



Energy Industry in Indonesia



General State of the Economy

Indonesia, the official name – The Republic of Indonesia is a country located in Southeast Asia, with its capital in Jakarta. The country has land borders with East Timor, Malaysia and Papua New Guinea, and also has access to the Pacific and Indian Oceans.

According to 2022 statistics, Indonesia, which is the largest island nation in the world, is home to more than 277 million people. In terms of population density the country is 87th in the world from 247 countries consi-

dered [1,2,3]. The total length of the country's coastline is 54,716 km [3].

The political form of government is presidential republic, the official language is Indonesian. The administrative map of the country is divided into 31 provinces [3]. Indonesia has a developed and balanced economy, which is reflected in the diagram presented in Figure 1. For five out of ten indices presented, the positioning of the country is at the level of the world average or higher, in the top quarter of the graph (i.e. among the 25% best countries in the world included in the rating). However,



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 Indonesia

for such indicators as GDP per capita and inflation, the country is lower than the world average.

From the early 1990s, the country experienced sustained GDP growth in purchasing power parity, both in general and per capita [4,5]. GDP at purchasing power parity increased from \$2.937 trillion in 2015 to \$3.243 trillion in (8th in the world) in 2017 and to \$3.130 in 2020 [3]. The country's GDP at purchasing power parity per capita is substantially lower (132rd in 2020): from \$11,500 in 2015 to \$12,400 in 2017 and to \$11,400 in 2020 [3]. The level of inflation between 2016-2017 grew from 3.5% to 4% and fall to 2.8% in 2019; in terms of this indicator the country is 141th out of 227 countries, ranked from smaller to larger, which does not always correspond to the level of positivity or negativity [3].

According to The Global Competitiveness Report 2019, presented by the World Economic Forum, Indonesia was 50th out of an estimated total of 141 countries ahead of, for example, India. 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 exported high-tech products in 2019-2020, the country was 33rd, behind the leading Asian countries, but outstripping a number of highly developed EU countries and Australia. According to the Index of Economic Freedom 2022, which is based on freedom of business, freedom from government action, property protection, and freedom from corruption, the country was 63rd out of 177 countries considered. In terms of gold reserves and foreign exchange reserves, Indonesia was 20th in 2017, behind China, India, Japan, Taiwan and South Korea in the region.

According to the indicator for the average GDP growth in percentage over the last 10 years, in 2020 the country was 33rd out of 206 countries. In terms of public debt, calculated as a percentage of the country's GDP, in 2017 Indonesia was ranked 166th out of 210 countries considered.

For more information on the Indonesia economy see the attached link library by clicking [here](#).

Energy resources

Indonesia has significant fossil energy resources; the most important of which is definitely coal. According to data for 2021 in terms of tons of oil equivalent proved coal reserves were 93.8%, natural gas – 4.9%, oil – 1.3% (Fig. 5).

According to the Energy Information Administration [6], as of the end of 2021, the proven oil reserves were 2.5 billion barrels, and according to [3] in 2021 were estimated to be at 2.48 billion barrels, about the same value

is given in the BP report 2021 – 2.4 billion barrels in 2020 [7].

Reproduction of oil reserves is significantly behind production. Over the past 20 years, according to [7], the volume of proved reserves has decreased by almost 25%. In January 2021, proven oil reserves, according to the Handbook of Energy & Economic Statistics of Indonesia, amounted to 3.95 billion barrels [8]. According to the same source, the volume of potential oil reserves in Indonesia was 1.70 billion barrels in 2021.

Table 1. Fossil energy resources of Indonesia

Resource/explanations	Crude oil	Natural gas	Coal	Tight Oil*	Shale Gas*	Natural Bitumen	Coal mine methane
Value	2.48	1.408	34 869	7.9	46.4	422	264,5 - 674,8
Unit	billion bbl	Tcm	Million tonnes	billion barrels	Tcf	Million barrels	Bcm
Year	2021	2021	2020	2013	2013	2008	2018
Source	[3]	[3]	[7]	[9]	[9]	[10]	[11,7]

*unproved technically recoverable

Proven natural gas reserves in Indonesia in 2021 according to [3] were 1,408 Bcm. According to [6], the Oil and Gas Journal estimated the country's natural gas reserves at the end of 2015 at 103.4 Tcf. According to BP's report in 2020, natural gas reserves in Indonesia were 1.3 Tcm [7]. According to [8], the proven natural gas reserves in the country were 60.61 Tscf in 2021.

The main fossil resource of Indonesia is coal, and in 2019 they were estimated at 43.9 billion short tons [6], and according to [7] at the end of 2020 were 34,869 million tons. According to the Handbook of Energy & Economic Statistics of Indonesia, coal resources as of December 2021 were 91,606.04 million tons [8]. The country has large reserves of shale gas, which according to data for 2013 were 46.4 Tcf, and tight oil reserves were 7.9 billion

on barrels [9]. Natural Bitumen oil reserves in 2008 were estimated at 422 million barrels [10].

According to Advanced Energy Technologies calculations, the methane utilization potential, according to the methodology based on methane emissions from coal mining [11] and its reserves in 2018 from [7], was 264,5 – 674,8 Bcm. In [6] coalbed methane resources in Indonesia were estimated at 453 Tcf, while according to the Federal Institute for Geosciences and Natural Resources (BGR) [12] they amounted to 3,180 Bcm of coal methane in 2016.

Indonesia has a variety of renewable sources for energy production. A selection of basic indicators of this type of resource is presented in Table 2.

Table 2. Renewable energy resources of Indonesia

Resource/explanations	Solar Potential (GHI)*	Wind Potential (50 M)*	Hydro energy Potential**	Bio Potential Agricultural area	Bio Potential Forest Area	Geothermal Potential	Municipal Solid Waste
Value	<5.0	<4.0	2 150	31.2	51.7	29 000	0.68
Unit	kWh/m ² /day	m/s	TW/year	% of land area	% of land area	MWe	Kg/per capita /day
Year	2018	2018	2013	2018	2018	2014	2016
Source	[13]	[15]	[16]	[17]	[18]	[19]	[20]

*for the majority of the territory of the country

**gross theoretical capability

The level of global horizontal irradiation for the majority of the country does not exceed 5.0 kWh/m²/day, the maximum level of solar radiation of between 5.5-7.1 kWh/m²/day can be registered in the south-eastern part of the country, in the provinces of Bali and Nusa Tenggara [13]. According to experts from the International Energy Agency, the total potential of solar energy is 12,000 GW [14].

The distribution of wind resources is as follows: for the majority of the country the wind speed does not exceed 4.08 m/s, and in the south-eastern part of the country, in the provinces of Papua and South Sulawesi it can reach 6.0-7.0 m/s [15].

According to the International Energy Agency, hydropower potential of Indonesia is estimated at 75 GW, although the resources are located at a great distance from the potential consumers [14]. The theoretical hydro potential of the country according to [16], as of 2013, was estimated at 2,150 GWh/year.

About 31.2% of Indonesia is covered by agricultural land [17], and about 51.7% is forested. This indicator has decreased by 15% over the last 25 years [18]. Nevertheless, according to [14], the biomass potential is 32 GW. According to [19], the total potential of geothermal re-

sources of Indonesia is 29 000 MWe, and is the largest in the world ahead of that, for example, in India (10 000 GWe), and in other countries at a high level of seismic activity. At the same time, according to other sources [8], the proven potential of geothermal reserves in the country is only 3,105 MW, the possible –9,547 MW, the probable –1,770 MW. According to [14], Indonesia's share in the global biomass potential is 40% and is estimated at 28 GW. The level of generation of municipal waste in Indonesia – 0.68 kg per person per day, is significantly lower than, for example, in China (1.69 kg per person per day) and in New Zealand (1.99 kg per person per day); however, it exceeds Philippines's potential (0.39 kg per person per day). A small increase of up to 0.857 kg per person per day is predicted by 2025. This resource is a valuable raw material for recycling or energy production, given the size of the population of Indonesia; however, it requires serious legislative, financial and social measures for its development [20].

A detailed list of sites and special reports on Indonesia energy resources can be found [here](#).

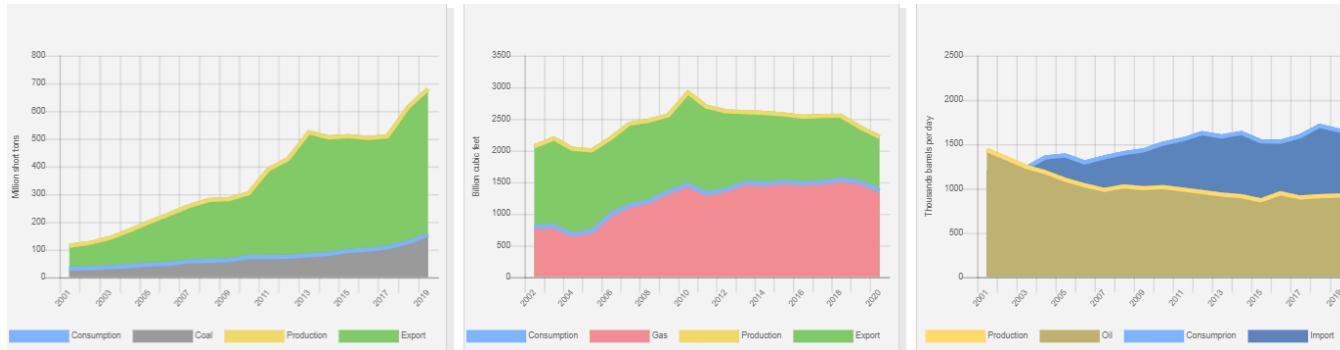
Energy Balance

According to the Statistical Review of World Energy 2022, primary energy consumption in Indonesia in 2021 amounted to 8.31 exajoules and was dominated by coal – 39.5%, followed by oil – 34%, natural gas – 16%, renewable energy – 7.6%, and hydroenergy – 2.7% [7].

According to [8], Primary Energy Supply by Sources in 2021 was the following: coal – 36.2%, oil and petroleum products – 32.1%, gas – 16.2%, hydroenergy – 2.3%, geothermal energy, biofuels, bioresources and other renewables – 12.6%.

Using data from [3,7] we calculated an estimated value of the energy intensity of GDP in Indonesia in 2020 – \$17.2, taking into account the PPP in 2011 prices per unit of energy expended (the equivalent of energy contained in one kg of oil), which is the fifth largest in the world indicator of the efficiency of GDP production in terms of energy consumption. For comparison in India – 11.1, Japan – 12.8, China – 6.6, South Korea – 7.8 \$/kgoe.

Oil production between 2001 and 2017 decreased by almost 30% and in 2017 reached the level of 910 thousand barrels/day and fall to 858 thousand barrels/day in 2021 [21].



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

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

BP reported similar figures in 2021 – 692 thousand barrels/day and 1,471 thousand barrels/day, respectively [7]. According to [8], oil production in 2021 was at the level of 240,367 thousand barrels. Oil imported into Indonesia in 2021 was 104,403 thousand barrels [8]. The main supplier of oil to Indonesia is Saudi Arabia. Due to the absence of import pipelines, the transportation of oil and oil products is carried out via sea vessels [6]. The main export destinations are Japan and Australia [6]. The volume of exports was 204,000 barrels/day in 2018 [3] and 43,769 thousand barrels in 2021 [8].

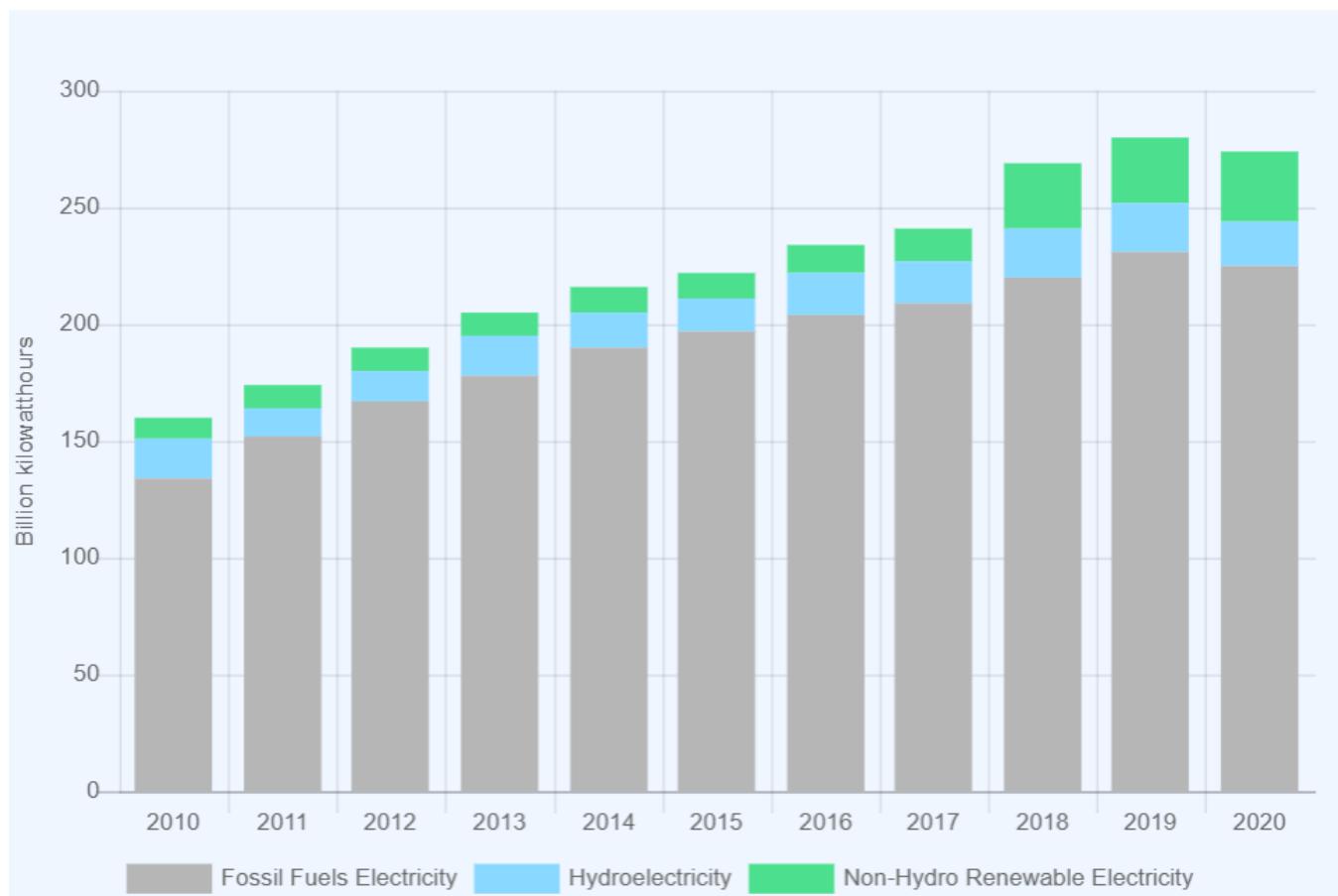
Natural gas production increased between 2005 and 2010, then slowed, and in 2020 it was 2211 Bcf. Gas consumption in Indonesia between 2005 and 2020 grew rapidly, reaching 1366 Bcf in 2020 comparing to 726 Bcf in 2001 [21]. According to the BP Statistical Review of World Energy 2021 [7] estimated production in 2020 to be at 63.2 billion cubic metres, and consumption at 41.5 billion cubic metres. According to [8], the country pro-

duced 386,561 MMSCF of associated gas and 2,047,116 MMSCF of natural gas in 2021.

Indonesia exports natural gas mainly in the form of LNG, but approximately 30% of total exports to Singapore and Malaysia are via pipelines – in 2020, exports amounted to 593 Bcf. In 2020, Indonesia was the seventh-largest exporter of LNG. Indonesia is the largest exporter of thermal (steam) coal in the world [6].

Coal production in the country grew rapidly between 2001 and 2013, then slowed, and in 2019 amounted to 679 mln short tons [21]. Coal consumption in the country gradually grew from 2001 to 2019 and amounted to 153 million short tons [21], and according to BP's report in 2020, coal production amounted to 13.88 exajoules, and consumption was at 3.26 exajoules [7]. In 2021, the production of thermal coal in the country was at the level of 613,990,256 tons, while 435,217,208 tons were exported. The main export destinations are India and China [8].

Historically, Indonesia has a high share of fossil fuels in electricity production (Fig. 3).



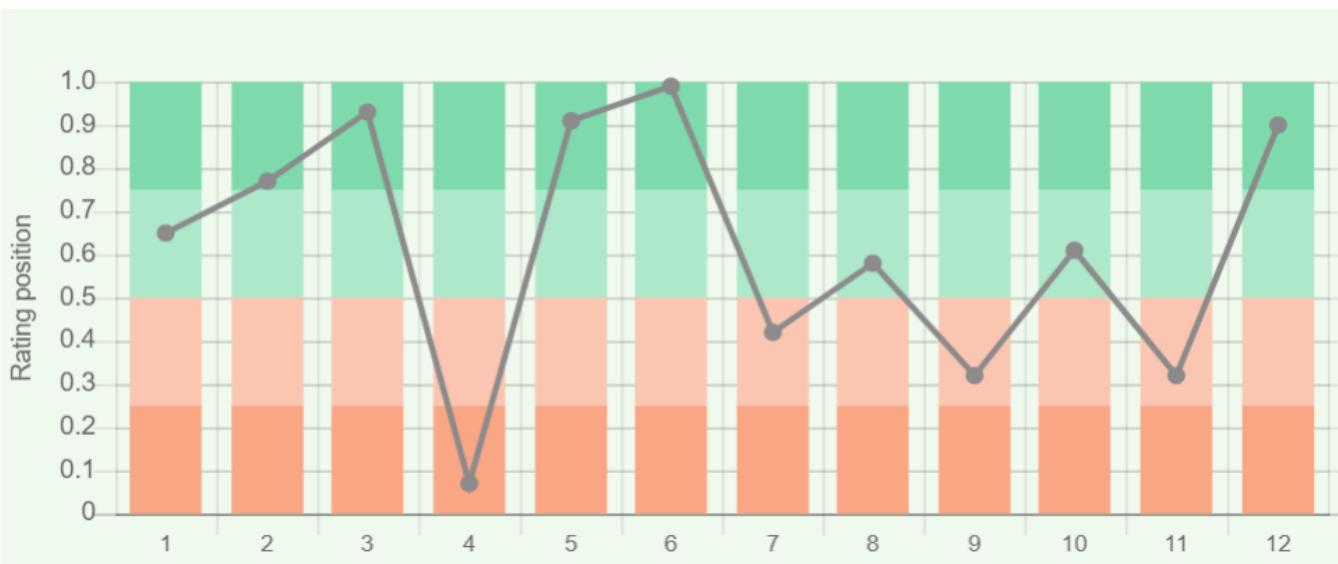
Sources:

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

Figure 3. Electricity generation in Indonesia

According to the U.S. Energy Information Administration in 2020 the country produced about 272.95 TWh of electricity, where the share of fossil fuels was 82.3%, hydroenergy – 6.8%, renewable resources – 10.9% (Fig.7). Indonesia's position in the comparative diagram of energy index is shown in Figure 4. Despite significant oil resources, the production and consumption ratio of oil is

below the world average, which indicates an increasing demand for oil, but in the case of other energy sources, indicators are extremely high. In terms of the share of electricity production from renewable energy sources (excluding hydropower), in 2017 Indonesia was 98th out of 170 countries selected for consideration.


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

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 Indonesia

Indonesia is ranked 50th, ahead of Australia in the EAPI of 2017 (Energy Architecture Performance Index), which is based first on the level economic growth, environmental safety, and energy independence of the country, including access to energy. Over the last 8 years the country has gained 11 positions in the rating.

In terms of GDP per unit of energy use, Indonesia is ahead of the world average – 7th out of 66 countries considered, but this indicator per capita is somewhat lower – 60th place in the world.

Energy Infrastructure

A territorial map of the distribution of the largest infrastructure projects of the fossil-fuel sector in Indonesia is shown in Figure 5.

As previously mentioned, the proven reserves of coal account for 93.8%, natural gas reserves account for 4.9%, crude oil reserves – 1.3% (Fig.5).

In terms of electricity consumption per capita, the country is 147th in the world, however, for the indicator of combination of electricity production-consumption, Indonesia is 21st in the ranked list of 216 countries, behind of a number of EU countries.

For more information on the energy balance of Indonesia see the documents in our link library [here](#).

The main oil fields of Indonesia are predominantly on-shore fields; gas fields are offshore. According to Chevron, oil production from the Minas field is at the level of 420,000 bpd [22].

In 2021, Indonesian refineries had a total installed capacity of 1.1 million barrels/day (Fig. 5). The largest refinery in the country is Cilacap owned by Pertamina, with an installed capacity of 348,000 bpd [23].

The main oil terminal of Indonesia is Jakarta (Tanjung Priok) (251,025 cbm) [24]. As of 2021, crude oil is transported via oil pipelines with a total length of 7767 km. Refined products are transported via pipelines with a total length of 728 km, and the liquid petroleum gas pipeline is 119 km (Fig. 5).

The main gas field of the country is the Tangguh; in 2011 production from this field was at the level of 1.3 Bscfd [25].

Gas imports are carried out via 4 LNG terminals, the largest of which is Pertamina/Aceh with a total capacity of 400 Mmscf/d [26]. The largest LNG export terminal is

Bontang with a total capacity of 21.6 mtpa [27]. Gas is transported throughout the country via a network of pipelines with a total length of 11 702 km, and 1 064 km of condensate pipeline and 150 km of condensate gas pipeline (Fig. 5). Extraction of oil and gas on the shelf is also carried out, including by FPSO, the largest of which is Belanak of Conoco Phillips. The installed capacity of FPSO Belanak 1 for oil production is 100,000 barrels of liquids per day (bpld); gas production is at 350 million standard cubic feet [28].

The infrastructure of natural gas processing is represented by five plants (Fig. 5).



Figure 5. Basic infrastructure facilities of conventional oil and gas sector in Indonesia

A map of territorial distribution of the largest infrastructure projects of unconventional fossil resources of Indonesia is presented in Figure 6.

The largest coal reserves are located in South Sumatra, South Kalimantan and East Kalimantan [29]. The leading coal mining company of the country with production volume of 57.65 million tons in 2016 is PT Kaltim Prima Coal (KPC) [30]. The export of coal is carried through 8 terminals, the largest is Tanah Merah, with stockyard capacity of 700,000 tons per year [31].

In the total potential of natural resources, shale gas accounts for 51.4%, tight oil for 45.2%, oil sands and extra heavy oil for 2.6%, and the methane utilization potential for 0.8% (Fig. 6).

The largest heavy oil field is Duri, developed by Chevron; oil extraction from that field was carried out at the level of 240-250 thousand bpd [32]. Three coalbed methane fields have also been found in the country (Fig. 6). In 2011, BP and ENI were the first in the world to export coalbed methane through the Bontang LNG Plant, from the Sanga-Sanga field in East Kalimantan, converting it to LNG [33].

Talang Akar (4.1 billion bbl of technically recoverable shale oil) has the largest reserves of unconventional oil, and the largest shale gas field is Bintuni basin (29 Tcf of technically recoverable shale gas) [34].

Gas hydrate occurrences were found in the Makassar Strait between the islands Borneo and Sulawesi [35].



Figure 6. Basic infrastructure facilities of coal and unconventional oil and gas sector in Indonesia

The map of the territorial distribution of Indonesia's largest infrastructure facilities for electricity generation is presented in Figure 7.

According to the Central Electricity Authority, the share of fossil fuels in energy production in Indonesia in 2020 was 82.3% (Fig.7).

The country has a significant number of stations that produce electricity from hydrocarbons, including two oil stations with a capacity of more than 100 MW, four gas-

fired power plants with a capacity of more than 200 MW, nine coal-fired power plants with a capacity of more than 700 MW, five combined-type plants of 100 MW (Fig.7). The largest gas power plant is Muara Tawar, with total capacity of 2,144 MW [36], oil power plant – Pesanggaran with installed capacity of 152 MW [37], combined power plant – Gresik with installed capacity of 2,218.9 MW [38], coal power plant - Paiton, with installed capacity of 4,710 MW [39].

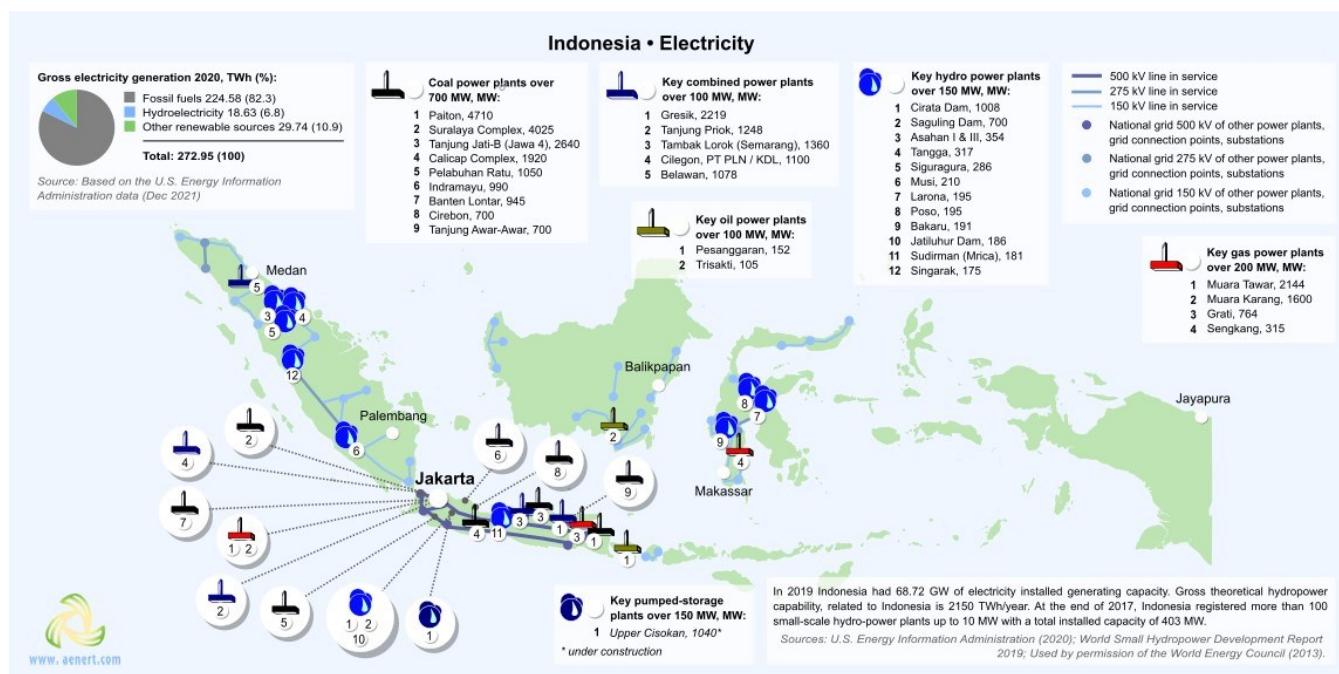


Figure 7. Electricity production in Indonesia

Hydropower in Indonesia does not play a decisive role (6.8% of the total generation) in electricity generation, and is represented by several hydro power plants, which in 2020 produced 18.6 TWh (Fig.7). The country's largest hydroelectric power station is Cirata Dam with installed capacity of 1008 MW [40], Upper Cisokan pumped storage power station with installed capacity of 1,040

MW is under construction [41]. In addition there were about 100 small hydroelectric power stations with a total capacity of 403 MW registered in Indonesia in 2017 (Fig. 7).

In Figure 8, you can see the main facilities of the Indonesian infrastructure for the production of energy from renewable sources.

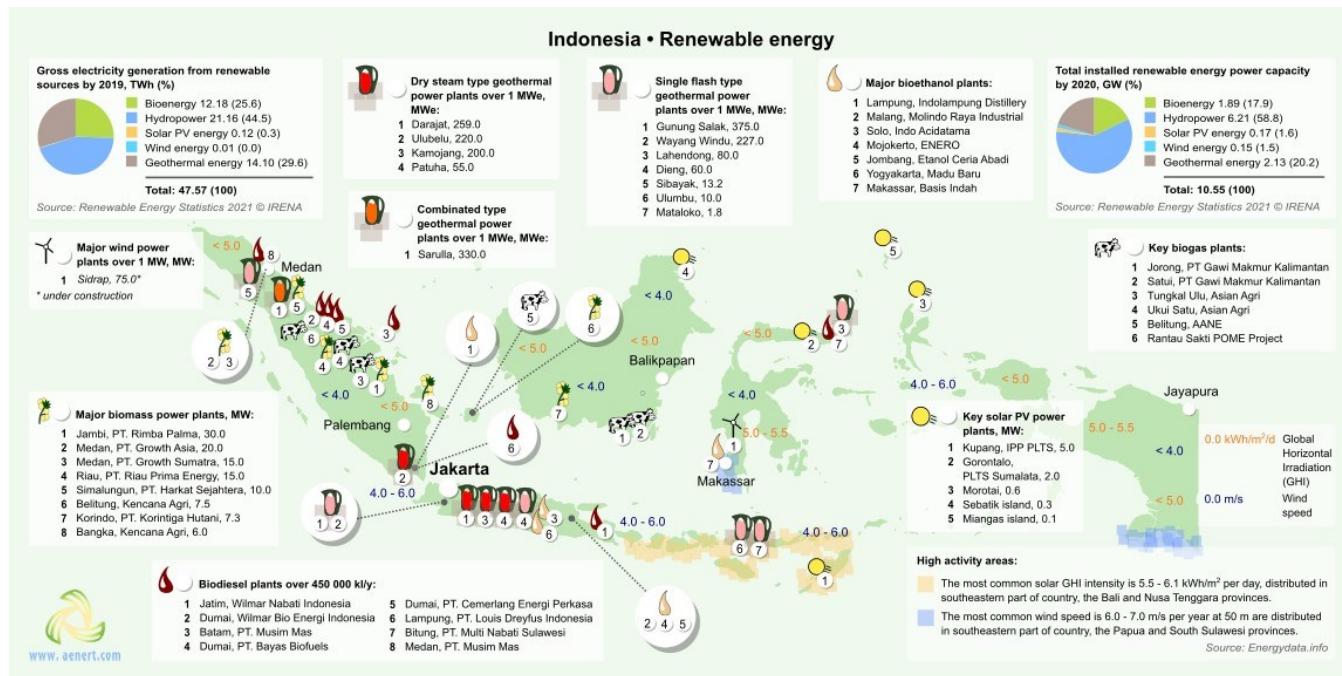


Figure 8. Renewable energy in Indonesia

Renewable energy in Indonesia does not have a decisive influence on electricity generation. Thus, the total production of electricity from renewable sources in 2017, excluding hydropower, was 29.74 TWh (Fig. 8). As previously mentioned, the level of global horizontal radiation in some areas of the country can reach 6.1kWh/m²/day, which is a vast resource for energy production. As a result, there are a number of solar energy facilities installed in the area, including five photovoltaic stations. The largest photovoltaic station is the Kupang IPP PLTS, with installed capacity of 5 MW [42]. It is planned to build a number of wind parks in the areas of relatively high wind activity; one of the main projects is at Sidrap, which will have an installed capacity of 75 MW [43]. Bioenergy is actively developing in Indonesia and according to IRENA the installed capacity of enterprises operating in this energy sector was about 1.89 GW (Fig. 8). The country has biomass and municipal waste processing plants, biogas, biodiesel, bioethanol, pellet, as well as waste gasification and biomass plants. The largest biogas plant is Jorong with installed capacity of 2.4 MW [44]. Indonesia is also one of the world's largest pro-

ducers of palm oil, which is often used to produce bioenergy products.

Indolampung Distillery can produce 60,000 litres of bioethanol annually at the country's largest enterprise – Lampung [45].

In the east of the island of Java, Wilmar Nabati Indonesia produces biodiesel at the largest plant – Jatim with an installed capacity of 1,665,517 kl/year [46]. There are also several biomass processing plants operating in the country, Jambi, PT. Rimba Palma Biomass power plant is the largest and has an installed capacity of 30 MW [47]. As previously mentioned, the country possesses a very large potential for geothermal energy; as a consequence the country has various types of enterprises represented using the energy of the earth to produce electricity. The largest single flash type geothermal plant is Gunung Salak, with installed capacity of 375 MW, the largest dry steam type geothermal power plant – Darajat has an installed capacity of 259 MW, and the leading combined type geothermal power plant Sarulla, has a capacity of 330 MW [48, 49, 50].

According to the IRENA report, despite a large share of fossil resources in the country's energy consumption, Indonesia plans to increase the share of renewable resources to 23% by 2025, and to 31% by 2050 [51]. According to specialists' forecasts, in 2030 the energy balance will be as follows: the share of coal will be 33%, oil – 20%, natural gas – 19%, and renewable sources will account for 27% [51]. Special attention will be paid to solar energy, the installed capacity of which, according to forecasts, will be 9 GW in 2030 [51]. The annual volume of investments will increase to an average of \$9.4 billion, between 2015-2030 [51].

One of the most important areas of development is bio-energy, and in April 2017 a waste-to-bioethanol project was launched in Jakarta, which cost \$10 billion. Upon completion of the construction work, Jabab ECO will pro-

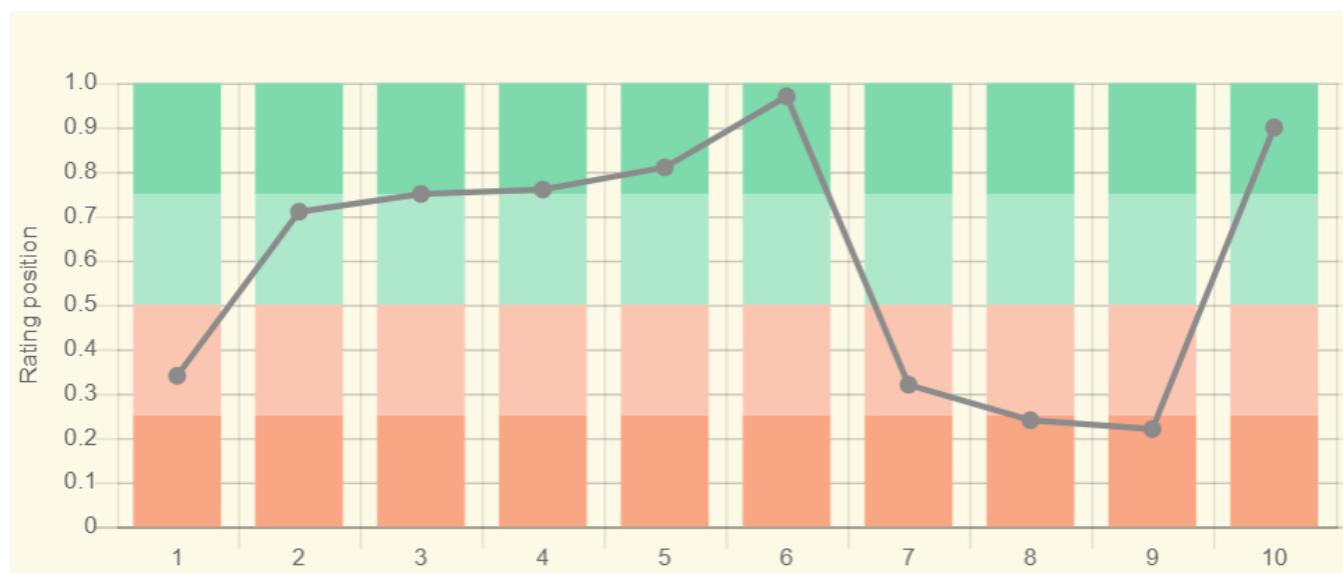
duce 2.3 million litres annually [52]. In the field of geothermal energy it is worth mentioning the construction of the first low temperature geothermal plant Lahendong, which will have a capacity of 500 kW and provide electricity to 1,200 households [53]. In 2017 Indonesia allocated \$224 million for a Geothermal Drilling Fund [54]. An even larger investment was made in the development of ocean energy; independent company SBS Energi Kelautan (SBSEK) will receive about \$750 million to build three Nautilus marine energy projects in Lombok, the station will have a capacity of 150 MW [55].

For current information on the development of energy in the country see [here](#). More information about Indonesia energy infrastructure is also available [here](#).

Education and Innovation

The set of indices reflecting the position of Indonesia among other countries in the field of education and innovation can be seen in Figure 9. According to the Global Innovation Index, Indonesia is ranked 87th out of 132 countries in 2018 (see diagram for links).

According to the number of patents granted to Indonesian residents, both inside the country and abroad, the country ranked 53rd in the world. However, by the number of patents in force, the country was 27th in the world, which largely characterizes the country's patent attractiveness.



Sources:

11. The Global Innovation Index 2021, Rankings / Knowledge / World Intellectual Property Organization / Cornell University, INSEAD, and WIPO (2021): Energizing the World with Innovation. Ithaca, Fontainebleau, and Geneva *132

2. Patent Grants 2011-2020, resident & abroad / Statistical country profiles / World Intellectual Property Organization *185

3. Patents in Force 2020 / Statistical country profiles / World Intellectual Property Organization *109

4. QS World University Rankings 2022 *97

5. SCImago Country Rankings (1996-2020) / Country rankings / SCImago, (n.d.). SIR-SCImago Journal & Country Rank [Portal]. Retrieved 17 Nov 2021 *240

6. Internet users in 2018 / The World Factbook / Central Intelligence Agency *229

7. Internet users in 2018 (% Population) / The World Factbook / Central Intelligence Agency *229

8. Government expenditure on education, total (% of GDP), 2019 / United Nations Educational, Scientific, and Cultural Organization (UNESCO) Institute for Statistics. License: CC BY-4.0 / Data as of September 2021 *177

9. Research and development expenditure (% of GDP), 2018 / UNESCO Institute for Statistics. License: CC BY-4.0 / Data *119

10. Scientific and technical journal articles, 2018 / National Science Foundation, Science and Engineering Indicators. License: CC BY-4.0 / Data *197

* Total number of countries participating in ranking

Figure 9. The indices of education and innovation in Indonesia

In terms of government expenditure on education as a percentage of the country's GDP, the country demonstrates a result below the world average out of 177 countries selected for consideration. Nevertheless, 16 Indonesian universities are included in the QS University Rating. It should also be noted that the country's GDP is high, therefore, in absolute terms the costs of education and research are, significant. In terms of the amount of government expenditure on research and development as a percentage of GDP, the country is 93rd. Indonesia is 45th out of 240 participating countries in the Scimago ranking, and in Scientific and Technical Journal Activities it is ranked 19th out of 197 countries.

Indonesian universities, such as University Gadjah Mada, Bogor Agricultural University, Mulawarman University, and the University of Pembangunan National Veteran train specialists in various fields of energy, including Geological Engineering, Petroleum Engineering, Mining Engineering, Environmental Engineering, and Geophysical Engineering, etc.

In the field of synthetic fuel the Bandung Institute of Technology, University Gadjah Mada, and the University of Indonesia are conducting scientific research. The Bandung Institute of Technology conduct research in

the field of extraction and processing of unconventional oil. The leading research organizations in the field of coal mine methane are Pertamina, VICO Indonesia, and Malikussaleh University.

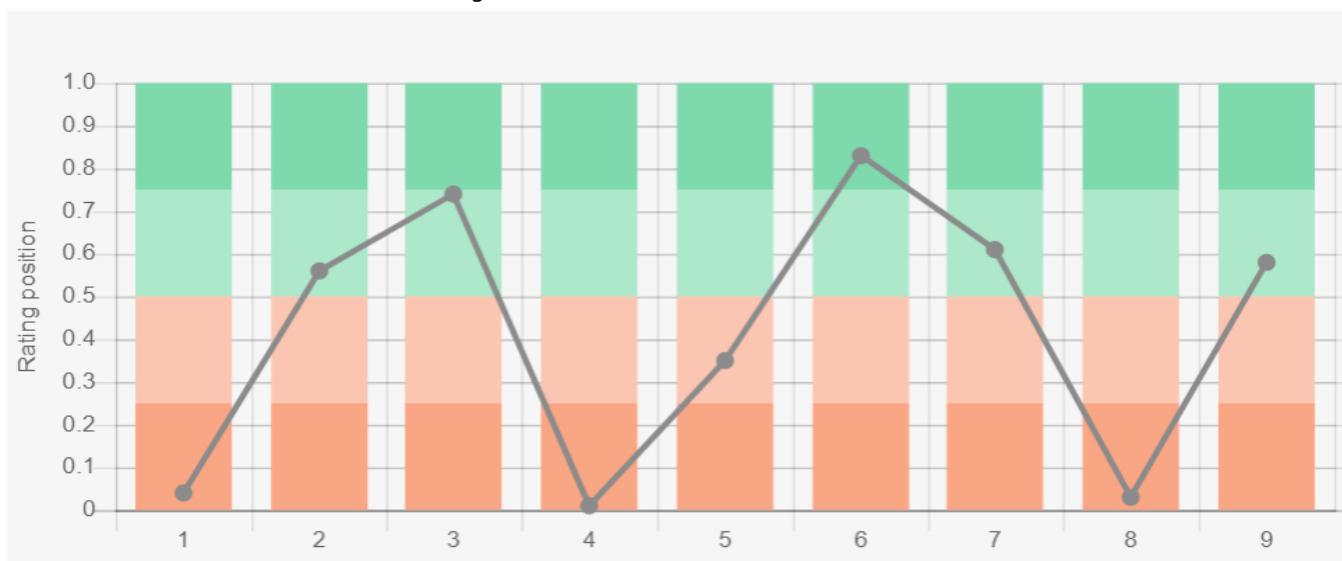
The leaders among Indian researchers in such an important area as gas hydrates are companies and organizations - University Gadjah Mada, Chevron Indonesia Company; and in the field of hydrocarbon production from reservoirs with low permeability – Pertamina and the Chevron of Indonesia Company.

Research and development in the field of bioenergy is carried out by the University of Jember and the Bandung Institute of Technology.

A large number of Indian research institutes conduct research in the field of energy production from renewable sources. In the field of solar energy – the Indonesian Institute of Science, Institut Teknologi Sepuluh Nopember. Institut Teknologi Sepuluh Nopember and University Gadjah Mada are ahead in the number of publications in the field of wind power.

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

the country. The indices shown in the diagram provide an opportunity to evaluate to a certain degree the ecological situation of a country.



Sources:

1. CO2 total emission by countries 2020 / European Commission / Joint Research Centre (JRC) / Emission Database for Global Atmospheric Research (EDGAR)*208
 2. CO2 per capita emission 2020/European Commission/Joint Research Centre (JRC) / Emission Database for Global Atmospheric Research (EDGAR) *208
 3. Forest area 2020 (% of land area) / The Global Forest Resources Assessment 2020 / Food and Agriculture Organization of the United Nations *234
 4. Forest area change 2010-2020 (1000 ha/year) / The Global Forest Resources Assessment 2020 / Food and Agriculture Organization of the United Nations *234
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- * Total number of countries participating in ranking

Figure 10. Indonesia's environmental indices

In terms of forest area as a percentage of the country, Indonesia is 61st in the world and also demonstrates a negative trend in the forest area change – 232nd place out of 234 countries.

The situation is worsened by a relatively low valuation of Indonesia in the Environmental Performance Index rankings (EPI), which focuses primarily on assessing the environmental performance of national governments. Here, the country is 116th out of 180 countries surveyed in 2020.

Moreover, according to the Environmental Vulnerability Index, which is based on years of observations and 50

indicators that include, for example, changing climatic characteristics or the quality of water resources, waste volumes, oil spills and other hazardous substances, etc. Indonesia is 141st out of 234 countries and is characterized as "highly vulnerable". The overall negative picture is aggravated by the Ecological Footprint Atlas rating, according to which Indonesia is among a number of ecological debtors.

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

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