Analysis of the development of global energy production and consumption by fuel type in various regions of the world

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Abstract. This article is devoted to the analysis of the geographical structure of the world energy industry. The article analyzes trends in global energy production and consumption from 1990 to 2018. Statistical indicators of energy production and consumption are also considered. The study notes that the leading countries in GDP production are the largest energy consumers in the world. The authors consider the issues of distribution of production and consumption of energy resources across the world, changes in the relationship between the leaders in primary energy production and energy consumption. Electricity consumption and production by regions of the world are considered, and the share of global energy intensity of energy by fuel type is determined. In addition, the article analyzes the world consumption of natural gas and coal, as well as its extraction. Changes in world demand for petroleum products and their consumption are considered.

1. Introduction

Energy is the basis for the development of the economy of the modern world. Energy consumption in a country is determined by industrial and transport needs, as well as the needs of the population [1]. Russia was the second largest energy consumer after the United States in 1990 [2]. The growing economies of Asian countries have changed the global division in energy consumption. Economic activity in most industrialized countries increased in the 1990s, resulting in increased energy needs [1].

Russian energy efficiency is not exceptionally high. In Russia, energy consumption declined significantly in the 1990s, and by the turn of the Millennium it was in line with the European average, that is, higher than in southern Europe, but noticeably lowers than in Norway, Finland, and Sweden, and significantly lowers than in the United States and Canada [3]. A comparison of countries shows that the higher the energy consumption, the higher the standard of living, income, solvency, production levels, etc. Although in Russia the level of energy consumption is generally at the European level, the level of energy consumption by the population has significantly decreased than in developed industrial countries [4].
In recent years, many analysts have realized the danger of another wave of growth in global energy consumption. However, the largest developing countries – China and India – are currently increasing their per capita energy consumption at an increasingly rapid pace. Rapid population growth and high energy intensity of the economy, the energy needs of these countries are growing rapidly, given the continued economic growth of developing Asian countries. Energy consumption in Africa and Latin America is growing at a faster rate, and even per capita energy consumption has increased in the European Union.

2. Energy consumption and production by fuel type

Today, all the energy used by humans does not exceed 0.3% of the photosynthetic energy that supports life on Earth. However, in the future, what is important is not the level, but the growth rate of human energy consumption. In the last century, the dynamics of global energy consumption indicates its clearly exponential growth, which can disrupt the planet's thermal balance and lead to catastrophic climate changes [5].

Over the entire historical period of human development, the level of human use of anthropogenic energy increased at the end of the 19th century, reaching 1 billion tons of fuel. And over the past century, it has grown almost 17 times, reaching 16.5 billion tons of fuel in 2006. In other words, the average level of energy consumption has increased by several orders of magnitude since biblical times.

In 2018, global energy consumption increased significantly due to sustained economic growth and growing demand in China, which has been the world's largest energy consumer since 2009 (figure 1).

Figure 1. Diagram of global energy consumption by fuel type.

China's energy consumption showed the highest growth since 2012, mainly due to electricity production, strong industrial demand and increased fuel consumption in the transport sector, which was helped by a growing fleet. In the United States total energy consumption reached a record 2.3 Gtoe in 2018, which is 3.5% more than in 2017, partly because of weather stipulations. On the other hand, in the European Union, energy consumption fell by 1%, and in particular in Germany by 3.5%, partly due to falling electricity consumption, a mild winter, reduced consumption and improved energy efficiency.

Global energy production continued to grow in 2018 (2.8%), exceeding the historical trend. The United States and China have made a main contribution to increasing global energy production, with growth of 54% in 2018 [6]. In the European Union, energy production continued to decline due to a small reduction in nuclear power production, depletion of oil and gas resources, and climate policies. Despite an increase in hydroelectric power production after a dry year and a moderate increase in energy consumption, this decline is occurring.

Global energy intensity (total energy consumption per unit of GDP) it decreased by 1.3% in 2018, which is slightly below the historical trend (-1.6% per year on average from 2000 to 2017). The dynamics of energy intensity is shown in figure 2. Levels and trends of energy intensity vary
significantly across the world, reflecting differences in the structure of the economy and advances in energy efficiency. Between 2000 and 2018, energy intensity in China increased by almost 40%, and last year – by 2.7% due to energy efficiency policies focused on energy-intensive industries. For some time, China has developed and applied energy intensity reduction targets in response to energy-intensive industries, which has led to high demand for energy efficiency services.

![Figure 2. Diagram of energy intensity of all types of fuel.](image)

In the US, energy intensity increased (+ 0.6%) in 2018 compared to a downward trend (-1.9% per year) in 1990-2017. Energy efficiency improvements continued in the European Union, the region with the lowest energy intensity in the world. However, this was facilitated by weather conditions (mild winter).

Since 2000, the energy intensity in the CIS region has been steadily decreasing (-2.7% per year), but remains the highest in the world (75% higher than the global average). The high energy intensity in the CIS, the Middle East, China and other developing countries in Asia is due to the dominance of energy-intensive industries, exporting countries and low energy prices, which do not contribute to energy efficiency.

3. Electricity consumption and production by region of the world
The energy sector of the former USSR developed as a single economic complex for a long period of time. The formation of independent States on the territory of the USSR led to radical changes in the development of the electric power sector.

At this time, changes in the political and economic situation in the country began to have a significant negative impact on the development and operation of electric power: power production and power consumption is reduced. Indicators of the quality of electrical energy deteriorated. The number of consumer restrictions and blackouts has increased, and electricity supplies to Eastern European countries have significantly decreased.
Most of the increase in global electricity consumption is accounted for Asia (almost 80%, almost 60% in China). Demand for electricity in China has accelerated on the back of sustained economic growth and industrial demand. Demand also increased in India, South Korea, Japan, and Indonesia (figure 3) [7].

In the US, electricity consumption decreased by 1% in 2017, and recovered in 2018 (+ 2.2%). Most of this growth was in the residential sector (+ 6.2%), mainly due to increased electricity consumption for household appliances and air conditioning. Economic growth and industrial demand also contributed to the increase in the consumption of electricity in Canada, Brazil and Russia. It also increased in Africa, especially in Egypt and the Near East, which was promoted by Iran.

As in 2017, electricity consumption in Europe remained stable in 2018: it declined in France and Germany, stabilized in other major countries (Great Britain, Italy, Spain), and grew in the Netherlands, Poland, and Turkey. The main growth in global electricity production occurred in Asia (+ 6.1%) in 2018: China accounted for almost 60% of global growth due to high demand and rapid capacity development [7].

Electricity production also increased in the USA (+ 3.6%), as weather conditions and economic growth stimulated electricity consumption, while in Canada it decreased slightly. Electricity production continued to grow in Russia (economic recovery), the Near East, and Africa. Latin America remained stable as growth in Brazil and Mexico was offset by a strong decline in Venezuela due to political tensions. In Europe, electricity production remained stable, despite growth in France and Turkey due to increased production of hydroelectric power and renewable energy. On the other hand, electricity production fell in Belgium, Germany, Italy and the UK (mild winter).

4. Global natural gas consumption

Global gas consumption accelerated in 2018 thanks to the efforts of the United States and China, which accounted for about two-thirds of the additional consumption. In the US, gas demand grew by 10% in 2018, the highest growth rate in the past 30 years, driven by electricity (+15 GW of new gas-fired power plants) and construction (figure 4).

Gas consumption also increased in China (+ 18%), according to the policy of replacing coal with gas in the electricity and heat supply sectors. Growth was also seen in India and South Korea due to sustained economic growth. However, in Japan, consumption declined as the restart of nuclear reactors reduced the need for gas-powered electricity.

Gas consumption also continued to grow steadily in Russia (although at a slower pace than in 2017) and accelerated in Canada, Iran, and Algeria. Despite economic growth, gas consumption has
declined in Europe, especially in Turkey, France, Germany and Italy, due to rising temperatures, increased availability of nuclear and hydro power, and increased production of renewable energy.

In the United States, gas production increased (+11.5%), with the world's largest gas company accounting for 45% of the increase, triggered by recent events in the Permian basin and Haynesville, as well as an increase in domestic shale gas consumption. In the United States, shale gas currently accounts for about 70% of the country's gas production.

Growth in gas production occurred in Russia (+6.7% in 2018), which was facilitated by a significant increase in domestic demand, as well as growth recorded in Iran after the launch of new stages of projects in the fields from South Pars. In Australia, gas production continued to grow (+15%) due to the launch of new LNG lines in 2017 and 2018. In Egypt, gas production grew very rapidly (+20%) due to the start of new stages of the project in the West Nile Delta. In Europe, gas production continued to fall (-15%) as the Netherlands reduced domestic gas production.

5. Global coal consumption and production

Growth in coal consumption was driven by India and China, the two largest coal-consuming countries, with Turkey and Russia also contributing to demand growth in 2018 (figure 5).

![Figure 5. Diagram of global coal consumption.](image)

In China, which accounts for almost half of global coal consumption, coal consumption has increased for the second year in a row, mainly due to electricity generation and certain industries such as steel, chemical and cement industries. In 2018, coal consumption increased again due to slowing economic growth and concerns about gas supplies for the transition from coal to gas heating. This contradicts previous efforts to green the economy while maintaining prosperity.

The United States has seen the largest drop in coal consumption (-4%), reaching its lowest level in 40 years as a result of decommissioning coal-fired power plants, stricter emissions standards, and the availability of cheaper natural gas for power generation. In Europe, coal consumption has fallen for the sixth year in a row due to climate policy, increased competition from renewable energy and gas sources, and the increased cost of CO2 emissions (tripling in 2018) in the European Union; in Turkey, by contrast, coal demand has increased by 11%.

China has strengthened its position as the world's largest producer of coal and lignite (45% of global production). In 2018, the country approved more than 45 billion yuan ($6.7 billion) for new coal mining projects. The recent gas shortage in the country has weakened the government's motivation to switch from coal to gas for indoor heating and has kept the demand for coal alive. China's coal and lignite production accounts for 70% of global growth.

Increased coal imports to China supported a strong international coal market, increasing production in Australia, Indonesia and Russia, the three main coal suppliers.

In India, production increased significantly (+5.3% in 2018) due to domestic demand and the government's desire to reduce its dependence on imports. In the US, coal production has fallen to its
lowest level in 39 years, despite rising exports. In the European Union, coal production continued to decline.

6. Global demand and consumption of petroleum products
Global demand for petroleum products increased in 2018, increasing by 0.9%, due to expansion in the transport and petrochemical sectors. Increased demand for petroleum products led to increased consumption in 2018, driven by the development of petrochemicals, especially in the US, and increased fuel consumption in the transport sector (figure 6).

The largest increase in demand was recorded in Asia, mainly in China and India (growth of 6% and 2.7%, respectively) and, to a lesser extent, in Thailand and Indonesia (decline in Japan). Consumption of petroleum products also increased by 2.5% in the United States, mainly due to industrial demand. In Russia, consumption of petroleum products increased slightly (+0.5%) and decreased slightly in the European Union (-0.6%), as demand in industry and transport remained unchanged. Consumption of petroleum products in Latin America, which has been declining since 2014, reached a maximum decline in 2018 (-3.3%). This was due to lower oil production in Mexico, rising prices, and the introduction of international sanctions in Venezuela [8].

Figure 6. Diagram of global consumption of petroleum products.

Production of petroleum products increased in 2018 (+ 0.8%), although it is lower than the historical average (+ 1%). The bulk of global growth (58%) was in Asia, primarily in China and India. The Near East, especially Kuwait, saw a decline in production after last year's growth, as companies in the Near East sought growth opportunities in international markets, as well as in Latin America, where Venezuela and Mexico continued to reduce oil production [9].

Oil products in the European Union, especially in Germany, Great Britain and France, continued to fall. In the Near East, the recent closure of refineries and a growing desire to process crude oil locally has led to a decline in oil refining volumes in the EU [10].

7. Conclusion
Thus, energy production is the foundation of industrial civilization and the condition for the existence of modern material culture. In China, economic growth and growing demand have led to an increase in global energy consumption. Natural gas consumption increased in all regions of the world. But on the other hand, coal consumption in Europe has declined due to climate policy. With the development of petrochemicals, the demand for petroleum products increased, which led to an increase in consumption.

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