

# Energy Industry in Libya

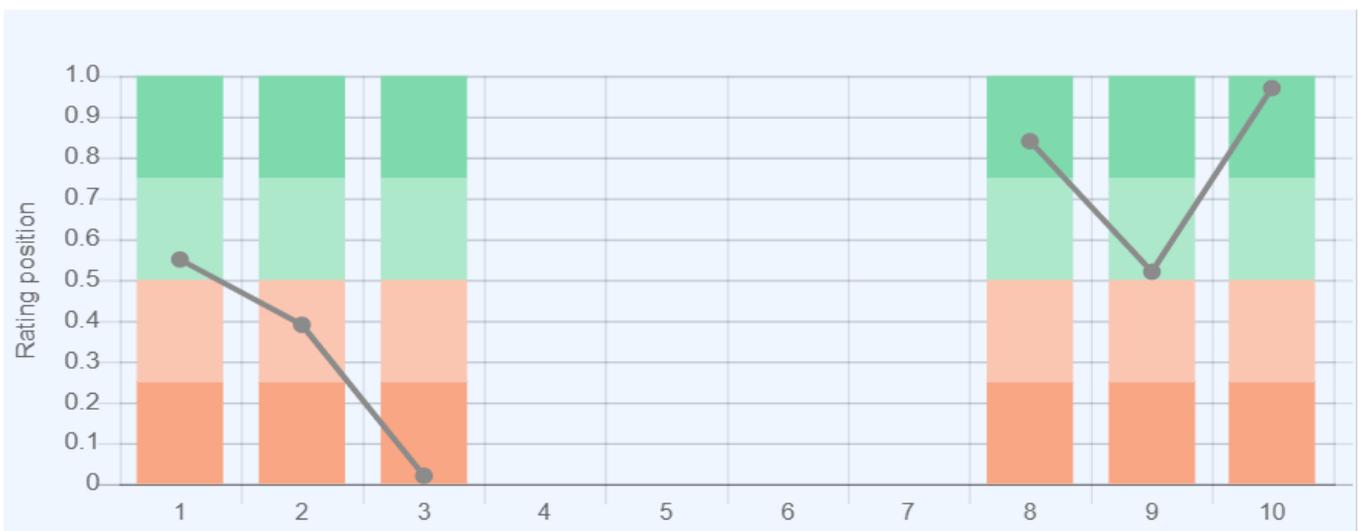


## General State of the Economy

After the overthrow of Libyan leader Muammar Gaddafi in 2011, the country lacks political and economic stability. In addition, the huge flows of refugees and civil war have caused great damage to the country's economy, including its foundation - the oil industry. Accordingly,

many statistics on Libya do not exist, or require additional testing (Fig.1). The same applies to the energy infrastructure. In this regard, some of the following figures show the pre-crisis data.

Libya is located in North Africa on the Mediterranean coast; it is the fourth largest country of the continent. Most of the country is occupied by the desert.



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
4. Charges for the use of intellectual property, receipts (BoP, current US\$), 2020 / International Monetary Fund, Balance of Payments Statistics Yearbook, and data files. / License: CC BY-4.0 \*88
5. The Global Competitiveness Index 2019 / Rankings / Reports / World Economic Forum \*141
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 Economics / 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 Libya

To the east and west Libya is bordered by two other major African countries – Egypt and Algeria. In terms of the size Libya is 18<sup>th</sup> in the world, and according to the population density the country is

237<sup>th</sup> [1,2]. The total length of the country's coastline is 1 770 km [3]. According to 2022 data, the country is home to 7 137 931 people [3].

According to [3] GDP purchasing power parity in Libya reached \$70.65 billion in 2020 (101<sup>st</sup> in the world), with a steady GDP decline observed over the past couple of years [3,4]. GDP purchasing power parity per capita is lower (140<sup>th</sup> in 2020), and decreased from \$15 000 in 2018 to \$10 300 in 2020 [3,5]. The inflation level increased from 25.9% in 2016 to 28.5% in 2017, in terms of this indicator Libya is 222<sup>nd</sup> in the world. In terms of reserves of foreign exchange and gold the country is 31<sup>st</sup> in

the world, behind Algeria, but ahead of Lebanon. According to the indicator for the average GDP growth in percentage over the last 10 years, in 2020 the country was 99<sup>th</sup> out of 206 countries. In terms of public debt, calculated as a percentage of the country's GDP, Libya was ranked 205<sup>th</sup> out of 210 countries considered in 2017.

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

## Energy resources

Libya has the largest oil reserves and third largest gas reserves among African countries (Table 1). In terms of tons of oil equivalent, in 2021 proved reserves of conventional hydrocarbons in Libya were: oil – 83%, gas – 17% (Fig.5). The unconventional natural resource matrix looks much different: shale oil (tight oil) – 52.6%, shale gas – 47.4% (Tabl.1).

According to the U.S. Central Intelligence agency and BP, the crude oil reserves in 2021 amounted to 48.36-48.4 billion bbl, and the gas reserves to 1.4-1.5 trillion m<sup>3</sup> [3,6]. In the ranking of countries based on the technically recoverable reserves of shale oil, Libya occupies the fifth place with 26.1 billion barrels, shale gas reserves amount to 121.6 trillion cubic feet [7].

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

Resource/explanations	Crude oil	Natural gas	Coal	Shale Gas*	Tight Oil*
<b>Value</b>	48.36	1.505	No data	121.6	26.1
<b>Unit</b>	billion bbl	Tcm	-	Tcf	billion bbl
<b>Year</b>	2021	2021	-	2013	2013
<b>Source</b>	[3]	[3]	-	[7]	[7]

\*unproved technically recoverable

Libya has a significant potential for the development of renewable energy (Table 2). The level of solar radiation is very high (5.7-6.3 kWh/ m<sup>2</sup>/ day) and scattered over most of the country. Along the

country's south-eastern borderline with Chad, between Kurfa and Muruq district this figure reaches 7.4-7.9 kWh/ m<sup>2</sup>/day [8].

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

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 - 6.3	6.0 - 7.0	No data	8.7	0.1	No data
<b>Unit</b>	kWh/m <sup>2</sup> /day	m/s	-	% of land area	% of land area	-
<b>Year</b>	2018	2018	-	2020	2020	-
<b>Source</b>	[8]	[13]	-	[10]	[10]	-

\*for most of the territory of the country

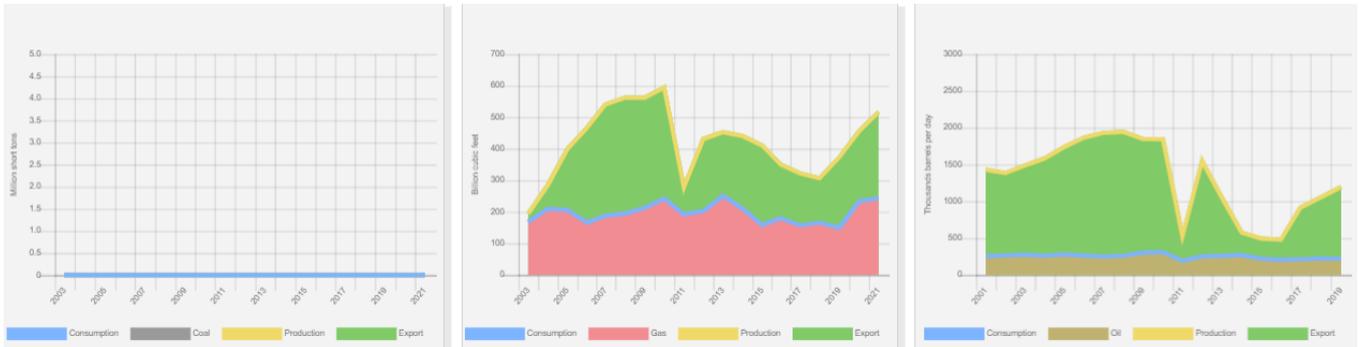
Wind speed in most parts of Libya is 6.0-7.0 m / sec, and in the south-western part of the country it can reach over 8.0 m / sec [9]. About 8.7% of Libya is covered by agricultural land, and 0.1% is covered by forest [10].

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

## Energy Balance

As previously mentioned Libya is the holder of the region's largest crude oil reserves [11]. Oil production has

fallen significantly over the past 15 years (Figure 2) with a sudden drop in 2011, and in 2012 it reached the level of 1547 000 barrels day, however it has decreased in 2021 to the level of 1252 thousand barrels day [12].

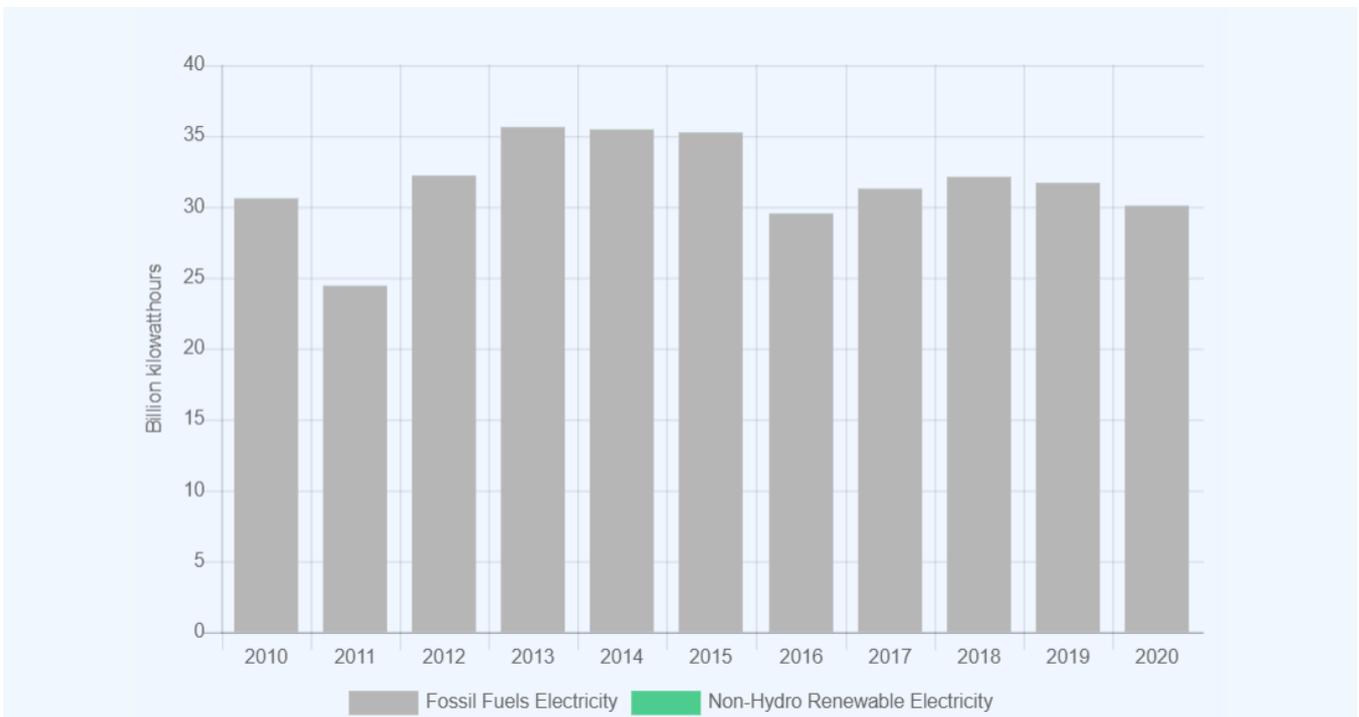


Source: U.S. Energy Information Administration (Oct 2022) / <https://www.eia.gov/>

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

According to BP crude oil production in 2021 was 1269 thousand barrels per day [16]. Natural gas production in the country has declined in 2011, in 2013 it was 452 Bcf and in 2021 it was 517 Bcf [12]. In 2021, Libya consumed

243 Bcf of natural gas, while exporting 274 Bcf of natural gas [12]. Historically, Libya purely relies on fossil fuels for the electricity production (Figure 3).



U.S. Energy Information Administration (Oct 2022) / <https://www.eia.gov/>

Figure 3. Electricity production in Libya

In 2020, Libya produced about 30.09 TWh of electricity, of which 99.9% by fossil fuels, and 0.1% by other renewable energy sources [14].

Libya's position in the comparative diagram of energy index is shown in Fig. 4..



Sources:

1. Crude oil proved reserves, 2021 / International Energy Statistic/Geography / U.S. Energy Information Administration (Nov 2021)\*98
  2. Natural gas proved reserves 2021 / International Energy Statistic / Geography / U.S. Energy Information Administration (Nov 2021) \*99
  3. Total recoverable coal reserves 2019 / International Energy Statistic / Geography / U.S. Energy Information Administration (Nov 2021) \*81
  4. Combination production-consumption for Crude oil 2018 / International Energy Statistic / Geography / U.S. Energy Information Administration (Nov 2021) \*219
  5. Combination production-consumption for Natural gas 2019 / International Energy Statistic / Geography / U.S. Energy Information Administration (Nov 2021) \*123
  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
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  10. The Global Energy Architecture Performance Index Report (EAPI) 2017 / Rankings / Reports / World Economic Forum
  11. Electric power consumption (kWh per capita), 2016 \*217
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  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 Libya

Libya's indices based on reserves of oil and gas and their production-consumption ratio, are higher than the world's average. However, other indices look less convincing.

In the Global Energy Architecture Performance Index 2017, which is based first on the level economic growth, environmental safety, and energy independence of the country, including access to energy, Libya lost 38 ranking positions over the previous year, and is 105<sup>th</sup> in the world.

The country is in the lower half of the ranked list of countries for such indicators as GDP per unit of energy use in 2020 –61<sup>st</sup> out of 66 countries considered, while energy consumption per capita is much higher – 38<sup>th</sup> out of 127 countries.

In terms of electricity consumption per capita, the country is 67<sup>th</sup> in the world, however, for the indicator of com-

bination of electricity production-consumption, Libya is 43<sup>rd</sup> in the ranked list of 216 countries.

More information on the energy balance of Libya can be found [here](#).

## Energy Infrastructure

Map of territorial distribution of the largest infrastructure projects of the fossil fuel sector in Libya is shown in Figure 5. As previously above, Libya has substantial con-

ventional fossil fuel reserves. The largest oil extraction field is an offshore Buori, the production of which is 60 000 barrels per day [13].

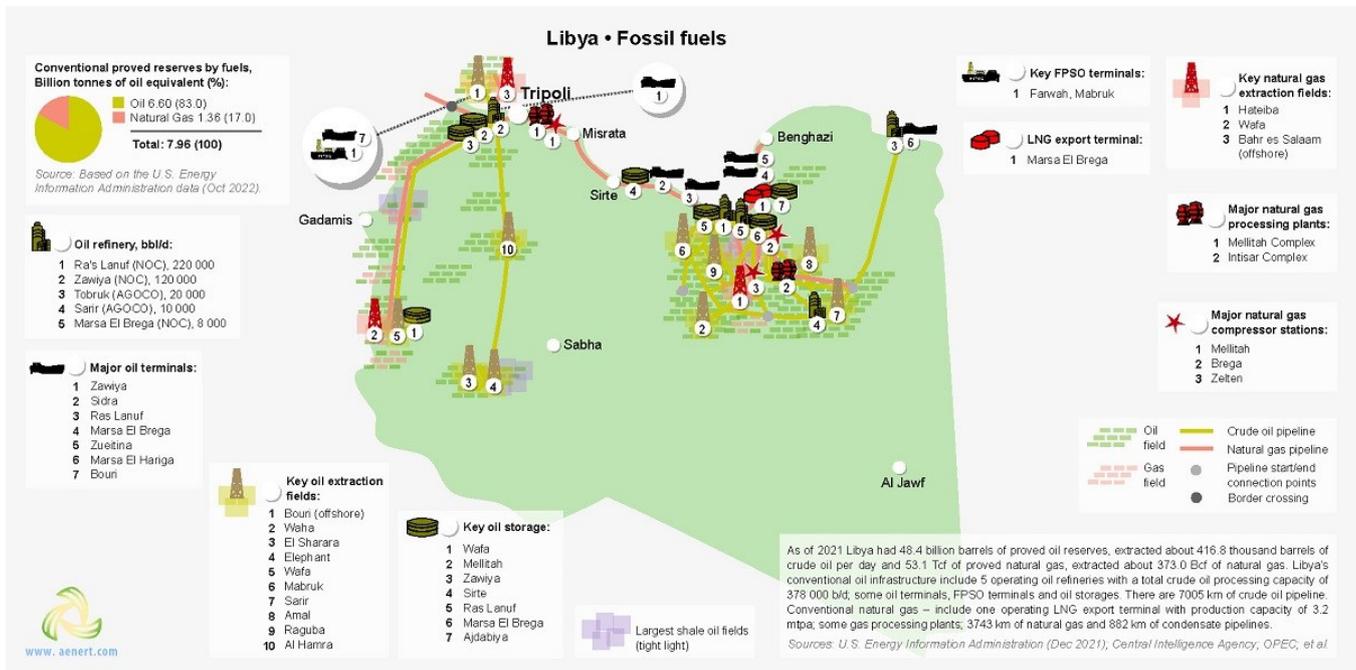


Figure 5. Basic infrastructural facilities of the fossil fuel sector in Libya

Libyan energy infrastructure is mainly concentrated in the vicinity of the field, or on the coast. Next to every major oil fields there is oil storage. For example, Wafa oil Storage, located near the Wafa field, with a reservoir of 220 thousand barrels [14]. In the north, there are seven major oil terminals. The largest of them, Zawiyah, 50 kilometres west of Tripoli, has the capacity of 480 vessels per year [15]. Oil and gas fields are connected to terminals via three oil pipelines and one gas pipeline. Export gas pipeline GreenStream, is 520 kilometres long, and supplies gas to Italy since 2003, it is the largest underwater gas pipeline of the Mediterranean Sea [16]. Refining needs are met at five refineries, the largest of which is Ras Lanuf Oil Refinery, with an installed capacity of 220 thousand barrels / day [17].

There are three large natural gas extraction field (Fig.5). The largest gas processing plant is Mellitah Complex with a capacity of 695MMSCFD of Gas sales, 31.000 bbls per day of liquids and 450 metric tons of solid sulphur [18]. Mellitah is also one of the largest gas compressor stations and is being operated by Green Stream and Sirte Oil Company [18]. There is one LNG export terminal—Marsa El Brega with a capacity of 3.2 million tons/annum [19].

Libya also uses the technology of Floating Production

Storage and Offloading Unit (FPSO) - Farwah, Mabruk, with a storage capacity of more than 900,000 barrels and production capacity of 40,000 barrels per day [20].

The map of the territorial distribution of the largest infrastructural objects of electricity production and renewable energy of Libya is shown in Fig. 6.

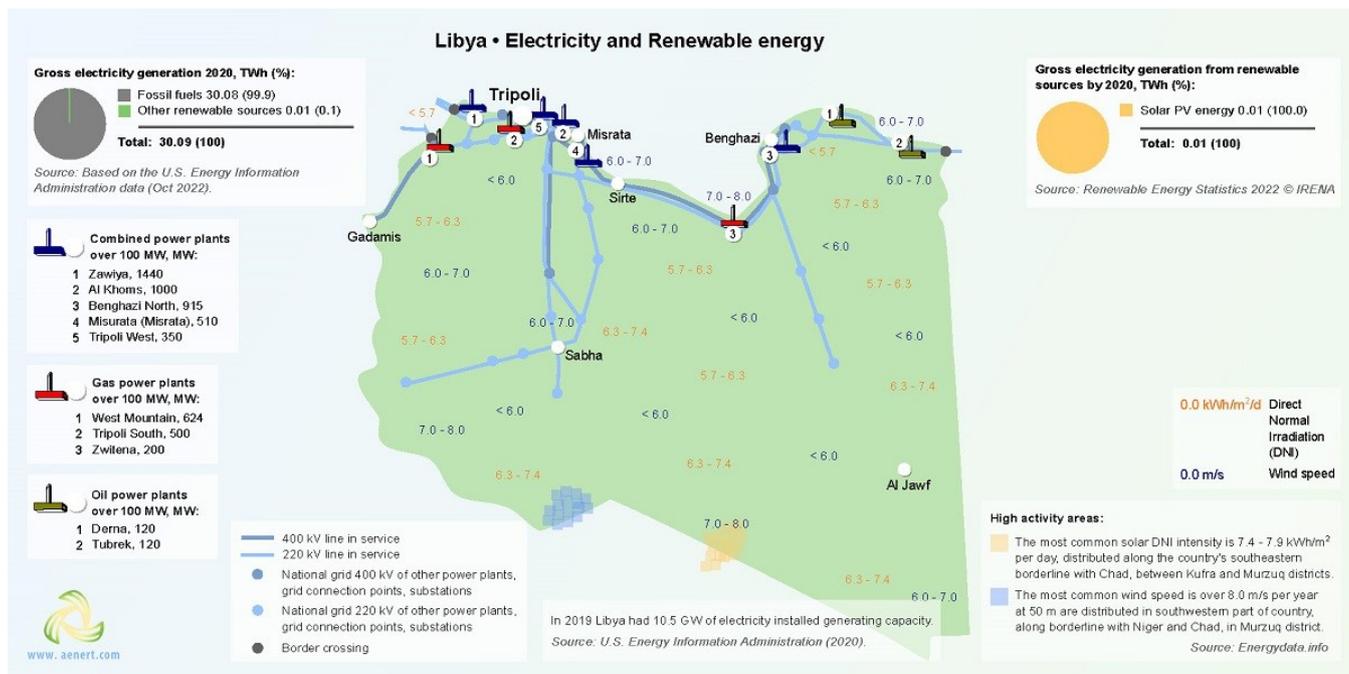


Figure 6. Energy infrastructure of Libya: Electricity and Renewable Energy

There are ten fossil fuel power plants with a capacity of more than 100 MW each in the country. The largest power plants are– Derna oil power plant with an installed capacity of 120 MW West Mountain gas power plant with an installed capacity of 624 MW, Zawiya combined

power plant with an installed capacity of 1440 MW [21,22,23].

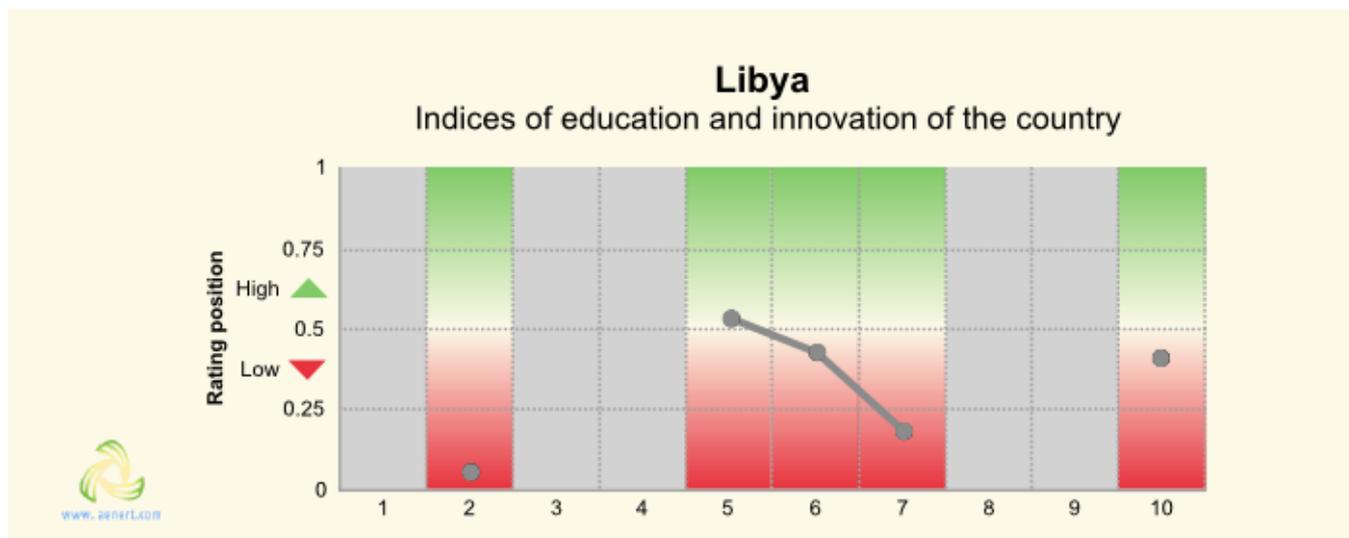
For more information about the energy infrastructure of Libya click [here](#).

## Education and Innovation

The set of indices reflecting the position of Libya among other countries in the field of education and innovation can be seen in Figure 7.

Figure 7 shows the indices that have an indirect effect on the energy sector, but in many respects predetermine its future.

According to the number of patents granted to the residents of Libya, both inside the country and abroad, the country ranks 167<sup>th</sup> in the world.



Sources:

1. The Global Innovation Index 2018, Rankings/Knowledge/[World Intellectual Property Organization](#)/Cornell University, INSEAD, and WIPO (2018): Energizing the World with Innovation. Ithaca, Fontainebleau, and Geneva \*126
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8. Government expenditure on education, total (% of GDP), 2016/United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics. License : CC BY-4.0/Data/[The World Bank](#) \*169
9. Research and development expenditure (% of GDP), 2015 / UNESCO Institute for Statistics. License : CC BY-4.0/Data/[The World Bank](#) \*120
10. Scientific and technical journal articles, 2016 / National Science Foundation, Science and Engineering Indicators. License : CC BY-4.0/Data/[The World Bank](#)\*196

\* Total number of countries participating in ranking

Figure 7. The indices of education and innovation in Libya

According to Scimago Journal and Country Rank the country is 114<sup>th</sup> in the world out of 239 countries considered, and 116<sup>th</sup> according to the Scientific and Technical journal articles in 2016 out of 196 countries.

Fugro Rovtech Limited and Misurata University are actively involved in the research in the field of unconventional oil.

JOWFE Oil Technology is among the leaders of scientific publications among Libyan companies in the field of synthetic fuels.

A large number of Libyan universities conduct research in the field of energy production from renewable sources. In the field of concentrated solar power— Zawia University, Sebha Univerisity and Sirte University. University of Ben-

ghazi, Al-Jabel Al-Garbi University and Center for Solar Energy research and Studies have the largest number of scientific publications in the field of wind energy.

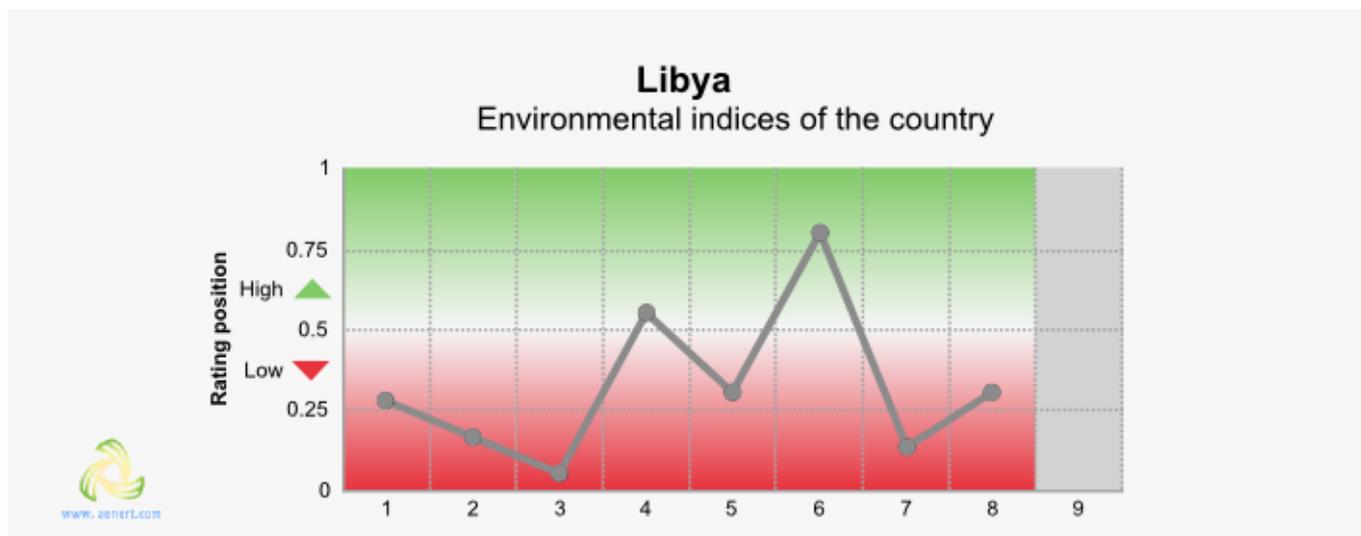
Additional information about education in the country can be obtained [here](#), and the list of research institutes in the country [here](#).

## Ecology and Environment Protection

A diagram of environmental indices is shown in Figure 8. To some extent the indices represented in the diagram reflect the ecological situation in Libya.

First of all, Libya demonstrates relatively high level of CO<sub>2</sub> emissions in general, and per capita, and the highest methane emissions.

There is also no positive trend in forest conservation. 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. Libya is 48<sup>th</sup>, and is characterized as " at risk".



Sources:

1. CO2 total emission by countries 2016/European Commission/Joint Research Centre (JRC)/Emission Database for Global Atmospheric Research (EDGAR) \*208
  2. CO2 per capita emission 2016/European Commission/Joint Research Centre (JRC)/Emission Database for Global Atmospheric Research (EDGAR) \*208
  3. Forest area 2015 (% of land area)/The Global Forest Resources Assessment 2015/Forestry Statistics/Food and Agriculture Organization of the United Nations \*234
  4. Forest area change 2010-2015 (ha/year)/The Global Forest Resources Assessment 2015/Forestry Statistics/Food and Agriculture Organization of the United Nations \*234
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- \* Total number of countries participating in ranking

Figure 8. Environmental indices of Libya

There is also no positive trends in forest conservation. In this respect Libya has a low ranking place in the Environmental Performance Index in 2018, where the country is 123<sup>rd</sup> out of 180 countries is quite significant, because this index focuses primarily on the assessment of the environmental performance of national govern-

ments as well as The Ecological Footprint Atlas, where Libya is among the leading ecological debtors.

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For more information on the energy complex of Libya see the attached link library by clicking [here](#).

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  - [9] Wind Map / Global Wind Atlas 2.0, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU) in partnership with the World Bank Group, utilizing data provided by Vortex, with funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: <https://globalwindatlas.info>
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*The sources of charts and curves are specified under the images.*