Original article
https://doi.org/10.53658/RW2022-2-2(4)-178-201

Historical sciences

The impact of the gas crisis of 2021–2022 on energy sustainability and the implementation of climate commitments by the largest emitters of carbon dioxide

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Abstract. Under the Paris Climate Agreement, 193 states have committed themselves to reducing carbon emissions and adapting to climate change. Almost half of them have now adopted programs to achieve carbon neutrality. Last year, leading up to the 26th UN Climate Conference in Glasgow, many of the leading CO2 emitters stepped up their climate targets significantly. However, the desire to increasingly reduce fossil and nuclear energy in favor of «clean» sources has collided in 2021 with a global energy crisis that has called into question the sustainability of energy systems tailored to achieve climate goals. The purpose of this study is to identify the relationship between the rapid growth in natural gas prices and the implementation of climate commitments and national plans of states dependent on natural gas imports. The author analyzes the impact of the energy crisis on gas prices, and then, using the example of developed and developing countries among the largest emitters of carbon dioxide, monitors the impact of this price increase on the implementation of their climate obligations. Based on statistical data, the author studies the energy balance of China, Japan, India and Germany, its vulnerability to gas prices, the reaction of energy systems to the crisis and the subsequent measures of states to mitigate it in terms of following climate paradigms, in particular, abandoning coal. As a result of the study, the author comes to the conclusion that the issuing states in times of crises are forced to partially deviate from their previous climate measures, respectively, the implementation of their ambitious climate commitments that do not take into account such risks is in question.

Keywords: climate commitments, NDC, energy security, natural gas, renewable energy, import dependence

ISSN 2782-3067 (Print)

For citation: Ksenia M. Dorokhina. The Impact of the Gas Crisis of 2021-2022 on Energy Sustainability and the Implementation of Climate Commitments by the Largest Emitters of Carbon Dioxide. Russia & World: Scientific Dialogue. 2022. No. 2(4). pp. 178-201. https://doi.org/10.53658/RW2022-2-2(4)-178-201

Introduction

Since the entry into force of the Paris Agreement on climate change, the understanding of the role that the commitments of participating States can have on the global economy has changed.

The Paris Agreement was signed by 193 states, 194 countries (including Eritrea, which is not a party to the Paris Agreement[1]) submitted Nationally Determined Contributions (NDC) – plans to reduce emissions and plans to adapt to climate change[2]. By the end of the UN Climate Change Conference in Glasgow (COP26), 151 countries had submitted updated climate plans (in March 2022 – already 156 States)[3].

I.A.Stepanov, N.D.Aghikyan and E.E.Muzychenko identify the following factors that influence the climate concernment of states [4]:

- vulnerability to global climate change;
- level of socio-economic development;
- energy policy (for ex. dependence on imports in energy supply);
- the problem of air pollution;
- specialization in the extraction and export of fossil fuels.

The authors distinguish the following clusters of States according to the scale of climate commitments:

1. Cluster "Very rich and with a lack of energy" (for example, Austria, Germany, Denmark, Ireland).

2. Cluster "Moderately wealthy and with an extremely lack of energy" (for example, Greece, Spain, Italy, Cyprus, Lithuania).

3. Cluster "Moderately wealthy and with abundance of energy" (for example, Azerbaijan, Russia, Indonesia, Kazakhstan).

4. Cluster "Poor and energy – supplied" (for example, Botswana, Guatemala, Belarus, Uzbekistan).

The results of the authors' analysis indicate that the most large-scale goals for reducing emissions are in developed countries. In turn, the countries of the fourth cluster have rather modest ambitions in climate policy, while at the same time, it is in the countries of the fourth cluster we see extremely high values of local air pollution and climate changes, which, as the authors suggest, is explained by high negative correlation with the level of

1 NDC Registry. UNFCC. Available: https://www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx.
2 Available: https://www.un.org/ru/climatechange/all-about-ndcs.
3 NDC Enhancement Tracker. Climate Watch. Available: https://www.climatewatchdata.org/2020-ndc-tracker.

economic development. In addition, the results indicate that energy-abundant countries tend to be less active in climate policy [4].

According to Net Zero Tracker in March 2022, 83 countries that emit 74.2% of greenhouse gas (GHG) have set a goal of achieving carbon neutrality and fix it in national strategic documents or political commitments, but the results depending on the factors outlined above, may be called into question in the situation of global economic shocks.

Economies heavily dependent on fossil fuels are most vulnerable to various energy market shocks, primarily due to volatility in energy prices.

The energy crisis that began in 2021 poses risks and leads to a forced slowdown in climate projects or even a temporary waiver of a number of obligations in order to maintain economic and energy stability. This is especially true for states dependent on natural gas imports, as well as those where gas occupies a significant share in the country's energy balance or those where we see the transition to the use of gas instead of other sources with higher CO2 emissions.

Thus, the purpose of this study is to identify the relationship between the rapid growth in natural gas prices and the implementation of climate commitments and national plans of states dependent on natural gas imports.

Materials and methods

The study used the databases of the International Energy Agency (IEA) on the dynamics of gas prices in 2020–2022 (2022), the IEA databases on the energy balances of the countries studied (n.d.), the report BP Statistical Review of World Energy (2021), the report "World gas market, Monitoring" (January 2021) of the Moscow School of Management Skolkovo (2021), as well as statistical data and specialized reports from government agencies in China, India, Japan, Germany and the Republic of Korea. In addition, the author uses information and analytical reports from Russian and foreign media and expert comments in the media to provide up-to-date data for 2022.

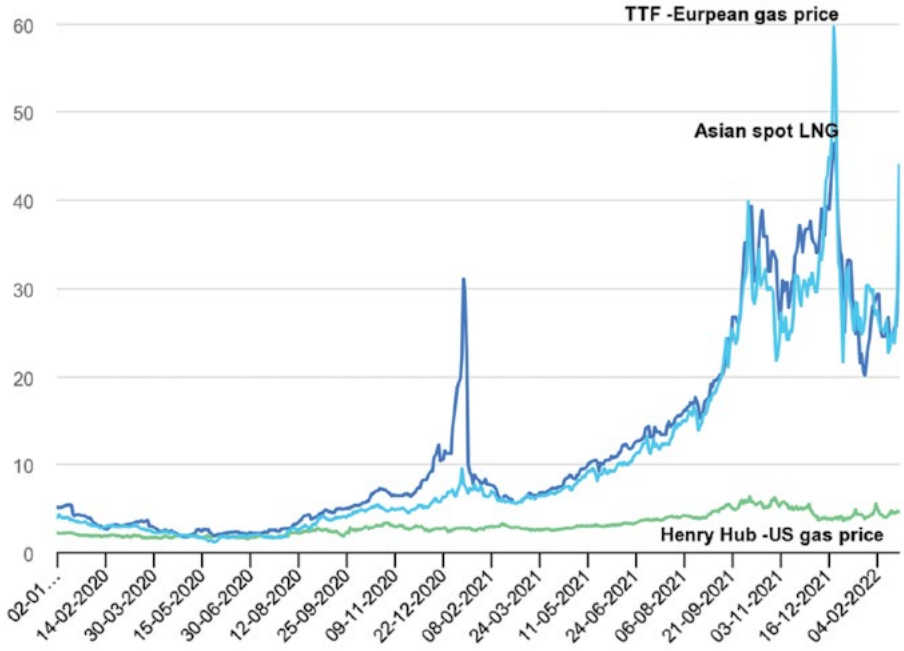
Results

Causes of the gas crisis and its dynamics

At the end of 2020, the price of gas in the spot markets began to rise (Figure 1), reaching its highest level since the beginning of the year. The growth spurt in January 2020 was recorded in the Asian spot market, it was associated with strong demand due to weather conditions, as well as an increase in demand from China due to the ongoing policy of replacing coal with gas[4]. After a typical spring slowdown in demand, in particular

4 The global gas market. Monitoring January 2021. Skolkovo. Moscow School of Management. Available: https://energy.skolkovo.ru/downloads/documents/SEneC/Monitoring/SKOLKOVO_EneC_.

Figure 1. Dynamics of gas prices in spot markets in Europe, Asia and the USA in 2020-2022 ($ / MBTU)



Source: International Energy Agency. IEA, Natural gas prices in Europe, Asia and the United States, Jan 2020 – February 2022. IEA, Paris, 2022. URL: https://www.iea.org/data-and-statistics/charts/natural-gas- prices-in-europe-asia-and-the-united-states-jan-2020-february-2022.

due to weather conditions, prices began to rise actively, reaching the first price record on the European and Asian stock markets of autumn 2021. It should be noted that the experts predicted a rise in prices at the European and Asian hubs not only due to an increase in demand on the eve of the winter heating period, but also due to low reserves in gas storage facilities, a series of supply disruptions (deliveries usually occur during a period of low demand in summer for filling gas storage facilities), the post-COVID economic recovery and the associated increased demand in Asia[5]. In addition, the new climate policy of European countries also has an impact, that implies the abandonment of coal in favor of gas and the reduction of their own production by European states (which, in particular, is explained both by the cessation of a number of countries of production in the North Sea and the depletion of North Sea deposits)[6]. As Deputy Prime Minister of the Russian Federation Alexander Novak noted, European countries have abandoned long-term investments in that economic sector, preferring spot contracts, which led to supply disruptions due to increased demand for LNG in Asian markets. Another reason, according to the Deputy Prime Minister, is in

5 Record-breaking summer European gas prices signal an expensive winter. Reuters, 7 July 2021. URL: https://www.reuters.com/business/energy/record-breaking-summer-european-gas-prices-signal-an-expensive-winter-2021-07-07/.

6 The causes of the gas crisis in Europe. Oil and capital, 17.11.2021. Available: https://oilcapital.ru/interview/17-11-2021/prichiny-gazovogo-krizisa-v-evrope?amp=1.

weather conditions – due to the risks of a new cold winter and a shortage of gas, futures prices began to react with growth, laying in advance the conditions for increased demand[7]. The Deputy Prime Minister also notes that the reason that aggravated the crisis in countries that have relied on RES was a decrease in wind speed, which directly affects the energy generation by wind turbines, and the onset of autumn, as expected, reduced the volume of energy generation at solar power plants [3].

Following European gas prices, the cost of "blue fuel" in Asian markets has increased. The rise in prices in European markets was accompanied by strong demand in Asia[8], especially due to the energy crisis in China caused by the lack of coal[9], as well as Beijing's policy to increase the use of gas in the transport industry, industry and electric power industry[10].

The Ukrainian crisis and the accompanying conflict between Russia and Western countries only exacerbated the situation with gas pricing. Now it is difficult to predict the long-term development of the situation. However, there are already signs that, in order to stabilize the economic situation and ensure energy security, import-dependent countries are forced to neglect part of their climate commitments.

UN Secretary-General António Guterres said that the current situation could mean that the world's leading economies, in an attempt to find alternatives to Russian fossil fuel supplies, risk prolonging their dependence on this energy source in future and can miss the opportunity to keep global warming within 1,5oC [11].

In this regard, we looked at four countries that are among the ten largest emitters of carbon dioxide and depend on gas imports, and tracked their actions in fulfillment of their climate obligations in the energy sector starting from 2021.

Below are data on the ten largest emitters of carbon dioxide in 2020 (Table 1). The analysis showed that four countries are dependent on natural gas supplies due to their own limited production: China, India, Japan, Germany.

China and India have been criticized by the environmental community for what the greens say is not active enough to combat climate change.

Japan and Germany, on the contrary, are among the nations that are constantly updating their climate commitments and placing them at the center of their energy policies.

7 Novak named six reasons for the gas crisis in Europe. RBC. Available: https://www.rbc.ru/business/29/12/2021/61cb3bc99a7947b4aef9c3ff.

8 Asia LNG price rise on firm Chinese demand, eyes on Russian flow. Reuters. Available: https://www.reuters.com/business/energy/asia-lng-price-rise-firm-chinese-demand-eyes-russian-flow-2021-10-15/.

9 China power crisis. S&P Global. Available: https://www.spglobal.com/commodity-insights/en/market-insights/topics/china-power-crisis-news.

10 Outline of the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and Vision 2035 of the People's Republic of China. Center for Security and Emerging Technology (CSET). Translation, 12 May 2021. Available: https://cset.georgetown.edu/wp-content/uploads/t0284_14th_Five_Year_Plan_EN.pdf.

11 UN Secretary-General: We are moving further and further away from the goal of keeping global warming within 1.5 degrees Celsius. UN,21.03.2022. Available: https://news.un.org/ru/story/2022/03/1420252.

Table 1. Top 10 carbon emitters in 2020

Country	Volume of emissions (Mt)
China	9 899,3
USA	4 457,2
India	2 302,3
Russia	1 482,2
Japan	1 027,0
Iran	678,2
Germany	604,9
Republic of Korea	577,8
Indonesia	575,9
Saudi Arabia	570,8

Source: BP Statistical Review of World Energy 2021. URL: ttps://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf

Below are statistical data on the production, import and consumption of natural gas in each of these countries, as well as the energy balance, which allows you to track the degree of their dependence on gas supplies and price volatility. Then, political actions and decisions in the energy industry and other branches of the economy related to the supply of "blue fuel" that affect the climate policy of each state are considered.

The reaction of import-dependent countries to the gas crisis in the context of climate commitments

China

China is the largest emitter of carbon dioxide, so its climate policy in recent years has received particular attention. Introduced by China in October 2021, the updated NDC includes a goal of peaking carbon dioxide emissions by 2030, followed by reductions to achieve carbon neutrality by 2060. It also it is planned to reduce emissions per unit of GDP by more than 65% from the 2005 level and to increase the capacity of wind and solar energy by 2030 to more than 1.2 billion kW[12].

As part of the 14th Five-Year Plan (2021–2025), it is assumed, firstly, to increase the share of non-fossil resources in energy consumption by about 20% by 2025[13] and

12 China's Achievements, New Goals and New Measures for Nationally Determined Contributions, 28 October 2021. NDC Registry. Available: https://www4.unfccc.int/sites/NDCStaging/pages/Party.aspx?party=CHN.

13 Outline of the 14th Five-Year Plan (2021–2025) for National Economic and Social Development and Vision 2035 of the People's Republic of China. Center for Security and Emerging Technology (CSET). Translation, 12 May 2021. Available: https://cset.georgetown.edu/wp-content/uploads/t0284_14th_Five_Year_Plan_EN.pdf.

in energy production by about 39%[14], and secondly, the development of solar and wind energy, construction of new coastal nuclear power stations, a significant role is given to the development of hydrogen energy.

Table 2. Statistics of production, import and consumption of natural gas in China in 2021

Year	Gas production (billion m3)	Import[15] (billion m3)	Consumption (billion m3)
2021	205,3	167,5	372,6

Source: Energy production in December 2021. National Bureau of Statistics, 17 January 2022 (in Chinese). URL: http://www.stats.gov.cn/tjsj/zxfb/202201/t20220117_1826406.html; Brief analysis of natural gas exploitation in China in 2021. China Gas Association, 22 February 2022. URL: http://www.chinagas.org.cn/mobile/index.php/m/c/5/6/58079 (in Chinese)

China is about fourth in terms of gas production[16], but about 45% is the need for imported gas (Table 2).

Despite the relatively small share of gas (7% in the country's energy balance), in recent years its consumption has increased markedly (in 2021 – 17.6%)[17]. This is due both to the recovery in demand after the pandemic and the economic policy pursued by Beijing. China is promoting large-scale use of natural gas in sectors including industrial fuels, electricity generation and transportation as part of efforts to combat air pollution[18]. In addition, natural gas is actively used in the transport industry: in particular, buses and taxis are being converted to "blue fuel", China's gas fleet is also actively developing. Beijing recognizes gas as a clean energy source that complies with climate commitments[19], and the approval of natural gas as a "clean" energy source in the EU taxonomy is also beneficial for China[20]. The 14th Five-Year Plan (2021–2025) presupposes expanding the use of natural gas, however, the emphasis is on increasing domestic production to reduce dependence on imports[21].

14 New energy to play increasing role with LNG continuing to contribute. The State Council of the People's Republic of China, 24 March 2022. Available: http://english.www.gov.cn/news/topnews/202203/24/content_WS623bd672c6d02e5335328368.html.

15 Information on the volume of imports in the report is given in million tons. 1 Mt of LNG = 1.3802622498753 billion m3 of natural gas.

16 IEA Atlas of Energy. International Energy Agency. Available: http://energyatlas.iea.org/#!/tellmap/-1165808390.

17 Brief analysis of natural gas exploitation in China in 2021.China Gas Association, 22 February 2022. Available: http://www.chinagas.org.cn/mobile/index.php/m/c/5/6/58079.

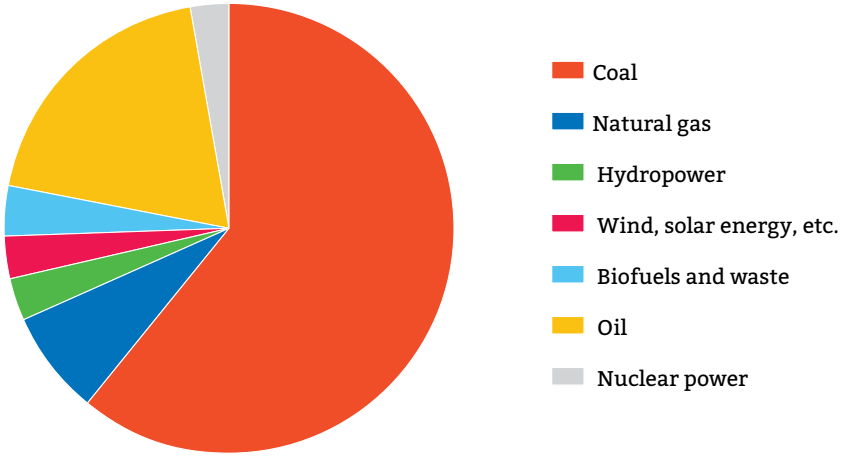
18 China's natural-gas consumption jumps in Jan.-Nov. period. Xinhua. Available: http://www.xinhuanet.com/english/20220102/b4752b18e4e54bcaa8a65d13bf9f05b1/c.html.

19 Energy in China's New Era. Ministry of Ecology and Environment the People's Republic of China, 22 December 2020. Available: https://english.mee.gov.cn/Resources/publications/Whitep/202012/t20201222_814160.shtml.

20 Questions and Answers on the EU Taxonomy Complementary Climate Delegated Act covering certain nuclear and gas activities. European Commission. Available: https://ec.europa.eu/commission/presscorner/detail/en/QANDA_22_712.

21 Outline of the 14th Five-Year Plan (2021–2025) for National Economic and Social Development and Vision 2035 of the People's Republic of China. Center for Security and Emerging Technology (CSET). Translation, 12 May 2021. Available: https://cset.georgetown.edu/wp-content/uploads/t0284_14th_Five_Year_Plan_EN.pdf.

Figure 2. Energy balance of China in 2019



Source: International Energy Agency. IEA World Energy Balances. Available: https://www.iea.org/countries/china

The energy crisis of 2021 was a serious blow to the Chinese energy industry. Among its reasons, experts primarily name the high share of thermal power production, which, due to the inaccessibility of coal (due to a physical shortage, a jump in prices, or the underdevelopment of logistics channels to ensure timely supplies both domestically and from abroad), has repeatedly led to interruptions in the supply of electricity in past[22]. Some experts believe that a significant role in the electricity shortage, which led to a series of blackouts in the country, was played by a plan to reduce emissions in the provinces, tightly controlled by the State Committee for Reform and Development. This has led to the closure of several coal mines with the largest carbon footprint[23], in addition, since the beginning of the year, mine safety requirements have been increased, which have also led to a number of closures of mines[24]. China's trade war with Australia also had an impact, which led to a ban on the supply of cheap Australian coal. Last but not least, this forced China to significantly increase LNG supplies, but the supply failed to meet the growing demand ahead of the winter season, thus creating a shortage also in other markets, in particular in the EU. High gas prices connected with growing demand in the north at the beginning of the heating season, according to Chinese analysts, led to a decrease in sales of gas filling stations from 5 to 30% in different regions[25].

The current situation has become a challenge for the Chinese government, which has repeatedly stressed that the achievement of climate goals and the energy transition should

22 Epikhina Raisa. The energy crisis in China. November 19, 2021. Available: https://russiancouncil.ru/analytics-and-comments/analytics/energeticheskiy-krizis-v-kitae/.

23 The reasons for the energy crisis in China are the struggle to reduce emissions. Vedomosti.11.10.21. Available: https://www.vedomosti.ru/economics/articles/2021/10/11/890712-energokrizisa-kitae.

24 Fitch: Due to lack of supply, projected prices for thermal coal have increased. Sina, 09.09.21. Available: https://cj.sina.com.cn/articles/view/7194157228/1acce20ac00100vc1x.

25 China's natural gas consumption will continue its upward trend (中国天然气表观消费量将保持增长态势). Comnews, 12.01.2022. Available: http://www.comnews.cn/article/cysj/202201/20220100094978.shtml.

not be to the detriment of the country's economic and energy security, and the climate transition should be soft and gradual[26]. The country's authorities were forced to make a decision to reactivate temporarily frozen coal mines, which can produce up to 67 million tons of coal per year[27]. Rising energy prices led to an unprecedented increase in electricity prices and caused losses to suppliers, so forcing the State Committee for Reform and Development to increase the tariff for end consumers by 10%[28]. That's why for the Chinese government ensuring the sustainability of the economy turned out to be a higher priority than the fulfillment of climate obligations.

China's policy on "dirty" energy has been controversial even until that situation. The designated 14th five-year plan, in addition to increasing renewable capacities, also contains plans to increase oil production, as well as coal production – a resource necessary not only for electric power generation, but also in metallurgy and the steel industry. The plan provides for retention of the indicator of coal production at 4.1 billion tons, but at the same time it provides for the construction of new coal-fired electric power stations[29]. In 2021, the year the plan was adopted, construction of coal-fired electric power stations with a total capacity of 33 GW began – more than in 2016[30]. This was the basis for widespread criticism from Western environmental organizations, who accused China of double standards in the field of climate[31]. However, it is important to note that both the 14th Five-Year Plan and the new conclusion by two National Commissions released in January 2022 highlight that China is pursuing a policy of modernizing coal-fired electric power stations across the country, decommissioning outdated production facilities and promoting "clean" coal energy with a high degree of filtration, as well as promoting the construction of new, more environmentally friendly coal mines[32][33].

26 «14th five-year plan» Planning of a modern energy system. National Development and Reform Commission (NDRC), National Energy Administration (NEA). Available: https://www.ndrc.gov.cn/xxgk/zcfb/ghwb/202203/P020220322582066837126.pdf.

27 Fitch: Due to lack of supply, projected prices for thermal coal have increased. Sina, 09.09.21. Available: https://cj.sina.com.cn/articles/view/7194157228/1acce20ac00100vc1x.

28 The causes of the energy crisis in China are the struggle to reduce emissions. Vedomosti. 11.10.21. Available: https://www.vedomosti.ru/economics/articles/2021/10/11/890712-energokrizisa-kitae.

29 China will limit annual coal production to 4.1 billion tons by the end of 2025. Xinhua, 04.03.2021. Available: http://russian.news.cn/2021-03/04/c_139782781.htm.

30 BRIEFING: Most coal power plants since 2016 entered construction in China in 2021, investment in coal-based steelmaking accelerated. CERA. Available: https://energyandcleanair.org/china-coal-power-steel-2021/.

31 China starts building 33 GW of coal power in 2021, most since 2016 -research. Reuters, 24 February 2022. Available: https://www.reuters.com/markets/commodities/china-starts-building-33-gw-coal-power-2021-most-since-2016-research-2022-02-24/.

32 Outline of the 14th Five-Year Plan (2021–2025) for National Economic and Social Development and Vision 2035 of the People's Republic of China. Center for Security and Emerging Technology (CSET). Translation, 12 May 2021. Available: https://cset.georgetown.edu/wp-content/uploads/t0284_14th_Five_Year_Plan_EN.pdf.

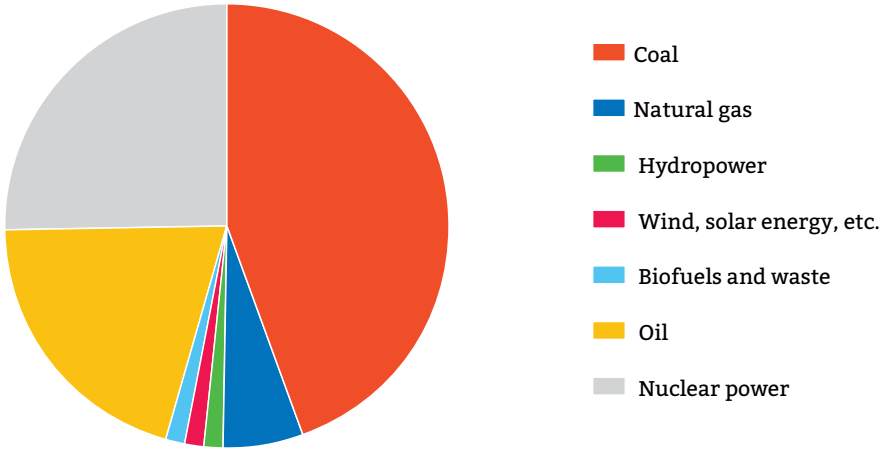
33 Conclusions of the National Development and Reform Commission and the National Energy Administration on improving the Institutional Mechanism and Policies and Measures for Green and Low-Carbon Transformation. Government of the People's Republic of China, 2022. Available: http://www.gov.cn/zhengce/zhengceku/2022-02/11/content_5673015.htm.

India

India, ranked third in terms of CO2 emissions, is one of the countries where climate reforms are proving to be the most difficult. That country did not present an updated version of the NDC for the Glasgow climate summit, but during the conference, Prime Minister Narendra Modi said that with financial support from developed countries, India is able to achieve climate neutrality in 50 years, by 2070. He stated that $1 trillion would be needed to achieve India's climate goals[34]. At the Paris conference, Modi emphasized that the responsibility for global warming lies primarily with the developed countries, and therefore they should provide financial support to less wealthy countries in the implementation of costly climate policies[35].

Back in 2018, India adopted the 13th Five-Year National Electricity Plan, according to which by 2022 the expected increase in capacity from renewable sources (wind, solar power plants, biomass, small hydropower plants) will be from 117.8 GW to 175 GW, and by 2027 year will increase by another 100 GW (as of December 31, 2021, the installed RES capacity was 151.4 GW)[36] . In addition, the development of nuclear energy is planned, while coal-fired power plants with a total capacity of 9.5 GW will be decommissioned by the end of 2022[37].

Figure 3. Energy balance of India in 2019



Source: International Energy Agency. URL: https://www.iea.org/countries/india

34 Modi Surprises Climate Summit With 2070 Net-Zero Vow for India. Bloomberg, 1 November 2021. Available: https://www.bloomberg.com/news/articles/2021-11-01/india-will-reach-net-zero-emissions-by-2070-modi-tells-cop26.

35 India pushes rich countries to boost their climate pledges at Paris. The Guardian, 2 December 2015. Available: https://www.theguardian.com/environment/2015/dec/02/india-takes-leading-role-for-global-south-nations-in-climate-talks.

36 Industry Scenario. Invest India. Available: https://www.investindia.gov.in/sector/renewable-energy.

37 National Electricity Plan (Vol. 1). Central Electricity Authority, January 2018. Available: https://cea.nic.in/wp-content/uploads/2020/04/nep_jan_2018.pdf.

At the conference, the Prime Minister announced five new principles for India's climate policy: achieving 500 GW of energy capacity from non-fossil resources – about 50% in the energy balance by 2030, reducing the carbon intensity of the economy by 45%, achieving zero emissions by 2070[38].

Even in 2018, India adopted the 13th Five-Year National Electricity Plan, according to which by 2022 the expected increase in capacity from renewable sources (wind, solar power plants, biomass, small hydropower stations) will be from 117.8 GW to 175 GW, and by 2027 year they will increase by another 100 GW (on December 31, 2021, the installed RES capacity was 151.4 GW). In addition, the development of nuclear energy is planned, and at the same time coal-fired power electric stations with a total capacity of 9.5 GW will be closed by the end of 2022.

Table 3. Statistics of production, import and consumption of natural gas in India in 2021-2022

Year	Gas production[39] (billion m3)	Import[40] (billion m3)	Consumption[41] (billion m3)
2021–2022 (April-February)	31,13	29,29	59,61

The growth of gas generation by the end of 2022 was projected to 25.7 GW, this figure was planned to save until 2027, due to the low level of domestic fuel production in the country[42]. At the early 2022, India really had an approximate gas-fired stations installed capacity of 24.9 GW[43]

Based on IEA data for 2019, natural gas gave about 6% of India's energy balance (Figure 3), and it remained at the same level in 2022. However, according to the plan of Prime Minister Narendra Modi, the country will increase the share of gas in the fuel balance to 15% by 2030 as a "green" fuel for the country's energy transit.

The growth in demand for natural gas is also predicted by a representative of India's largest gas company GAIL, linking it to the growing needs of the industry (including through the new industries), as well as the policy of phasing out coal. There is also the demand for gas in the transport industry and among households[44].

38 National Statement by Prime Minister Shri Narendra Modi at COP26 Summit in Glasgow. Prime Minister's Office of India, 1 November 2021. Available: https://pib.gov.in/PressReleasePage.aspx?PRID=1768712.

39 Monthly Production Report for February 2022. Ministry of Petroleum & Natural Gas, 22 March 2022. Available: https://pib.gov.in/PressReleasePage.aspx?PRID=1808113.

40 Import of LNG. Ministry of Petroleum & Natural Gas. Available: https://www.ppac.gov.in/content/153_1_ImportNAturalgas.aspx.

41 Gas consumption. Ministry of Petroleum & Natural Gas. Available: https://www.ppac.gov.in/content/152_1_Consumption.aspx.

42 National Electricity Plan (Vol.1). Central Electricity Authority, January 2018. Available: https://cea.nic.in/wp-content/uploads/2020/04/nep_jan_2018.pdf.

43 Power Sector at a Glance All India. Government of India, Ministry of Power, 11 February 2022. Available: https://powermin.gov.in/en/content/power-sector-glance-all-india.

44 India's gas consumption to jump more than 3 times by 2030: GAIL Director. Business-Standard, 25 November 2021. Available: https://www.business-standard.com/article/current-affairs/india-s-gas-consumption-to-jump-more-than-3-times-by-2030-gail-director-121112500902_1.html.

The state is approximately 48.5% dependent on the import of "blue fuel" (Table 3). The 2021 gas crisis has led to fears that the country will abandon its obligations to increase the use of gas and return to the use of coal and petroleum coke[45]. In addition, the crisis coincided with the largest coal crisis, which led to a decrease in the generation of electric power by most coal-fired power stations and rolling blackouts. Coal deliveries in India in the fall of 2021 increased despite the crisis, due to an increase in the volume of their own production, including mines, which products are intended for the inner consumption. The government also called on housing utilities to increase coal imports, despite rising prices[46],[47]. High gas prices have played a major role in driving India's coal-fired power generation up to 72.9% in the first eight months of 2021. Rising LNG prices led to a decrease in imports and a reorientation towards long-term supplies, rather than spot contracts, which were massively abandoned among Indian companies in October 2021[48].

This crisis has demonstrated that, despite its climate commitment targets, and with gas prices still high, India is likely to continue to rely on coal for its energy security, at least as a back-up source. Growing dissatisfaction with high domestic gas prices may also play a role: back in August, Congress launched a massive criticism of the Modi government due to the lack of subsidies for the population because of unprecedented price increases[49]. Such criticism continued until the spring of 2022, despite the fact that the Prime Minister confirmed that the growth of gas in the country's energy balance will continue[50]. In addition, the Indian Ministry of Coal Mining has announced the intention to loosen some environmental regulations ahead of the summer season, so not to repeat the situation of 2021[51]. Given the complexity of introducing renewable energy sources for a number of reasons, such as Indian bureaucracy and a complex tax system that involves tariff barriers for domestic cell and module manufacturers, achieving climate goals is becoming increasingly difficult, especially in the absence of support from developed countries.

45 High prices could slow India's transition to gas. Economic Times, 20 October 2021. Available: https://economictimes.indiatimes.com/industry/energy/oil-gas/high-prices-could-slow-indias-transition-to-gas/articleshow/87165103.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.

46 So called "captive coal mines". India asks "captive" coal mines to increase output as power demand rises. Reuters, 7 September 2021. Available: https://www.reuters.com/world/india/india-asks-captive-coal-mines-increase-output-power-demand-rises-2021-09-06/.

47 India asks housing utilities to import coal amid short supply as demand spikes. Reuters, 2 September 2021. Available: https://www.reuters.com/world/india/indias-august-power-output-rises-161-coal-fired-power-by-237-2021-09-01/.

48 High LNG prices put spotlight on India's exposure to global gas market volatility. S&P Global, 15 October 2021. Available: https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/lng/101521-high-lng-prices-put-spotlight-on-indias-exposure-to-global-gas-market-volatility.

49 LPG price rose by Rs 265 in 9 months, Congress slams Modi govt over Rs 25 hike. The Times of India, 18 August 2021. Available: https://timesofindia.indiatimes.com/india/lpg-rose-by-rs-265-in-9-months-congress-slams-rs-25-price-hike/articleshow/85426250.cms.

50 India sets target to raise share of natural gas in energy mix to 15 per cent by 2030. The Print, 24 March 2022. Available: https://theprint.in/economy/india-sets-target-to-raise-share-of-natural-gas-in-energy-mix-to-15-per-cent-by-2030/887140/.

51 India's coal miners want to loosen environmental regulations. Oil and capital, 28.03.2022. (In Russ). Available: https://oilcapital.ru/news/abroad/28-03-2022/ugolschiki-indii-hotyat-oslabit-ekologicheskie-normy.

Japan

Japan has set a goal in its NDC to reduce «greenhouse» gas emissions by 46% by 2030 compared to 2013 levels. Tokyo plans to achieve climate neutrality by 2050. Reductions in energy-related CO2 emissions are expected to be up to 760 Mt compared to 1.4 Gt in 2013[52].

The target of achieving climate neutrality by 2050 was adopted in 2020, the same year the "green growth" and environmental protection strategy was adopted, which covers industries such as energy, automobiles, batteries, food, agriculture, forestry, construction, shipping and aviation, semiconductor/information and communications, and lifestyle industries[53]. It is interesting that the strategy recognizes that it is unrealistic to cover the entire demand for electricity only from renewable energy sources. Thus, by 2050 Japan's energy balance will consist of 50–60% renewable energy sources, 10% hydrogen and ammonia, and 30–40% of energy will be generated by nuclear and thermal power stations. The strategy recognizes that the promotion of electrification in all sectors will increase the demand for electricity by 30–50%[54].

Table 4. Statistics of production, import and consumption of natural gas in Japan in 2020

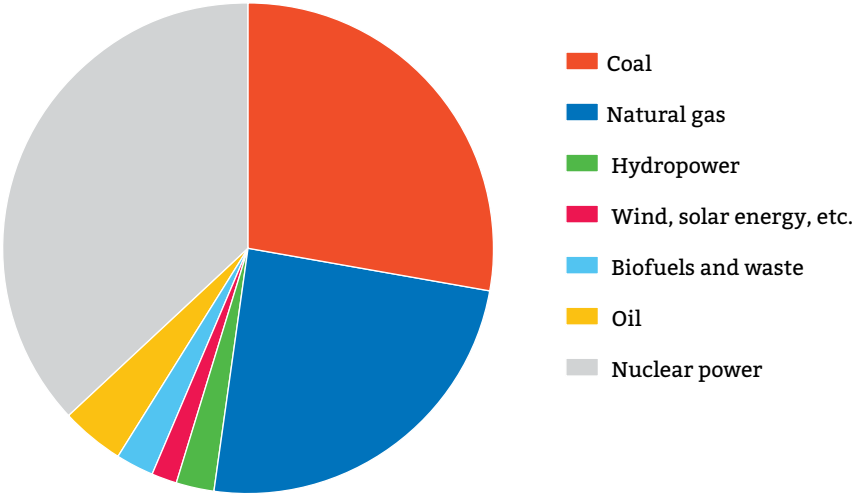
Year	Gas production[55] (billion m3)	Import[56] (billion m3)	Consumption [57] (billion m3)
2020	3,872	102	104,4

According to the strategy, by 2050 it is planned to build a distributed energy system that ensures the efficient use of heat through the implementation of gas cogeneration, as well as to develop the supply of synthetic methane (equivalent to LNG) at a cost equivalent to LNG (40-50 yen/m3) through the development of innovative technologies such as higher methanation efficiency[58].

In addition, intelligent energy systems are becoming an important - an automated software package, based on the collection of information from all participants in the system and its intermediate elements, will allow to distribute all available energy among consumers as efficiently as possible, will ensure the stability of the operation of the

52 Japan's Nationally Determined Contribution (NDC). NDC Registry. Available: https://www4.unfccc.int/sites/NDCStaging/pages/Party.aspx?party=JPN.
53 Green Growth Strategy through Achieving Carbon Neutrality in 2050. Ministry of Economy, Trade and Industry. Available: https://www.meti.go.jp/english/policy/energy_environment/global_warming/ggs2050/index.html.
54 Ibid.
55 OPEC Data. OPEC. Available: https://asb.opec.org/data/ASBData.php.
56 BP Statistical Review of World Energy 2021. Available: ttps://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2021-full-report.pdf.
57 Ibid.
58 Green Growth Strategy Through Achieving Carbon Neutrality in 2050. Ministry of Economy, Trade and Industry. Available: https://www.meti.go.jp/english/policy/energy_environment/global_warming/ggs2050/index.html.

Figure 4. Energy balance in Japan in 2020



Source: International Energy Agency. Available: https://www.iea.org/countries/japan

power grid, while regulating various technical aspects of the process, such as voltage and frequency [2].

In an effort to reduce dependence on imports and at the same time achieve climate goals, Japan announced in July 2021 its intention to reduce the share of LNG in the energy balance to 20% by 2030[59]. It should be noted that the growth of fossil fuels in Japan was noticeable after the disaster at the Fukushima nuclear power station in 2011 and the minimizing of nuclear energy programs for almost a decade. However, the new energy goals imply an increase in nuclear energy as well as renewable energy. In 2010, before the disaster, Japan's energy self-sufficiency rate was 20.3%. The most critical point in the fall of this indicator was 2014 – the level of self-sufficiency of Japan in energy decreased to 6.4% [2].

However, the share of gas consumption of 20% is quite high, taking into account the degree of Japan's dependence on imports by almost 98% (Table 4). The 2021 gas crisis caused a 9–month record increase in electricity prices, with wholesale prices rising to 13-year highs. However, the policy of Japanese utility companies, which began replenishing LNG reserves in advance, prevented a repeat of the winter 2021 crisis due to energy shortages. The snowy winter made adjustments against the backdrop of persistently high gas prices. Coal imports hit a 13-month high in January 2022, but Tokyo expects that gradual restart of the country's nuclear power stations will help to offset periods of rising demand without the need for additional purchases of "dirty" fuel[60]. But the restart of the nuclear power stations is connected with a number of difficulties: first of all, among the Japanese public,

59 Japan set for 60% non-fossil fuel power supply in 2030 in GHG slash drive. S&P Global, 21 July 2021. Available: https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/electric-power/072121-japan-set-for-60-non-fossil-fuel-power-supply-in-2030-in-ghg-slash-drive.

60 Japan coal imports hit 13-month high. Argus, 17 February 2022. Available: https://www.argusmedia.com/en/news/2187739-japan-coal-imports-hit-13month-high.

there is still a widespread opinion about the insecurity of nuclear energy, there are fears of a repetition of the 2011 disaster.

In October 2021, the cabinet held public hearings where conflicting positions about the restart were formulated. According to existing safety rules, nuclear reactors are allowed to operate for 40 years, with a possible one-time extension of their service life up to 60 years. Of the formally operating 33 reactors (in fact, 6 reactors are operating in the country, the rest are not in service[61]), 15 reactors with a total capacity of 14.1 GW should be decommissioned by December 2030, and by 2050 there will not be a single reactor that assumes 40- summer service life[62]. Restarting capacities in the near future is fraught with complex relicensing procedures and safety checks, so the country will have to rely on fossil fuels, despite criticism of the government (from representatives of Japanese renewable energy companies in particular)[63] .

Germany

Germany's Nationally Determined Contribution (NDC) is presented as a part of the European Union Common Plan. An updated version of the document was published in December 2020. It should be taken into account that in order to reduce emissions, the European Union has developed the Emissions Trading System (EU ETS) – a specialized tool that regulates through a system of quotas (in fact, limited by a certain level of permits) the maximum amount of greenhouse gases that can be emitted in a certain territory for a certain period of time. Emissions above the standards are subject to fines. Quotas can be distributed free of charge or sold. Permissions are allocated to each industrial installation covered by the system[64].

According to the EU NDC, by 2030 Germany will reduce its emissions from sectors outside the EU ETS by 38% from 2005 levels[65].

Germany's climate strategy, the Climate Action Plan 2050, aims to reduce emissions from the energy sector by 61–62% by 2030 compared to 1990 by moving away from fossil fuels in favor of renewable energy[66].

61 Reactor restarts could be 'best option' for Japan to ride out energy shortages, senior LDP lawmaker says. Japan Times, 8 March 2022. Available: https://www.japantimes.co.jp/news/2022/03/08/national/restart-nuclear-reactors-ldp-lawmaker/.

62 Japan remains focused on restarting nuclear reactors. Argus, 25 October 2021. Available: https://www.argusmedia.com/en/news/2266794-japan-remains-focused-on-restarting-nuclear-reactors?amp=1.

63 Goldman-Founded Firm Says Japan Must Do More on Clean Energy. Bloomberg, 16 December 2021. Available: https://www.bloomberg.com/news/articles/2021-12-16/goldman-founded-energy-firm-says-japan-must-do-more-on-climate.

64 EU Emissions Trading System (EU ETS). European Commission. Available: https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets_en.

65 Submission by Germany and the European Commission on Behalf of the European Unionand its Member States. NDC Registry. Available: https://www4.unfccc.int/sites/NDCStaging/pages/Party.aspx?party=DEU.

66 Climate Action Plan 2050 – Germany's long-term low greenhouse gas emission development strategy. Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. Available: https://www.bmuv.de/en/topics/climate-adaptation/climate-protection/national-climate-policy/climate-action-plan-2050-germanys-long-term-low-greenhouse-gas-emission-development-strategy#c12737.

The key components of the German energy transition are: increasing energy efficiency and introducing smart systems for generating and transporting electricity in order to reduce energy consumption, increasing the use of renewable energy sources in the energy sector, increasing the use of biomass in the transport sector and building heating, increasing the flexibility of the energy supply system, that is, the possibility of using storage drives energy and use them during periods of peak demand[67]. Also, under the government of Angela Merkel, a plan was adopted to abandon coal by 2038[68], the activists of the new government intend to accelerate the achievement of this goal until 2030[69].

In situation of the conflict with Russia, the German government published in April 2022 a new package of measures to expand renewable energy to 80% in the country's energy balance by 2030, among them 200 GW – from solar energy, 30 GW – from offshore wind and up to 100 GW – for overland wind generation[70].

Table 5. Statistics of production, import and consumption of natural gas in Germany in 2021

Year	Gas production[71] (billion m3)	Import[72] (billion m3)	Consumption [73] (billion m3)
2021	5,16	142	100

67 Electricity 2030. Federal Ministry for Economic Affairs and Energy, September 2016. Available: https://www.bmwi.de/Redaktion/EN/Publikationen/discussion-paper-electricity-2030.pdf?__blob=publicationFile&v=5.

68 Frequently Asked Questions on Germany's coal phase-out. Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection. Available: https://www.bmuv.de/en/topics/climate-adaptation/climate-protection/national-climate-policy/translate-to-english-fragen-und-antworten-zum-kohleausstieg-in-deutschland.

69 German Coalition Eyes 2030 Coal Exit, Years Ahead of Plan. Bloomberg Green, 15 October 2021. Available: https://www.bloomberg.com/news/articles/2021-10-15/german-coalition-eyes-2030-coal-exit-eight-years-ahead-of-plan.

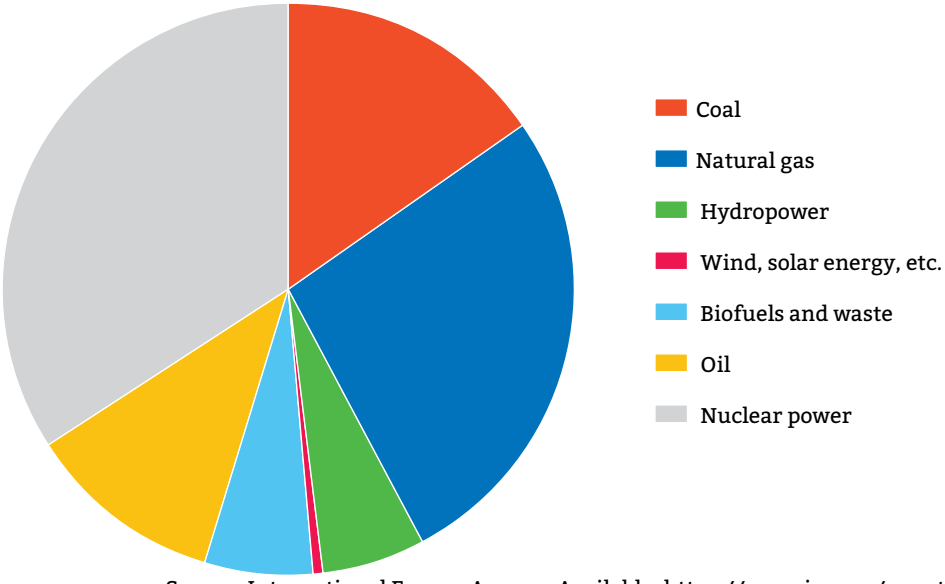
70 Germany unveils plans to accelerate green energy expansion. Reuters, 6 April 2022. Available: https://www.reuters.com/world/europe/germany-present-renewable-energy-expansion-measures-2022-04-05/; Germany to double down on wind, solar amid wider energy policy review. S&P Global, 4 March 2022, Available: https://www.spglobal.com/commodity-insights/en/market-insights/latest-news/electric-power/030422-germany-to-double-down-on-wind-solar-amid-wider-energy-policy-review.

71 Natural gas production on federal lands (Erdgasförderung nach Bundesländern), 30.03.2022. BVEG. Available: https://www.bveg.de/die-branche/statistik/erdgasfoerderung-nach-bundeslaendern/ (In German).

72 ErdgasINFO Dezember 2021 (Erdgasimporte). Bundesamt für Wirtschaft und Ausfuhrkontrolle, 21 February 2022. Available: https://www.bafa.de/SharedDocs/Kurzmeldungen/DE/Energie/Erdgas/2021_12_erdgasinfo.html. Информация на сайте Федерального ведомства по экономике и экспортному контролю дана в тераджоулях (TJ). The information on the website of the Federal Department for Economics and Export Control is given in terajoules (TJ). The equivalent in billion m3 is presented, for example, in the article: Reuters. Factbox: How dependent is Germany on Russian gas? Reuters. Available: https://www.reuters.com/world/europe/how-much-does-germany-need-russian-gas-2022-01-20/.

73 Fakten und Argumente Kurzfristige Substitutionsund Einsparpotenziale Erdgas in Deutschland, 17 March 2022. Available: https://www.bdew.de/media/documents/Kuzfristige_Gassubstitution_Deutschland__final_17.03.2022_korr1.pdf. The information on the website of the Federal Association of Energy and Water Supply Enterprises is presented in billion kWh. The equivalent in billion m3 is presented, for example, in the Reuters article Reuters (см. ссылку 75).

Figure 5. Energy balance of Germany in 2020



Source: International Energy Agency. Available: https://www.iea.org/countries/japan

Almost a third of Germany's energy balance is a natural gas (Figure 5), which is widely used not only in CHP stations, but also for heating buildings and transport. At the same time, dependence on external supplies (Table 5) is almost 95%. The share of Russian pipeline gas deliveries accounts for, according to various sources, from 40 to 50%[74] The conflict around the Nord Stream 2 gas pipeline with a capacity of 55 billion m3 per year, including the protracted certification, became one of the reasons for the rise in prices in the LNG market[75].

It is important to note that in the autumn 2021, a new government came to power in Germany, where the Green Party entered the ruling coalition, and their Head Annalena Burbock received the post of Minister of Foreign Affairs. It also affected the energy policy of the country. Burbock pressured the new chancellor, Olaf Scholz, to approve the Russian gas pipeline, despite significant increases in gas prices[76]. After the outbreak of the Ukrainian crisis and the confrontation with Russia, Burbock began to actively advocate for a complete rejection of Russian gas supplies[77].

74 See, for example: The statement of the Vice-Chancellor, Minister of Economy Robert Habek. Wie sich Deutschland unabhängig von Russlands Energie machen will. Spiegel, 25 March 2022. Available: https://www.spiegel.de/wirtschaft/service/so-will-sich-deutschland-unabhaengig-von-russlands-energie-machen-a-ebd11ed6-44ac-4b7a-bc0b-1bd84a080bdf (In German).

75 Natural gas prices surge on suspension of Nord Stream 2 approval. Currency.com, 16 November 2021. Available: https://currency.com/natural-gas-prices-surge-on-suspension-of-nord-stream-2-approval.

76 German green leader Baerbock opposes Nord Stream 2 permit, calls out Russian 'blackmail'. Politico, 20 October 2021. Available: https://www.politico.eu/article/baerbock-against-operating-permit-for-nord-stream-2/.

77 Baerbock warnt vor Gas-Importstopp. Tagesschau, 11 March 2022. Available: https://www.tagesschau.de/ausland/europa/baerbock-importstopp-gas-oel-101.html.

ISSN 2782-3067 (Print)

The situation worsened in 2021, when sharp criticism of the Russian Nord Stream 2 gas pipeline project began inside and outside the EU, according to experts, due to the increased dependence of the European bloc on fossil fuels and the expansion of Russia's geopolitical influence on the world stage. Russia has been accused of trying to capitalize on the current crisis [1]. Renewable energy began to lose ground to coal even before the start of the active phase of growth in natural gas prices. Thus, according to the results of the first seven months of 2021, the share of coal in energy generation increased to 26.1% in situation of a decrease in wind and solar power generation. Among the reasons, experts name the cold spring and the low length of sunny days, which caused, on the one hand, an increase in demand for heating, and on the other, a decrease in the efficiency of solar farms[78].

The situation worsened in 2021, when sharp criticism of the Russian Nord Stream 2 gas pipeline project began within the EU and outside it, according to experts, due to the increased dependence of the European bloc on fossil fuels and the expansion of Russia's geopolitical influence on the world arena. Russia has been accused of trying to capitalize on the current crisis [1].

High gas prices led to an increase in demand for coal fuel, especially in situation of reduced wind power generation[79]. Coal imports for 2021 amounted to 32.4 million tons, exceeding the level of the pandemic 2020 (however, less than the pre-crisis 2019)[80].

In general, this may indicate that against the backdrop of energy crises and with the start of economic recovery, the need for electricity in Germany it is necessary to cover by the most affordable resources, despite climate goals, especially against the background of the decommissioning of nuclear power stations. After the start of the conflict between the EU and Russia, the initiative to temporarily suspend the decommissioning of nuclear power stations was discussed in German government, but experts soon came to the conclusion that it would be too difficult and economically inexpedient to reverse the initiated procedure, and with a shortage of fuel and the need for significant modernization, the effect would not be noticeable for the winter season of 2022. Because of that (especially in situation of speculation about the complete abandonment of Russian gas), the German Energy Network Agency asked the country's coal-fired power electric stations to remain on standby mode instead of shutting down[81], and Vice-Chancellor Robert Habeck announced the formation of coal reserves that will allow Germany over 30 winter days to provide themselves with electricity even without Russian gas supplies. Notably, the decision was made by Vice Chancellor Robert Habek as a member of the Green Party[82].

78 European Electricity Review: H1-2021. EMBER, 28 July 2021. Available: https://ember-climate.org/insights/research/european-electricity-review-h1-2021/.

79 European Electricity Review 2022. EMBER, 1 February 2022. Available: https://ember-climate.org/insights/research/european-electricity-review-2022/.

80 Hard coal imports for the years 2017 to 2021. Statistisches Bundesamt. Available: https://www.destatis.de/EN/Themes/Economic-Sectors-Enterprises/Energy/Use/Tables/hard-coal-time-series.html#fussnote-1-63124.

81 Some EU members turn back to coal to cut reliance on Russian gas. Climate Home News, 15 March 2022. Available: https://www.climatechangenews.com/2022/03/15/some-eu-members-turn-back-to-coal-to-cut-reliance-on-russian-gas/.

82 Germany plans strategic gas and coal reserves. Clean Energy Wire, 25 February 2022. Available: https://www.cleanenergywire.org/news/germany-plans-strategic-gas-and-coal-reserves.

The current situation in the gas market is pushing Germany to increasingly ambitious targets in introduction of renewable energy. But given the dependence of solar and wind generation on weather conditions, as well as the current underdevelopment of the hydrogen market, reserve fossil fuel capacity during periods of peak demand is an urgent need . With gas prices remaining high or rising further, it is possible that Germany will continue to abandon ambitious climate targets in the short term in favor of energy sustainability.

Conclusions

Large-scale plans for the energy transition, largely amplified by the economic downturn because of the pandemic, postpone the development of clean energy for the long term. As this study shows, in most of the countries' strategies to reduce CO2 emissions, don't take into account potential crises in the fossil fuel market in the periods of increased demand for electricity during economic recovery.

There is a possibility that the changes proposed by import-dependent states in the context of the current crisis do not take into account potential future economic shocks that force in the short term to slow down the implementation of climate commitments in order to maintain energy sustainability.

There is a fundamental difference between India and China and Japan and Germany. The former adhere to the position that in order to ensure economic and energy sustainability, if necessary, one can give up part of the climate obligations, if possible, compensating for the damage when the situation stabilizes, as well as making a gradual, smooth energy transition, which will also allow avoiding additional costs for the end consumer. For India, where most of the population lives below the poverty line, in the absence of support from developed countries, the adoption of more ambitious targets for increasing "clean" energy inevitably means higher tariffs for electricity and fuel.

Japan and Germany, on the contrary, responding to the crisis, set an even higher bar for the implementation of climate commitments in the energy sector by financing the development of additional renewable energy capacities. However, now the introduction to use of new renewable sources capacities in the absence of a sustainable energy accumulation and storage system may not be sufficient during periods of peak demand for electricity in summer and winter – since the generation of wind and solar power stations depends on weather conditions, this in any case implies the need to store reserves of traditional energy sources. The energy transition and creating the infrastructure needed for it is going to be longer than the UN's proposed. Forcing the process, especially in developing countries, could lead to new domestic energy crises, as happened in China in 2021.

ISSN 2782-3067 (Print)

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Contribution of the authors

The author declares no conflicts of interests.

Article info

Submitted: May 10, 2022. Approved after peer reviewing: May 26, 2022. Accepted for publication: June 3, 2022. Published: 27.06.2022.

The author has read and approved the final manuscript.

Peer review info

«Russia & World: Scientific Dialogue» thanks the anonymous reviewer(s) for their contribution to the peer review of this work.