

Energy Industry in the Czech Republic



General State of the Economy

The Czech Republic is a state in Central Europe. Its capital city is Prague [1]. The country borders Austria (to the south), Germany (to the west), Slovakia (to the east) and Poland (to the north). The Czech Republic, which in terms of size is placed 116th in the world, is home to more than

10.7 million people as of 2022. In terms of population density the country places 90th in the world, from 248 countries considered [2,3].

The Czech Republic is a parliamentary republic, and the official language is Czech. The administrative map of the country is divided into 13 regions [3].



Sources:

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 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 the Czech Republic

The country's economy is based on the export of goods; the main industry is automotive, which constitutes around 80% of GDP. The Czech Republic demonstrates one of the lowest unemployment rates in the EU and has a developed market economy, which is reflected in Figure 1 [3]. For the majority of indices, the country places higher than the world average (ie. in the top half of the graph), and for 6 indices in the top quarter of the graph, among the 25% highest ranked countries in the world included in the rating.

Since the 1990s, despite having undergone a slight decline in 2008, the Czech Republic has experienced sustained GDP growth in purchasing power parity, both in general and per capita [4,5]. GDP at purchasing power parity increased from \$351.9 billion in 2015 to \$409.9 billion (47th in the world) in 2020 [3]. The country's GDP at purchasing power parity per capita was 46th in the world in 2020, also been demonstrating positive dynamics: from \$35,500 in 2017 to \$38,300 in 2020 [3]. The level of inflation changed from 2.4% in 2017 to 2.8% in 2019; in terms of this indicator the country was 139th in the world (ranked by levels of inflation, low to high) [3]. According to The Global Competitiveness Report 2019 presented by the World Economic Forum, the Czech Republic was 32nd (out of a total of 141 countries), ahead of a number of EU countries, including Portugal, Hungary and Poland. This rating reflects the effectiveness of the use of the country's 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 134 countries that exported high-tech products in 2019-2020, the Czech Republic was 16th, slightly behind the UK. According to the Index of Economic Freedom 2021, which is based on freedom of business, freedom from government intervention, property protection, and freedom from corruption, the country was considered "mostly free", and placed 27th, out of 178 countries. In terms of gold reserves and foreign exchange reserves the Czech Republic was 15th in the world.

According to the indicator for the average GDP growth in percentage over the last 10 years, the country was below the world average – 133rd out of 206 countries as of 2020. In terms of public debt, calculated as a percentage of the country's GDP, in 2017 the Czech Republic was ranked 153rd out of 210 countries considered, slightly behind Denmark and Norway. Despite the country's high level of GDP per capita, the latter two indices partially reflect a number of negative trends in the Czech economy, related to a rapidly ageing population, and lack of skilled personnel.

Detailed information about the economic development of the Czech Republic is available [here](#).

Energy resources

The Czech Republic has no significant reserves of fossil resources (Table. 1). According to proven reserves of oil and natural gas, the country is ranked 85th and 93th in the world, respectively [3]. According to data for 2021,

in terms of tons of oil equivalent, proved coal reserves amounted to 99.8%, natural gas – 0.1%, oil – 0.1% (Figure 5). The most valuable resource of the country is coal; according to BP its reserves at the end of 2020 amounted to 3 595 million tons. For comparison Poland has 28 395 million tons of proven coal reserves.

Table 1. Fossil energy resources of the Czech Republic

Resource/explanations	Crude oil	Natural gas	Coal	Shale Gas	Tight Oil	Coalmine methane
Value	15	3.964	3 595	-	-	1.8-7.8
Unit	million bbl	bcm	million tonnes	-	-	bcm
Year	2021	2021	2020	-	-	2018
Source	[3]	[3]	[6]	-	-	[6,7]

According to [3], at the beginning of 2021, oil reserves in the Czech Republic were estimated at 15 million barrels, with natural gas reserves at 3.964 bcm. According to Advanced Energy Technologies calculations, the potential for coal mine methane utilization - according to a

methodology based on methane emissions [7] and coal reserves [6] - amounted to around 1.8 - 7.8 bcm. The Czech Republic, due to its geographical location, has a variety of reserves of renewable energy sources.

A selection of basic indicators of this type of resource is presented in Table 2.

Technically exploitable hydropower capability in the Czech Republic amounted to 3 978 GWh/year. For comparison, this is around 7 times less than the economically affordable hydro potential of Austria [8]. The level of global horizontal radiation for the majority of the country is between 3.0-3.1 kWh/m²/day, and in Southern and

Northern Moravia this can exceed the level of 3.1 kWh/m²/day [9], which is comparable to Denmark, Southern Sweden, and Belgium.

Table 2. Renewable energy resources of the Czech Republic

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	3.0-3.1	5.5 – 6.5	3 978	45.6	34.67	No data	543
Unit	kWh/m ² /day	m/s	GWh/year	% of land area	% of land area	-	kg per capita
Year	2021	2021	2013	2020	2020	-	2020
Source	[9]	[10]	[10]	[11]	[12]	-	[15]

*for most of the territory of the country

** technically exploitable potential

The distribution of wind resources is as follows: for the majority of the country the wind speed does not exceed 5.5-6.5 m/s, although in the east of the country and in Northern Moravia, this figure may exceed 7.0 m/s at a height of 50 meters [10]. These figures indicate the potential for the development of wind energy in the power industry of the Czech Republic, which would allow it to compete with other traditional local renewable technologies, principally bio energy.

According to data for 2020, 45.6% of the territory of the country is occupied by agricultural land, the area of which has been decreasing over the last fifty years [11]; 34.7% of the territory of the country was forested,

which, like the previous indicator, is showing a slight increase [12]. According to Eurostat, in terms of municipal waste generation, the Czech Republic produced 543 kg per capita in 2020, placing it ahead of, for example, Poland at 346 kg per capita, but behind Slovenia at 487 kg per capita [15]. This resource is a valuable raw material for recycling or energy production, the technologies of which have reached a high level of development in the Czech Republic.

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

Energy Balance

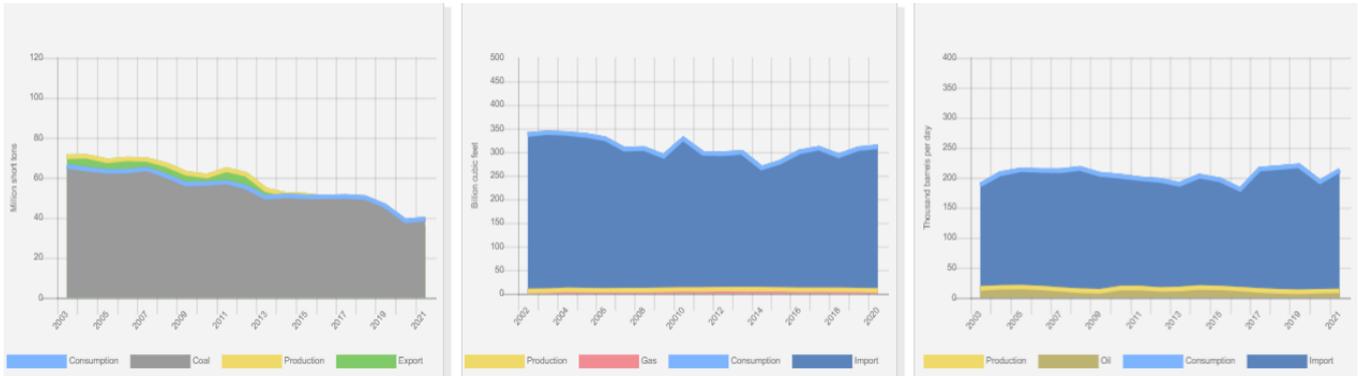
According to the BP Statistical Review of World Energy 2022, total primary energy consumption in the Czech Republic in 2021 was 1.68 exajoules, around 32.1% of which was coal, 24.4% – oil, 19.6% – natural gas, 16.7% – nuclear energy, 5.9% – other renewables, and 1.2% – hydro energy [6]. Using the data from [3,6] we calculated GDP per unit of primary energy use in the Czech Republic in 2017 was \$11.1, taking into account PPP in 2011 prices per unit of energy expended (the equivalent of energy contained in one kg of oil equivalent/\$ PPP per kg of

oil equivalent), which corresponds to the world average level of GDP energy efficiency.

Oil production between 2003 and 2021 remained practically unchanged (Figure 2), and in 2021 amounted to 11 thousand barrels/day [14]. At the same time consumption grew, having undergone a slight decline between 2008 and 2013, before rising again, and by 2019 amounted to 219 thousand barrels/day, and falling again to 212 thousand barrels/day in 2021 [14]. According to the BP survey, the level of oil consumption in the Czech Republic in 2021 was 200 thousand barrels/day [6]. In 2018, the main contribution to Total Primary Energy

Production (TPES) the Czech Republic – almost 36% – was provided by domestic coal production, while the total final oil consumption in the country amounted to almost 7 740 ktoe [15]. In 2018, oil imports to the Czech Republic were estimated at 150,200 barrels/day [3]. The

production of natural gas in the country between 2001 and 2020 did not exceed the level of 9.3 Bcf, and in 2020 it was 6.7 Bcf [14]. According to the BP Statistical Review of World Energy 2022, [6] gas consumption in the country in 2021 was 9.1 billion m³.

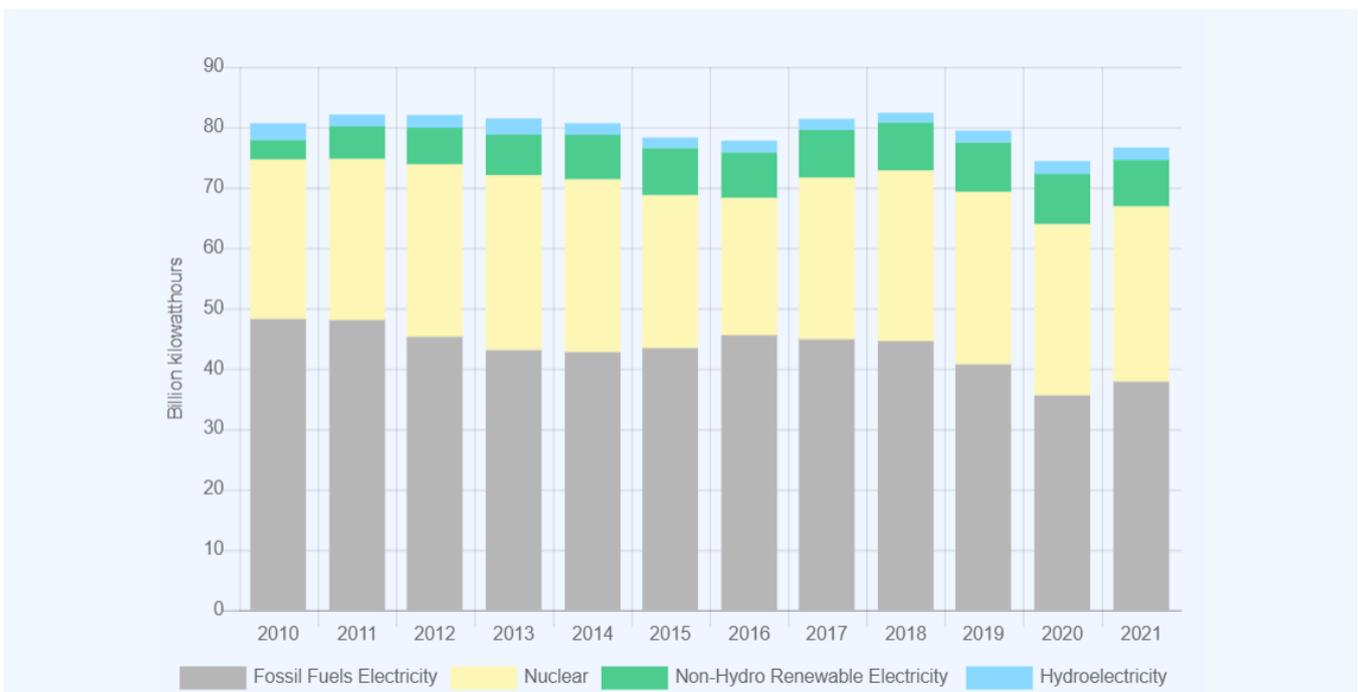


Source: U.S. Energy Information Administration (Oct 2022) / <https://www.eia.gov/>

Figure 2. The production and consumption of fossil fuels in the Czech Republic

According to the International Energy Agency, the total final natural gas consumption in the country amounted to 6 819 ktoe in 2018 [15]. In 2020 the Czech Republic imported about 7.590 Bcm of natural gas [3]. Coal production and consumption in the country has been gradually decreasing since 2003, and in 2021 amounted to 39,38 million short tons [14]. According to BP, in 2021, coal consumption amounted to 0.54 exajoules, and production totalled 0.43 exajoules [6]. The Czech Republic

uses fossil fuels and nuclear power for the production of electricity; however, it is worth noting a general decrease of fossil fuel use in the level of electricity consumption in the country in the last 5-7 years (Fig. 3). In 2021 the country produced 65.64 TWh of electricity, where fossil fuels constituted 49.3%, nuclear power – 37.9%, hydro energy – 2.7% and other renewable energy – 10.1% (Fig.6).

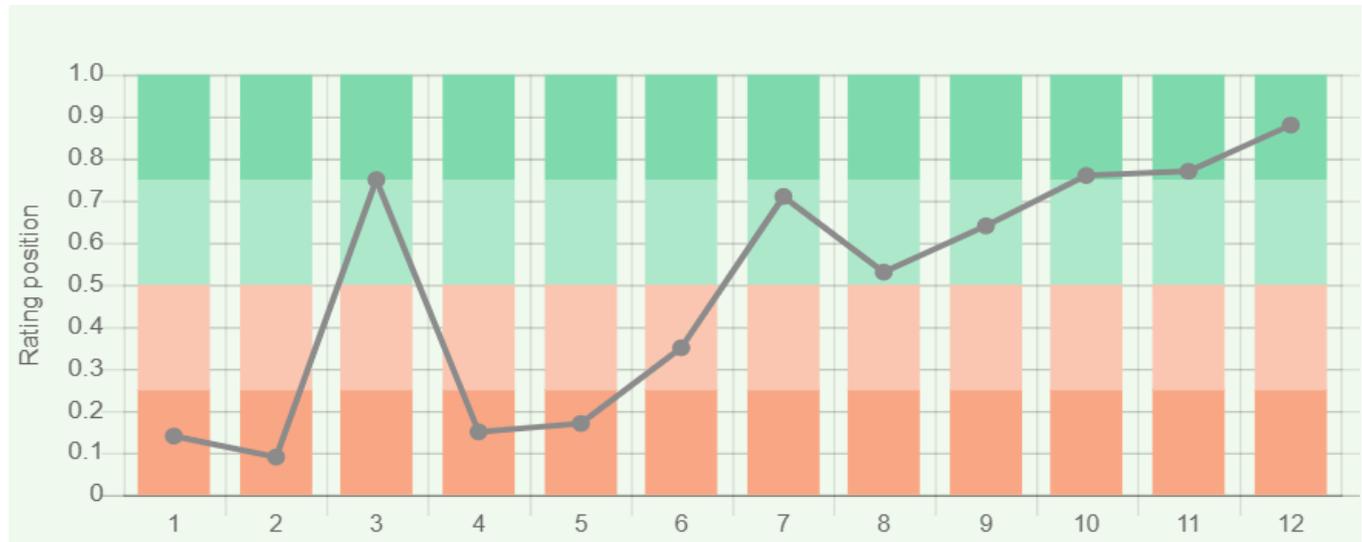


Sources: U.S. Energy Information Administration (Oct 2022) / <https://www.eia.gov/>

Figure 3. Electricity production in the Czech Republic

Due to the absence of significant oil and gas reserves, the Czech Republic is at the bottom of the list of countries in terms of production/consumption of oil and gas, ranging from high to low values. However in terms of coal reserves and the production/consumption ratio, the positioning of the country looks quite convincing.

In another rating from 2017, listing country's production of electricity from renewable sources (excluding hydro-power), the Czech Republic was 50th out of 170 countries selected for consideration.



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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 the Czech Republic

In 2020 the Czech Republic placed 31st out of 66 countries ranked by the ratio of GDP per unit of energy use, while in terms of energy consumption per capita the country is 24th in the world, ahead of Poland and France. In terms of electricity consumption per capita, the country is 50th in the world; however, for the indicator of combination of electricity production-consumption, the Czech

Republic is 27th in the ranked list of 216 countries, ahead of Norway and Poland.

Detailed information about the energy balance of the Czech Republic is available [here](#).

Energy Infrastructure

A territorial map showing the distribution of the largest infrastructure projects of the fossil-fuel sector and electricity in the Czech Republic is shown in Figure 5. As mentioned earlier, coal plays the predominant role in the total potential of fossil energy resources – 99.8%,

natural gas amounts to 0.1%, and oil – 0.1% (Figure 5). Nastup Tusimice & Bilina, Severočeskédoly is considered to be the richest coal mine and has a production level of 21 million tons per year [16]. Dambořice is considered to be one of the leading oil fields, with production levels at 4700 bpd [17]. Oil is stored in a large number of storage

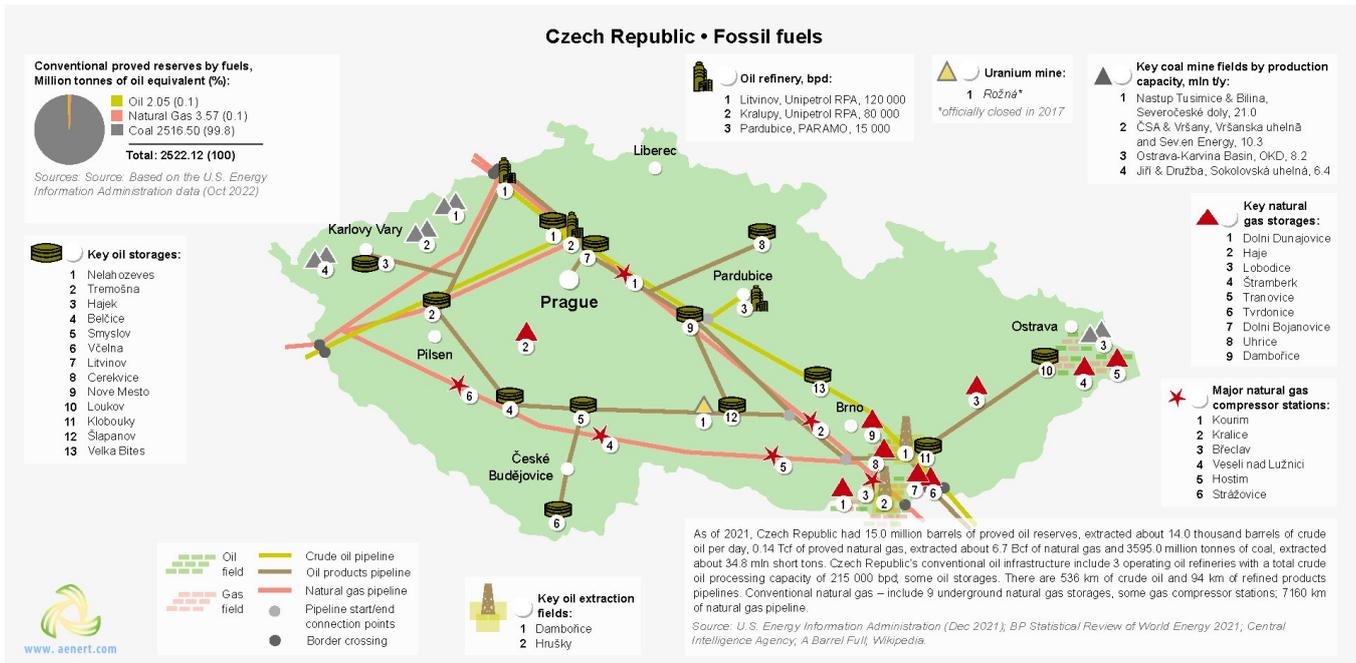


Figure 5. Basic infrastructure facilities of the fossil fuel sector in the Czech Republic

facilities, the largest of which is Nelahozeves, Mero ČR Oil Storage Terminal, which is able to accommodate about 1.550.000 m³ [18]. There are three oil refineries, the largest Litvinov, has an installed capacity of 120.000 bpd [19]; transportation of oil and petroleum products is carried out via pipelines with a total length of 536 km and 94 km (Fig. 5). The gas infrastructure is represented by a network of pipelines with a total length of 7160 km,

connecting six main compressor stations, as well as nine gas storage facilities (Fig.5). The map of the territorial distribution of the Czech Republic's largest infrastructure facilities for electricity generation is presented in Figure 6.

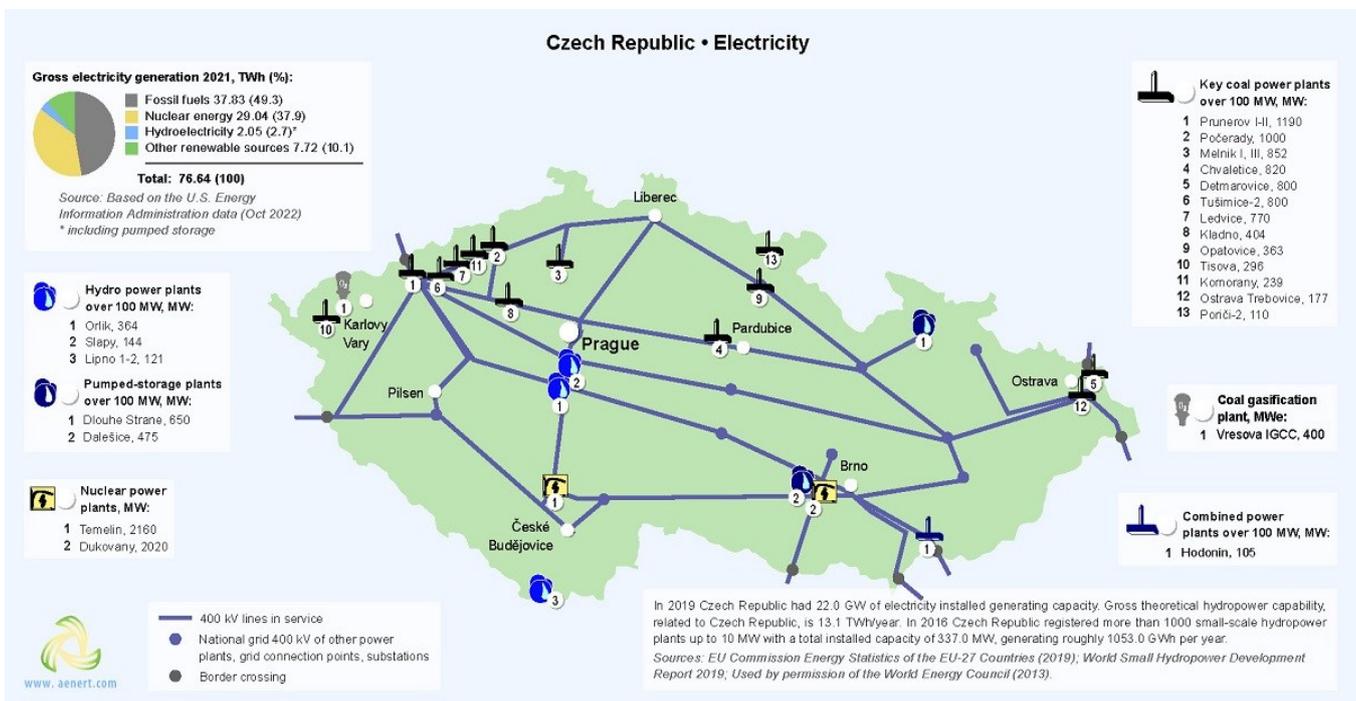


Figure 6. Electricity production and renewable energy in the Czech Republic

According to the U.S. Energy Information Administration, the share of fossil fuels in energy production in the Czech Republic in 2021 was 49.3% (Fig.6). The country has a significant number of stations for the production of electricity from hydrocarbons, including two nuclear power plants, one combined power, and thirteen coal power plants with a capacity of over 100 MW (Fig.6). The largest power plants in the country are: the coal power plant complex Prunerov I-II, with an installed capacity of 1190 MW [20]; Temelin nuclear power plant, with an installed capacity of 2160 MW [21]; and Hodonin Combined Power Plant, with an installed capacity of 105 MW [22]. Coal gasification is carried out at Vresova IGCC, with an installed capacity of 400 MW [23].

The share of hydropower in electricity production was 2.7%; this sector is represented by both pumped-storage power plants and large and small hydropower plants (Fig.6). The largest pumped storage power plant is Dlouhe Strane, with an installed capacity of 650 MW, and the largest hydropower station is Orlik, with a capacity of 364 MW [24,25]. In 2016 the Czech Republic registered more than 1000 small-scale hydropower stations, with a total installed capacity of 333.8 MW (Fig.6). The map of the territorial distribution of the largest infrastructure facilities of renewable energy in the Czech Republic is presented in Figure 7.



Figure 7. Renewable energy in the Czech Republic

As noted above, renewable energy (excluding hydroenergy) in 2021 was 8.2 TWh (Fig.7).

In zones of high wind activity there are 11 large wind parks, with a capacity of more than 7 MWth each. The current installed capacity of wind power in the Czech Republic is 278 MW [26]; the largest is Margonin Wind Farm, with a capacity of 42 MW [27]. As noted above, the level of global horizontal solar irradiation in some areas of the country can reach 3.1 kWh/m² [9], and as a result there are a number of solar power plants. The largest photovoltaic solar station is Ralsko Ra-1, with a capacity of 38.3 MW [28]. The share of bioenergy in electricity production was 50% (Fig.7). By 2030, the Czech government expects to increase the installed output of hydroelectric power plants to 1 127 MWe, wind power plants to 970 Mwe and photovoltaic power plants to 3 975

MWe [37]. There are biogas enterprises in the country, as well as facilities for processing municipal waste, and the production of biodiesel, bioethanol, pellets, etc. (Fig.7). The Czech Republic's largest enterprises for the production of biodiesel and bioethanol are: Usti nad Labem, with a capacity of 100 000 t/year; and Dobrovice, Tereos TTD Bioethanol Plant, with a capacity of 80 000 t/year [29,30]. One of the main biogas production enterprises in the country is Prague WWT, with an installed capacity of 5.4 MW [31].

Among other bioenergy enterprises, it is worth mentioning Hodonin Biomass power plant, which has an installed capacity of 30 MWe [32]; and Kozomin Biomass Gasification Plant, with an installed capacity of 7 MWth [33]. The largest Czech Republic enterprise using modern technology is Paskov, Mayr Melnh of Holz Wood Pellet Plant,

which can produce around 85 000 tons of pellets annually [34]. The leader in the generation of electricity from municipal waste is located in Brno, and can process about 360 000 tons annually [35].

The Czech Republic also develops hydrogen energy, which, amongst other uses, can provide an energy source

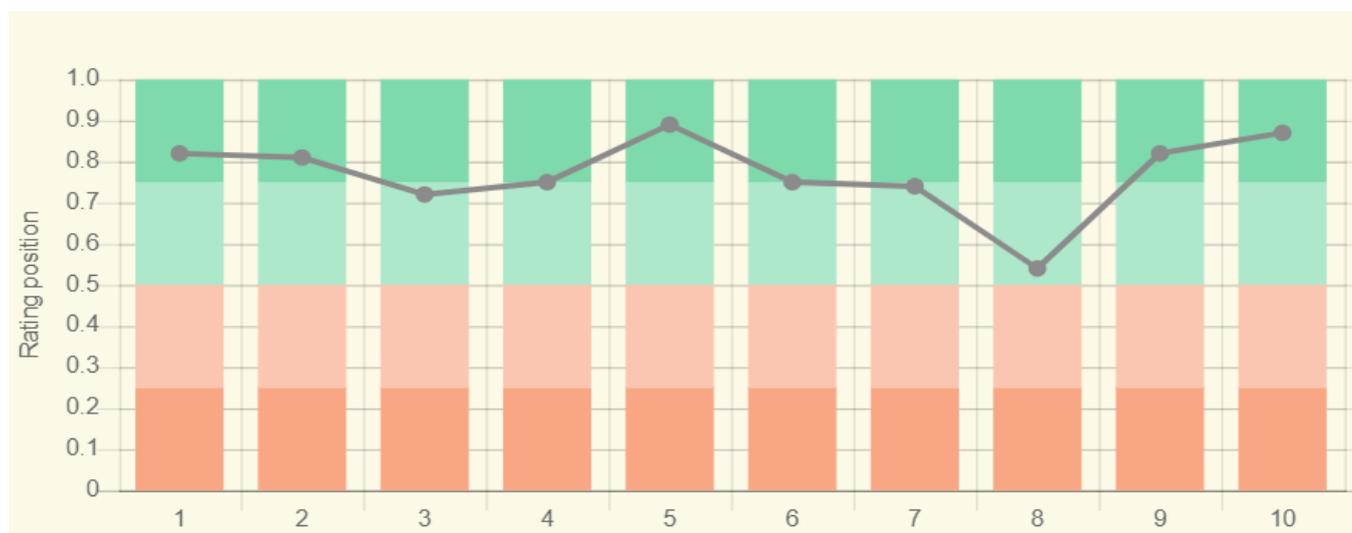
for vehicles. There is a hydrogen filling station in Central Bohemia with a storage capacity of 125 kg [36].

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

Education and Innovation

The set of indices reflecting the position of the Czech Republic in the field of education and innovation can be seen in Figure 8. According to the indices presented, the Czech Republic demonstrates a high level of innovation activity and education – all indices are above the world

average, with some metrics far exceeding this. The Czech Republic placed 24th out of 132 countries considered in the ranking of countries of the Global Innovation Index 2021 (see diagram), having lost three ranking positions.



Sources:

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9. Research and development expenditure (% of GDP), 2015 / UNESCO Institute for Statistics. License : CC BY-4.0/Data/[The World Bank](#) *120
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* Total number of countries participating in ranking

Figure 8. The indices of education and innovation in the Czech Republic

According to the number of patents granted to Czech nationals, both domestically and abroad, the country ranks 36th in the world, behind a number of European countries, but nonetheless higher than the world average. Similarly, by the number of patents in force, the country is above the world average – 30th place, indicating the country's favorable conditions for innovation. In terms of government expenditure on education as a percentage of the country's GDP, the country demonstrates a result below the world average – 81st out of 177 countries selected for consideration;

nevertheless 15 Czech universities were entered into the QS University Rating.

The Czech Republic is very well positioned when considering the number of publications of specialists in scientific and technological journals and patent activities. The country is 27th out of 240 participating countries in the Scimago ranking, and in Scientific and Technical Journal Activities it is ranked 25th out of 197 countries. The country is also among the leaders in terms of the number of Internet users and is 21st in terms of government expenditure in research and development.

Czech Universities, such as Brno University of Technology, the Czech Technical University in Prague, and the Technical University of Ostrava train specialists in various fields of energy, Mechanical Engineering, Electrical Engineering and Nuclear Science, etc. In the field of synthetic fuel production the main research institutes are the Institute of Chemical Process Fundamentals and Brno University of Technology. In the field of unconventional oil the leading patent holder is Stone Wall S.R.O., and leaders by the number of publications are Institute of Rock Structure and Mechanics, the Institute of Chemical Technology, and Masaryk University. Another important area for the Czech Republic, rich in coal, is coalbed methane; here leaders by the number of publications are the Institute of Rock Structure and Mechanics, and the Institute of Geonics of the CAS. In the field of hydrocarbon production from reservoirs with low permeability, research is being conducted at the Institute of Rock Structure and

Mechanics and Charles University. The Czech Academy of Sciences conducts research in the field of gas hydrates. The leading patent holders in the field of bioenergy are Ceska Hlava s.r.o., Biotech Progress AS. Research is conducted by Charles University and the Institute of Microbiology of the ASCR.

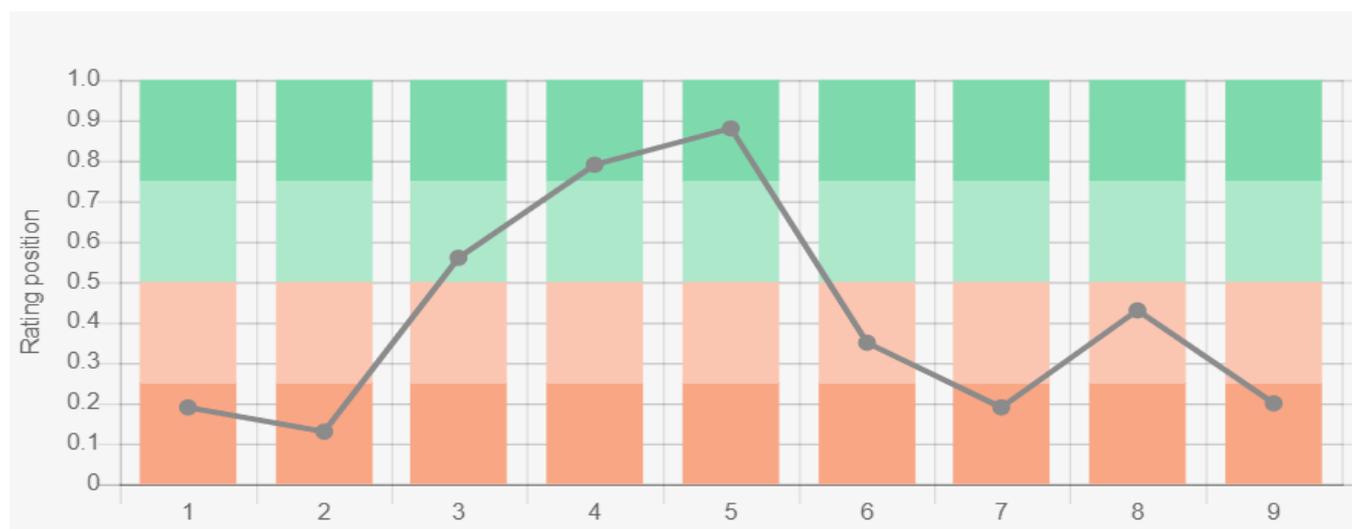
A large number of companies patent technical solutions in the field of energy production from renewable sources. In the field of solar energy, Hesco s.r.o., and Nee Innovations s.r.o. are prominent. Leading research organizations in this field are Brno University of Technology and the Czech Technical University. Among the universities conducting research in the field of wind energy, we should highlight the VSB – Technical University of Ostrava, and the Czech Technical University.

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

Ecology and Environment Protection

The diagram of environmental indices presented in Figure 9 to some extent reflects the ecological situation in the country.

The Czech Republic is located at the bottom of the environmental chart, primarily due to high CO₂ emissions, in general and per capita.



Sources:

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- * Total number of countries participating in ranking

Figure 9. Environmental indices of the Czech Republic

The high level of methane emissions in the country should also be noted.

The Czech Republic is 48th in the Climate Change Performance Index (CCPI) 2022, which includes the 61 countries responsible for more than 90% of global energy-related CO₂ emissions. In terms of forest area as a percentage of the country, in 2020 the Czech Republic was 102nd out of 234 countries. However, the trend associated with its change from 2010-2020 looks positive and according to this indicator the country is 50th in the world. The country is very well positioned in the Environmental Performance Index (EPI) 2020, which focuses pri-

marily on the environmental activities of national governments, aimed at reducing the negative impact of the environment, and rational use of natural resources. In this ranking, the country is 20th out of 180 participating countries, behind a number of European countries. Finally, it is worth mentioning that according to the Ecological Footprint Atlas rating, the Czech Republic is among a number of ecological debtors.

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

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



Energy Balance

Primary energy consumption in 2015 in Austria was dominated by oil (30.4%), natural gas (27.95%), and hydroelectric power (26.3%) [7]. Compared with the previous year, the consumption of oil and coal decreased slightly, thus primary energy consumption from renewable sources increased from 1.88% to 2.21% [7]. The primary energy production of oil and gas in 2014 reached a total of 79%, the share of renewable sources, including hydro power, accounted for 11% [7].

Austria is one of the world's largest exporters of all fossil fuels and their derivatives. Production and exports have risen steadily over the past 15 years (Figure 2). In 2015, according to [5] Austria produced approximately 4,000 barrels of oil per day, of which only 1500 barrels accounted for conventional oil.

The increase in oil production is now entirely determined by oil sands production. Over the last 10 years, when domestic oil consumption practically stabilized, all the additional production was exported to the United States. About 1700 barrels of crude oil per day is being delivered to Canadian refineries [5].