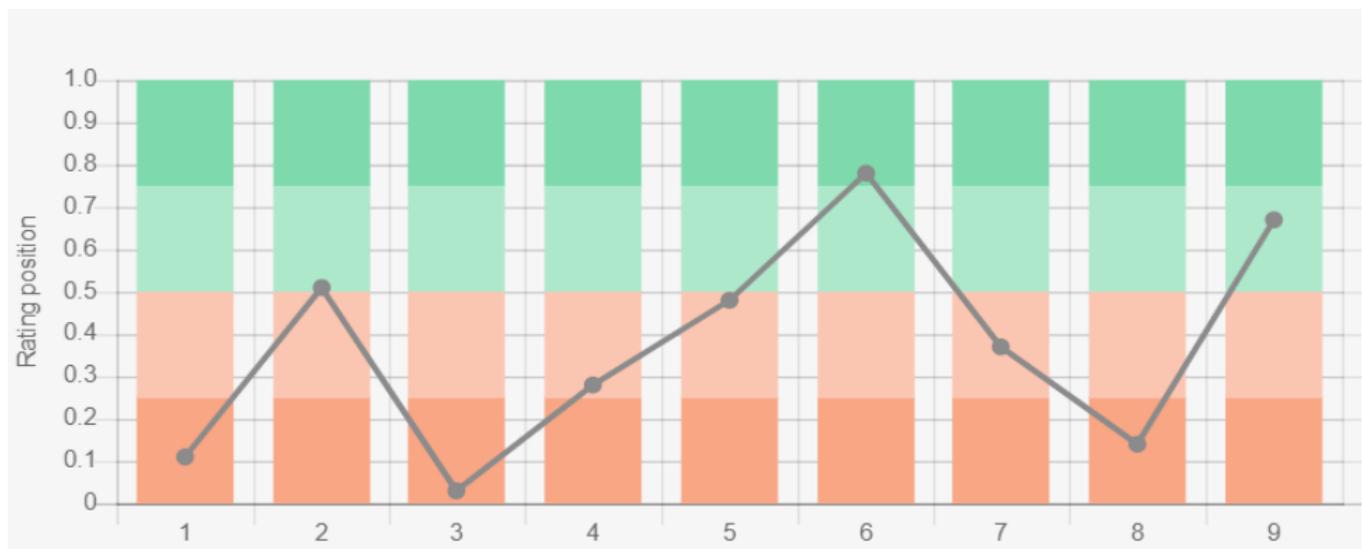
## Ecology and Environment Protection

A diagram of environmental indices is shown in Figure 9. The ecological situation in Egypt cannot be called favorable. Most of the indicators are located in the lower part of the chart.

Egypt has a high level of methane emissions, CO<sub>2</sub> emissions. Although there is a positive trends in forest area

change, in terms of the ecological footprint on a global scale, Egypt is a debtor, demonstrating one of the lowest indicators among African countries.

The situation is brightened, however, by a relatively high valuation of Egypt in the Environmental Performance Index rankings (EPI) 2020, which focuses primarily on assessing the environmental performance of national governments.



Sources:

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\* Total number of countries participating in ranking

Figure 9. Environmental indices of Egypt

In this rating Egypt is behind Lebanon and is 94<sup>th</sup> out of 180 member countries and demonstrates a positive trend.

According to The Environmental Vulnerability Index, which is based on years of observations and 50 indicators, which include for example, changing climatic characteristics or the quality of water resources, waste volumes, oil spills and other hazardous substances, etc. Egypt is 125<sup>th</sup>, and is characterized as "vulnerable". At the same time, the situation is aggravated by the fact that

Egypt is 18<sup>th</sup> in the Climate Change Performance Index (CCPI) 2022, which consists of 60 positions and includes 61 countries responsible for more than 90% of global energy-related CO<sub>2</sub> emissions.

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*For more information on Egypt's energy industry, please click [here](#).*

## References

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The sources of charts and curves are specified under the images.