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Green Energy: New Opportunities or Challenges to Energy Security for the Common Electricity Market of the Eurasian Economic Union Countries

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Abstract: The article discusses alternatives to the development of the common electricity market of the Eurasian Economic Union countries. In the study, the authors identified three tasks: to analyze the process of forming a unified energy market for the EAEU countries; to assess the achievability of indicators of "greening" the economy of the EAEU countries according to the adopted Millennium Goals by 2025 and 2030; and to consider the impact of various factors on the development of the common electricity market of the Eurasian Economic Union countries in the conditions of the current economic crisis. The research hypothesis suggests that the energy unification of the countries will not lead to the abandonment of the use of traditional energy resources, but the need to increase the efficiency and environmental friendliness of their use will come into focus, and the active inclusion of the electric power industry in modern global "green" trends based on the development of renewable energy generation sectors will make it possible to solve the problems of energy security of countries more effectively in the long-term participants of the CEM. The authors believe that it is not a deficit but on the contrary an excess of traditional energy resources that provides a trend of progressive movement towards a "green" economy, and the manifestations of the "Dutch disease" with a properly structured state energy policy and effectively selected incentive measures cannot serve as a significant brake on this movement. At the same time, the formation of a common electricity market of the EAEU countries should prioritize not just the idea of integration but also the idea of creating an alternative electricity market based on the introduction of modern electricity generation technologies and the creation of conditions that stimulate the development of alternative energy.

Keywords: common electricity market (CEM); green energy; renewable energy sources (RES); energy generation forecast; Eurasian Economic Union (EAEU)

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1. Introduction

The modern world energy industry has entered a new phase of its development characterized by the strengthening of integration processes; the improvement of technologies related to the extraction, production, and transportation of energy resources; as well as the search for new energy sources in order to ensure energy security.

In general, long-term energy security is understood as "uninterrupted availability of energy resources at an affordable price" [1] and the timely provision of energy resources to the production needs of companies and household needs of the population. Short-term energy security is associated with the ability of the energy system to respond quickly to possible changes in the fuel and energy balance.

Global energy markets are characterized by price volatility and instability of development. In order to minimize risks, importing countries adopt government programs aimed at increasing the share of renewable energy sources in both total energy consumption and electricity consumption. Hydrocarbon exporters are also actively investing in the development of renewable energy, as it is the provision of energy security that pushes countries to search for new energy sources and the development of new energy technologies.

The modern development of the world economy is aimed at implementing the strategy of "green growth" as an integral component of the concept of sustainable development. Green growth involves stimulating economic growth while preserving natural resources in order to ensure the well-being of present and future generations of Earth's inhabitants. The concept of green growth activates investments and innovations that ensure sustainable development and the emergence of new economic opportunities. At the same time, not only new ways of production and consumption must be found but also new ideas about progress. According to CAWATERinfo [2], the concept of green growth is based on four principles:

- "The principle of eco-efficiency", according to which the achievement of the maximum utility of goods and services should be ensured by a minimum impact on the environment in the process of their production and consumption;
- "The principle of resource conservation", meaning the conservation of natural resources;
- The "principle of unity", which requires the coordination of the actions of the subjects of economic processes in making managerial decisions concerning economic development;
- "The principle of intersectorality", supposing the involvement of various social segments in the process of managing economic development.

Green growth correlates with the concept of a green economy. According to the definition of UNEP [3], it is an economy in which "the costs associated with environmental degradation are internalized, and environmentally friendly and efficient technologies and sustainable agriculture serve as the main drivers of economic growth, job creation and poverty reduction". An inclusive green economy [4] is a high-tech, low-carbon or carbon-free, efficient, and clean-in-production economy that creates conditions for improving well-being and increasing social justice.

In the context of green growth, investments in renewable energy are intensifying all over the world, as a result of which energy security at the global, national, and local levels is increasing, and energy poverty is decreasing. The cost of renewable energy is becoming increasingly competitive compared to energy derived from fossil fuels. Growing investments in renewable energy are becoming part of an integrated greening strategy for global economic development [2]. In this regard, the principles of green growth should be integrated into the strategic planning and management of the development of both individual national economies and their unions, created, among other things, to solve energy security problems.

Thus, in the coming decades, the generation of energy from renewable sources will represent the defining trend of the global energy system. At the same time, the problem of efficient use of traditional resources and the potential of existing fuel and energy complexes remains urgent. This problem concerns, first of all, large exporters of energy resources, for example, the member countries of the Eurasian Economic Union (EAEU).

According to T. Mansurov, a member of the Board (Minister) for Energy and Infrastructure of the Eurasian Economic Commission [5], the Eurasian Economic Union accounts for about one-fifth of the world's reserves and production of natural gas and more than one-fourth of its exports, more than one-fifth of coal reserves and 6% of its production, 7% of world oil reserves and 15% of its production and exports, and 5% of electricity production. In general, the share of the fuel and energy complex in the EAEU is one-sixth of the GDP and more than one-third of the industrial production. At the same time, exports are mainly focused on the countries of the European Union.

Accordingly, green growth, on the one hand, opens up new opportunities for the global economic system as a whole but, on the other hand, creates certain challenges for exporters of traditional energy resources. It is this problem upon which attention is focused in this article, the authors of which investigated the state and prospects for the development of the common electricity market (CEM) of the EAEU from the point of view of the possibilities of inclusion in global trends and overcoming risks and dangers through the "greening" of economic development.

The authors have previously considered the problems of the development of the electricity market in Kazakhstan and other oil-producing countries [6–9]. However, given Kazakhstan's entry into the emerging unified energy market of the Eurasian Economic Union, it seems appropriate to consider the prospects for the development of the common market.

The purpose of this study is to identify alternatives for the development of the common electricity market of the countries of the Eurasian Economic Union in the long term on the basis of forecasting the main development trends and assessing the impact of various factors in the conditions of the current economic crisis.

The author's hypothesis suggests that the unification of the countries will not lead to the abandonment of the use of traditional energy resources, but the focus of attention is on the need to increase the efficiency and environmental friendliness of their use, and the active inclusion of the electric power industry in modern global green trends based on the development of renewable energy generation sectors will allow, in the long term, to more effectively solve the problems of energy security of the CEM participating countries. At the same time, the current situation on the energy market, i.e., the rapid rise in energy prices, can not only slow down the global movement towards "greening" the economy due to funds for solving pressing economic problems and increasing costs associated with the green transition but also exacerbate the "Dutch disease" of energy exporting countries, including country participants of the CEM, which will jeopardize the timeliness of the implementation of the green agenda in them and the implementation of national programs for the transition to alternative energy sources.

The scientific novelty of the study is to identify the relationship between a pragmatic approach to a more efficient and environmentally friendly use of traditional raw materials and the movement towards the introduction of alternative models of energy production, allowing to accumulate resources for a timely transition to renewable energy sources, ensuring the position of energy-safe and economically efficient development of the country. At the same time, it is proven that not a deficit but on the contrary an excess of traditional energy resources provides a trend of progressive movement towards a green economy, and the manifestations of the "Dutch disease" with a properly structured state energy policy and effectively selected incentive measures cannot serve as a significant brake on this movement. Here, the formation of the common electricity market of the EAEU countries should prioritize not just the idea of integration but the idea of creating an alternative electricity market based on the introduction of modern electricity generation technologies and the creation of conditions that stimulate the development of alternative energy.

2. Literature Review

The focus of the scientific interest of this article is the problems of energy security raised in the works of Böhringer & Keller [10]; Checchi, Behrens, & Egenhofer [11]; Chester [12]; Cherp & Jewell [13]; Kruyt et al. [14]; Mitchell [15]; and Joskow [16]. Revealing the multidimensional nature of this phenomenon, a number of authors focus on economic efficiency, environmental component, social acceptability, as well as cultural and political aspects of this phenomenon [17–21]. The concept of energy security through the prism of risk identification and control is considered in the works of Winzer [22]; Jansen & Seebregts [23]; and Levèfre [24]. The solution to the problem of energy security by creating the common electricity market is reflected in the works of Mansurov [5]; Sarkisian [25]; Shafiev [26]; Tsedrik [27]; and others. In addition, of interest are studies, for example, of Bohi et al. [28], expanding the concept and considering it in relation to the concept of sustainable development.

The solution to the problem of energy security and sustainable development lies in the widespread use of the principles of the green economy. Scientists from all over the world are dealing with the correlation of the green economy and sustainable development as well as identifying the degree of their impact on economic growth. Thus, the problems of ecologization of the economy were raised in the works of Boulding [29]; Cato [30]; Costanza [31]; and Martínez-Alier & Muradian [32]. Ayres et al. [33]; Asafu-Adjaye [34]; Mahadevan & Asafu-Adjaye [35]; and Asafu-Adjaye et al. [36] assessed the contribution of energy to economic growth. Studies of Asafu-Adjaye & Mahadevan [37]; Le Quere et al. [38]; Cook et al. [39]; Morriss et al. [40]; Alvarez et al. [41]; Forstater [42]; Wei et al. [43]; and Bowen [44] are devoted to the issues of low-carbon development and green labor, the impact on the economy, and jobs of state support for renewable energy generation sectors. The consideration of sustainability as an opportunity, as a fair development that gives future generations a chance, is reflected in the works of Barrett [45]; Howarth [46] and Brown [47]. The problems of prospects for the use of renewable energy sources in the context of sustainable development of the electric power industry were considered in articles by such authors as Strielkowski et al. [48] and Chebotareva et al. [49].

Another aspect reflected in this article is the "Dutch disease". In this case, the "Dutch disease" is considered as one of the possible scenarios for the development of the economies of energy exporting countries in the conditions of a sharp increase in energy prices and the strengthening of the national currency. The implementation of the scenario may slow down the green transition. In the work of Corden & Neary [50], a classic model is presented that reveals the mechanism of the "Dutch disease" as well as the method of its treatment by redistributing by the state the received rent between sectors of the economy. Van Wijnbergen [51] focused on the issues of state policy regarding the use of the received windfalls. Among the works devoted to the analysis of "Dutch disease" can be highlighted the works of Oomes & Kalcheva [52]; Rajan & Subramanian [53]; Bereznyatsky & Brodsky [54], and a number of others.

3. Research Methodology

As the main scientific and methodological basis of the study, system analysis was adopted as a combination of methods and techniques for studying compound objects-systems representing a complex set of interacting elements, which is the Eurasian Economic Union as a whole and the common electricity market created by its members. At the same time, the emphasis is on identifying the connections between the elements of the system and establishing their influence on the behavior of the system as a whole. The documents regulating the creation of the CEM and defining the target model, forms, and methods of market regulation as well as mechanisms of interaction of market entities were analyzed.

In the process of factor analysis, internal and external factors contributing to or hindering the transition to an energy system based on renewable energy sources in line with global trends of green development were identified. The innovative changes taking place in the electric power industry, technological shifts in the generation of electricity, and options for the transition to new generations of energy systems were studied.

As part of the comparative and structural analysis, the assessment of the state of the energy industry of the member countries of the CEM was carried out. The analysis of the volume of electricity produced, its structure by fuel type, and the share of renewable energy sources in generation and final consumption was made. The comparison of tariffs for electric energy was also carried out.

Analytical calculations of trends for each type of generation were executed to assess the prospects for the development of renewable energy in the CEM countries. The mathematical model for each type of generation in each country is formed in accordance with the construction of graphic curves of trends and calculating the equations of regression that approximate actual data for previous periods. The construction of a general multifactorial regression model of energy generation, taking into account the contribution of various generation sources for each country, seems to be a very interesting task for the next research of the authors. At this stage of the study, it was important for the authors to understand whether it is possible to achieve targeted indicators of strategic documents of the countries under consideration in the generation of energy while maintaining existing energy generation trends from various sources. Based on the selected regression equations, the energy volume forecast for each type of generation for 2025 and 2030 for each country was calculated. Next, the average growth rates of energy volumes for all types of generation were calculated, and based on these data, the energy volume for each type of generation for 2025 and 2030 for each country was also calculated. By comparing the data obtained, conclusions were drawn about the possible volume of renewable energy generation and classical generation sources. The forecasts were supplemented by the results of expert assessments that consider the current situation on the world energy markets related to the start of Russia's military special operation in Ukraine and the subsequent adoption of sanctions against Russia. Expert assessments were obtained from open sources. The forecasts made by experts allowed us to draw conclusions about the realism of the forecasts obtained mathematically.

4. Global Trends and Their Impact on the State of the Common Electricity Market of the EAEU

Despite the significant reserves of natural resources, for the member states of the Eurasian Economic Union as well as for other countries of the world, the problems of energy security are urgent, which cannot be solved by countries individually. Strategically important in this aspect was the Treaty on the Eurasian Economic Union, signed on 29 May 2014 by the heads of state of Russia, Belarus, and Kazakhstan and later by Armenia and Kyrgyzstan. A significant section of the agreement is energy, the development of which determines the growth rates of national economies, their stability, and competitiveness in international markets.

In May 2015, the concept of the formation of the common electric power market of the Union was adopted, defining its target model, management structures, mechanisms of interaction of market entities, forms and methods of regulation, as well as stages of market formation. In December 2016, the program for the formation of the common electricity market of the EAEU was approved, which includes a complex of organizational and technical measures and legislative norms aimed at developing an electronic trading system, information exchange as well as a system of acts regulating the functioning of the electric power market. In May 2019, the Supreme Council of the EAEU signed an international agreement on the formation of the common energy market of the Union in the form of a protocol on amendments to the treaty on the Eurasian Union, the ratification of which is currently being carried out by the EAEU member states. On 20 December 2019, the action plan for the formation of the common energy market of the Union was approved, in particular, the dates for the entry into force of a number of rules concerning electric energy [55]:

- Access to services for interstate transmission of electric energy (capacity);
- Mutual trade in electric energy;
- Determination and distribution of the capacity of interstate sections;
- Information exchange;
- Development of interstate electric networks.

Undoubtedly, fossil fuels, primarily natural gas and oil, will remain the basis of the global energy system over the coming decades. The pressure on the energy system continues to grow. This is primarily due to the growth of the world population, which, according to the forecasts of the IEA [56], will grow by 2 billion people by 2050. Rising incomes will increase the demand for energy services. Energy consumption is also increasing due to the fact that many developing economies are currently experiencing a "historically intensive period of urbanization and industrialization".

At the same time, a sharp transition to an energy system based on renewable energy sources is likely, which poses a certain risk for the EAEU members. The World Energy Outlook [56] offers several development scenarios (Table 1).

Table 1. Demand for fossil fuels.

Scenario	Oil, mb/d	Natural Gas, bcm	Solar PV and Wind Generation, TWh
1. Historical, 2020	88	4000	2500
2. Stated Policies Scenario, 2030	103	4550	7700
3. Announced Pledges Scenario, 2030	96	4250	9300
4. Net Zero Scenario, 2030	72	3740	12,000

According to NetZero Scenario, in 2030, low-emission power generation sources will account for the vast majority of additional capacity, and the annual increase in solar and wind energy will reach 500 GW. As a result, coal consumption in the energy sector will decrease by 20% compared to the recent maximum. The report notes that the rapid growth in electric vehicle sales and the continued improvement in fuel efficiency will lead to a peak in oil demand around 2025, and global energy demand will reach a plateau after 2030 [56]. At the same time, the change in the structure of global energy demand is associated with an increase in the share of Asian countries in it to 60%.

An important factor of development is investment. Currently, the clean energy sector is attracting more and more investments while reducing capital investments in oil and gas exploration and production. Currently, the share of the oil, gas, and coal sector accounts for about 70% of investment injections, but in the future, this share may decrease to 60%. It should also be noted that due to the COVID-19 pandemic, the trend of sustainable development has been disrupted. This is especially true for poor countries. Investments to support energy transformation are not enough. Therefore, the bet is on attracting private investors, but here, there is a problem of motivating private players who do not yet see the right balance of risks and rewards.

A special emphasis in the development scenarios is placed on reducing the demand for coal (at 10–55%). In recent years, the construction of coal-fired power plants has sharply decreased. This is due to the possibility of replacing them with renewable energy alternatives as well as growing awareness of environmental risks and limited funding opportunities. In order to reduce emissions from coal-fired power plants, it is proposed to equip them with carbon capture, utilization, and storage (CCUS) to reconstruct them in order to ensure the possibility of co-burning coal with low-emission fuel (biomass or ammonia). However, this requires additional investment.

There is a stable structural dynamics of price changes. It is known that oil prices are formed mainly under the influence of financial factors on the world's leading stock exchanges, which leads to a high level of their volatility. In the long term, the level of oil prices will tend to decrease, and the fall in oil prices will intensify with the growth of inter-fuel competition and the transformation of oil into a "resource of yesterday" [57]. It is predicted that the gas pricing model will change with reference to the prices of final consumer services and not to oil prices. Coal prices will rise due to the development of clean coal technology, which requires additional investments. Prices for renewable energy sources will decrease due to solving the problems of energy storage, deployment of technologies with low short-term costs, and substantial government support in many countries of the world.

In order to have an idea of innovative changes in the electric power industry, we will give examples of technological shifts in electricity generation. It is possible to distinguish technologies that have already reached their maturity (technologies of gas, wind, bio- and hydro-electric power, thermal reactors in nuclear power) as well as emerging technologies that have the future behind them (fast neuron reactors; new coal-fired power-generation technologies related to the use of power units with supercritical and ultra-supercritical steam parameters, new coal combustion methods, and coal gasification technologies; solar photovoltaics based on thin-film and multi-node technologies) [57].

Regarding the transition to new generations of energy systems, the following options can be indicated:

- Firstly, smart grids (intelligent power supply networks), which are modernized power supply networks using info communication networks and technologies to collect information about the production and consumption of electricity, automatically ensuring the stability of the system, its efficiency, reliability, and economic feasibility [58];
- Secondly, "virtual electric stations" (groups of distributed electricity generators under unified management) is a high-tech system that aggregates electricity from several manufacturers (solar panels, biogas and wind farms, hydraulic installations, etc.) and/or consumers (organizations and households). Virtual electric stations support the energy system, acting as a balancing mechanism of production and consumption [59];
- Thirdly, technologies for the accumulation of electricity through the creation of pumped storage power plants used to equalize the daily heterogeneity of the electrical load schedule and increase the reliability of energy supply [60,61];
- Fourth, technologies for long-distance transportation of electricity based on the use of high-voltage direct current transmission lines (HVDC), which allow the transportation of electricity between unsynchronized AC power systems and are more economical when transmitting large amounts of electricity over long distances.

Thus, a new generation of energy systems with intelligent control is being formed, starting with production and ending with final consumption. At the same time, in the future, there will be a trend of outstripping growth in electricity consumption in relation to energy consumption as a whole. In terms of the growth rate of electricity consumption, developing countries will be ahead of developed countries. As a result, the share of developing countries in electricity consumption will increase from 48% in the current period to 52–55% by 2030 and to 65–69% by 2050 [57].

The growth of international electricity trade will require solving both technical, organizational, economic, and political problems. A wide variety of market models are being used in the electricity markets. At the same time, the evolution of electric power markets is aimed at transforming them from commodity markets into service markets and further, through the formation of new generation electric power systems, into technology markets.

When forming new markets, including the common electricity market of the EAEU, it is impossible not to consider modern trends that open up new prospects for development. Thus, the integration of the "greening" strategy into the activities of the EAEU and the use of new generations of technological innovations, which were mentioned above, will help to master new sources of development due to such factors as:

- Increasing productivity and improving the efficiency of the use of natural resources;
- Reduction of waste and energy consumption;
- Intensification of innovative activities that allow creating values in new ways and solving environmental problems;
- Creation of new markets that are more stable and predictable, including through public policy;
- Increasing investor confidence as a response to the growth of stability and balance of macroeconomic conditions.

Understanding the current state of the national electric power systems of the EAEU member states and the possibilities of their unification on a new basis will allow us to assess the prospects for their development considering global trends.

Table 2 shows the main technical and economic indicators of the operation of the energy systems of the states forming the EAEU common electricity market.

Table 2. Main technical and economic indicators of the energy systems of the participating countries of the EAEU common electricity market for 2020.

Indicators	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
Electricity production, total (million kWh), including:	7723	37,932	108,629.1	15,379.6	1,085,418
Thermal Power Plant (TPP)	3166.2	36,735	96,696.1	1580.5	648,899
Nuclear Power Plant (NPP)	2756.2	0	0	0	215,914
Hydroelectric Power Plant (HPP) over 25 MW	946.0	157.6	9102.2	13,782.7	214,240
Renewable energy sources, total, including:	854.6	1039.4	2830.8	16.4	6365
HPP less than 25 MW	831.6	240.4	558.1	16.4	0
Solar Power Plant (SPP)	21	175	1237.5	0	1862
Wind Power Plant (WPP)	2	194	1028.7	0	1138
Geothermal					421
Wastes	0	14	0	0	2944
Biogas	0	416	6.5	0	0
Share of generation in total output by fuel type (%)					
Coal	0	0.08	68.9	8.7	16.2
Gas and petroleum products	40.99	96.76	20.1	1.6	43.6
HPP	12.25	0.42	8.4	89.6	19.7
NPP	35.69	0	0	0	19.9
Renewable Energy Sources (RES) (with the exception of HPP more than 25 MW)	11.07	2.74	2.6	0.1	0.6
Electricity consumption, total (million kWh)	6710	37,432	107,874.4	15,232.2	1,074,680
Balance (million kWh)	1012	500	754.7	352.6	10,738
Installed capacity (MW)	3429.1	10,074.0	23,622.0	3893.4	251,097.0
Maneuverable power (MW)			3170.0	3031.0	82,423.0
Share of maneuverable power (%)			13.4	77.8	32.8
Absolute maximum load (MW)	1233.0	5897.0	15,671.0	3274.0	150,434.0

Source: compiled based on data from [62,63].

The data given in the table allow us to identify a number of economic factors contributing to the process of integration of the national electric power markets of the EAEU member states and the formation of a unified electric power market.

Thus, one of the fundamental factors is the low utilization rate of the installed production capacities of national energy systems since their significant underutilization leads to the possibility of exporting electricity to neighboring regions, especially if its prices are higher there. It is also possible to import electricity at a lower price, including to ensure continuous and reliable energy supply to consumers. The average utilization of generating capacities in the Union countries is about 55% of the available capacity. Further, the different structure of the generating capacities of national energy systems allows them to effectively complement each other to cover the base and peak loads of the member states [64].

An important factor in the formation of the common energy market of the EAEU is also the presence of a developed network infrastructure that connects the national energy systems of the Union states. The capacity of the existing cross-border transmission lines allows for electricity trade between the countries of the Union in the amount of about 30 billion kWh per year. At the same time, the actual volume of mutual trade in electricity is only about 10 billion kWh [64–66].

Consider the electrical balance of the participating countries of the common electricity market of the EAEU (Table 3). The maximum production and consumption of electricity falls on Russia. The table also shows that almost all countries (with the exception of Belarus) export more electricity than they import. Moreover, exports are carried out both to the EAEU countries and beyond. The dynamics of electricity production and consumption are positive.

Table 3. Power balance of the countries participating in the EAEU common electric power market, billion kWh.

Indicators	2015	2016	2017	2018	2019	2020
Armenia						
Installed capacity, GW	3.2	3.3	3.3	3.3	3.4	3.4
Electricity produced, billion kWh	7.79	7.31	7.76	7.79	7.68	7.72
Electricity consumed, billion kWh	6.5	6.4	6.6	6.4	6.72	6.7
Electricity import, billion kWh	0.17	0.28	0.31	0.2	0.3	0.32
Electricity export, billion kWh	1.42	1.22	1.44	1.63	1.25	1.33
Belarus						
Installed capacity, GW	9.7	9.7	9.7	9.7	9.7	9.7
Electricity produced, billion kWh	34.08	34.08	34.08	34.08	34.08	34.08
Electricity consumed, billion kWh	36.7	36.7	36.7	36.7	36.7	36.7
Electricity import, billion kWh	6.1	6.1	6.1	6.1	6.1	6.1
Electricity export, billion kWh	3.48	3.48	3.48	3.48	3.48	3.48
Kazakhstan						
Installed capacity, GW	21.3	22.0	21.7	22.1	22.9	22.936
Electricity produced, billion kWh	91.88	94.69	103.2	107.6	106.88	108.6
Electricity consumed, billion kWh	91.88	93.44	98.83	104.13	100.39	107.87
Electricity import, billion kWh	1.61	1.32	1.33	1.56	1.9	1.57
Electricity export, billion kWh	1.61	2.57	5.7	5.04	2.4	2.32
Kyrgyzstan						
Installed capacity, GW	3.6	3.6	3.9	3.9	3.9	3.9
Electricity produced, billion kWh	13.03	13.26	15.51	15.52	15.12	15.37
Electricity consumed, billion kWh	13.58	13.39	14.3	14.77	15.11	15.23
Electricity import, billion kWh	0.73	0.33	0	0	0.27	0.35
Electricity export, billion kWh	0.18	0.2	1.22	0.76	0.27	0
Russia						
Installed capacity, GW	243.2	244.1	246.9	251.1	253.6	253.6
Electricity produced, billion kWh	1067.5	1090.9	1094.3	1115.1	1121.5	1085.4
Electricity consumed, billion kWh	1055.9	1076.5	1083.7	1102.5	1103.1	1074.7
Electricity import, billion kWh	6.59	3.19	6.4	5.2	1.62	1.38
Electricity export, billion kWh	18.24	17.69	17.0	17.78	20.05	12.12

Source: compiled based on data from [55,62,67].

The formation of the common electricity market of the EAEU involves the establishment of free bilateral trade relations between market participants, in which they independently determine prices, volumes, and conditions for the supply of electricity. The expansion of cross-border trade in electricity will occur through the development of a segment of free bilateral contracts and the formation of a centralized platform for the sale of electricity based on the principles of free marginal pricing in the day-ahead trading segment. At the same time, national market models for the functioning of energy systems are preserved, which complicates the process of integrating national electricity markets and creating a common electricity market due to their diversity [66,68].

Table 4 presents the electricity tariffs in the CEM member countries. The minimum average tariff in 2020 was formed in Kyrgyzstan (USD 2.456 cents/kWh) and the maximum in Belarus (USD 10.00 cents/kWh). This is explained by the fact that in Kyrgyzstan, electricity generation is predominantly (90%) carried out by hydroelectric power plants and in Belarus (86%) by thermal power plants (Table 2). If we consider the share of generation in the total output by type of fuel, then in Belarus, 59% is gas and oil products; in Kazakhstan, 68.9% is coal; in Russia, 50% gas and oil products; and in Kyrgyzstan, 85% HPPs.

Table 4. Electricity tariffs in 2020, USD cents/kWh.

Indicators	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia	China	USA
Average tariff	8.21	10.00	4.47	2.456	5.6	9.57	9.665
Industry	7.36	10.28	5.04	3.06	6.051	10.3	6.83
Population	8.67	6.75	3.01	1.45	4.725	8.84	12.5

Thus, the purpose of the formation of the CEM was to ensure the sustainable development of the economies of the EAEU countries; increase energy security, economic efficiency, and reliability of the operation of electric power complexes; meet consumer demand for electric energy (capacity); reduce the growth rate of electricity prices; as well as increase competitiveness in the world market states, i.e., members of the EAEU, in the field of electric power industry. At the same time, the balance of economic interests of the CEM participants is maintained on the basis of market relations and fair competition.

The creation of the CEM within the framework of the EAEU is aimed at solving the following tasks:

- Development of market mechanisms for mutual trade in electric energy and increase in the volume of trade and increase in the level of competition in the supply of electricity;
- Ensuring access of the participants of the CEM to the services of natural monopolies in the field of electric power industry in the territories of the member states of the EAEU;
- Maintaining a high level of reliability and fault-tolerance of energy complexes due to the parallel operation of the power systems of the CEM;
- Increasing the transparency of pricing, convergence, and stabilization of prices for electricity, including a reduction in the rate of price growth for the end consumer;
- Optimization of the use of generating capacities, including optimization of fuel costs;
- Creating favorable conditions for investing in electric power facilities.

The possibilities of each subject of the internal wholesale markets of the member-countries when participating in the common electricity market of the Union will primarily depend on the energy stability in the participating countries and the economic situation in the world (growth of industrial production), on the development of generating capacities, and on the going policy in the field of power industry in the member countries.

The effect of the creation of a common market is expressed in an increase in the efficiency of the use of generating and transmission capacities and an increase in the volume of mutual and foreign trade in electricity. In addition, now we can talk about the lost profit that the EAEU countries have as a result of the separate operation of the electricity markets. There is an urgent task of lost profit assessment based on the development of predictive models for the growth of trade turnover due to an increase in the supply and transit of electricity between the EAEU countries. Its undertaking will make it possible to substantiate investments in the infrastructure of the common electric market as well as in new technologies for generating electricity, which have already been mentioned above.

The formation of the common electricity market of the EAEU as a whole is an effective tool for using internal reserves in the field of energy, jointly overcoming global economic challenges and developing and modernizing national energy systems in order to improve the welfare of the economies and ensure the energy security of the EAEU member states.

5. Development of "Green" Energy in the EAEU Countries

Speaking about the prospects for the development of the common energy market of the EAEU countries, it is necessary to focus on renewable energy sources since their share in energy generation is extremely low (Table 5).

Table 5. Renewable share in final energy consumption (SDG 7.2) *.

EAEU Country	2015	2016	2017	2018	2019
Armenia	10.7	13.2	12.6	11.1	10.3
Belarus	6.8	6.7	7.3	7.2	7.8
Kazakhstan	1.7	2.1	2.0	1.9	1.9
Kyrgyzstan	23.3	21.9	24.5	23.2	27.9
Russia	3.2	3.4	3.2	3.2	3.2

* including HPPs over 25 MW. Source: compiled from [69].

The share of renewable sources in generation is somewhat different from consumption (Table 6).

Table 6. Share of renewable energy sources as a percentage (%) of total energy supply *.

EAEU Country	2015	2016	2017	2018	2019
Armenia	28.34	32.18	29.28	30.02	31.71
Belarus	0.96	1.25	2.28	2.07	2.58
Kazakhstan	10.36	12.71	11.35	10.45	10.79
Kyrgyzstan	85.19	86.67	91.56	92.23	91.69
Russia	16.27	17.43	17.45	17.67	17.96

* including HPPs over 25 MW. Source: compiled from IEA data [70].

The difference in the share of RES in generation and consumption is explained by the fact that part of the generated energy is sold (if there is an excess in the country) or bought (if there is a shortage in the country) on the external market.

The EAEU ranks first in the world in oil production and second in the world in natural gas production. The total cost of Russia's raw materials alone is estimated at USD 75 trillion. The EAEU also ranks first in the world in terms of area and has a strategic geographical position between the EU and China with great potential for transit development [71]. Each of the EAEU countries itself forms plans for the development of its energy potential, but these plans are subsequently coordinated at the level of the EAEU. The same applies to plans for the transition of national economies to RES. Next, the plans of each country for the construction of renewable energy facilities will be considered.

5.1. Armenia

Today, RES accounts for 23.32% of all energy generation in Armenia. The main share of RES is represented by hydroelectric power plants (23.01%), with small hydropower plants accounting for 10.77% of electricity generated. The presence of mountain rivers represents a great potential for increasing renewable energy in the economy of the country. A consistent and reasonable transition to clean generation sources will allow Armenia to form its ideal "green square", and these goals have already been set in the new strategic energy program of Armenia until 2040.

According to the Energy Department of the Ministry of Territorial Administration and Infrastructures of Armenia, the main priorities for the development of the Armenian energy sector are to increase the share of renewable energy sources and the nuclear component. It is planned to build three large solar power plants by 2030: Masrik with a capacity of 55 MW, Aig-1 and Aig-2 stations with a capacity of 400 MW; five medium solar plants with a capacity of 120 MW, small solar power plants with a capacity of 325 MW, and autonomous stations with a capacity of 100 MW. Until 2040, it is planned to build wind farms with a total capacity of 500 MW, subject to competitive tariff offers. Moreover, by 2023, it is planned to additionally build small hydropower plants with a capacity of 50 MW within the framework of already-issued licenses [72].

In December 2019, Armenia committed itself to receive 30% of its electricity from renewable sources until 2025 [73], and by 2030, Armenia intends to increase the share of renewable energy in the country's energy balance to 70% [74].

5.2. Belarus

Today, 96% of energy in Belarus is generated using gas imported from Russia. This is primarily due to the low cost of producing such energy.

Back in 2017, the cost of generating electricity from the own sources of energy supply organizations amounted to USD 4.55 cents/kWh, and considering the costs of purchasing electricity (including import and purchasing it from block stations) as well as the transmission, distribution, and sale of electricity, the cost is USD 7.07 cents/kWh. At the same time, the weighted average tariff at which state energy supply organizations buy electricity produced by renewable energy installations is about USD 22 cents per kWh. The sellers of this energy only produce it, and the energy supply organizations bear the costs of transmission, distribution, and sale of energy to consumers.

Given such a ratio of prices for the production and purchase of electricity, it is very difficult to convince state energy supply organizations that it is more profitable for them to buy electricity from renewable sources at a price of USD 22 cents per kWh than to produce it on imported natural gas.

Belarus plans to ensure the share of renewable energy in consumed energy at 7% in 2025, 8% in 2030. Belarus now has about 500 MW of renewable energy capacity: 82 photovoltaic stations, 53 hydroelectric power plants, 30 biogas complexes, over 100 electric power plants, and 10 wood-fired mini-CHPs. All this allows not only to reduce the consumption of traditional energy sources but also to reduce CO_2 emissions. By 2025, it is planned to achieve a renewable energy capacity of about 630 MW. This level will allow keeping the share of RES at the level of 8% [75].

One of the areas of development of the electric power industry in Belarus is nuclear power. In 2011, a contract agreement was signed between CJSC Atomstroyexport (Russia) and State Institution "Directorate of Nuclear Power Plant Construction" (Belarus) for the construction of two nuclear power units in the Grodno region. Design capacity of two power units of 2400 MW each was planned, commissioning in 2021 and 2022. The generation of 18 billion kWh of electricity at the nuclear power plant will reduce gas consumption by 5 billion m3 per year. Greenhouse gas emissions into the atmosphere will be reduced by 7–10 million tons per year [76,77].

5.3. Kazakhstan

On 4 July 2009, Kazakhstan adopted the Law of the Republic of Kazakhstan No. 165-IV "On Supporting the Use of Renewable Energy Sources". In 2016, the necessary amendments and additions were made to this law. In the same year, by order of the Ministry of Energy of the Republic of Kazakhstan, targets for the development of the renewable energy sector until 2020 were approved.

According to the Energy Department of the Eurasian Economic Commission, the installed RES capacity in Kazakhstan in 2017 amounted to 300 MW, including:

- Small hydroelectric power plants—142 MW;
- Solar power plants—58 MW;
- Wind power plants—100 MW.

The share of RES in the energy balance of Kazakhstan in 2017 was 1.3%.

By the beginning of 2022, the installed capacity of facilities using renewable energy sources amounted to about 2000 MW, which is 6.7 times higher than in 2017. Of these, the installed capacity includes:

- Small hydro power plants—281 MW (2.8 times higher than the level of 2017);
- Solar power plants—1000 MW (17.2 times higher than in 2017);
- wind power plants—684 MW (6.8 times higher than in 2017);
- bioelectric power plants—7.8 MW.

Most of the electricity generation among renewable energy facilities is accounted for by wind (1.8 billion kWh/year or 42.1%) and solar power plants (1.6 billion kWh/year or 37.4%). Small hydroelectric power plants and bioelectric power plants account for a small share in the total volume of electricity generation (799.7 million kWh/year and 3 million kWh/year, respectively) [78].

According to experts, the technical potential of RES in Kazakhstan is quite high. The wind energy potential is estimated at 920 billion kWh/year, hydro potential at 62 billion kWh/year, and solar energy at 2.5 billion kWh/year.

According to the concept for the transition of Kazakhstan to a green economy, goals were set to increase the share of renewable energy sources in the country's energy balance from 1.3% in 2017 to 10% in 2030 and up to 50% in 2050 [74].

5.4. Kyrgyzstan

More than 90% of all electricity in the country is generated by large hydroelectric power plants. However, the development of hydro resources of small rivers in the republic is only 1.47%, which is the production of 18 small hydroelectric power plants with a total capacity of 53.86 MW. [79].

The concept for the development of the fuel and energy complex of the Kyrgyz Republic for 2019–2030 provides for the improvement of fiscal policy by providing tax incentives and loans for the development of RES, consideration of the tariff policy for RES, and the introduction of energy-saving and environmentally friendly technologies and equipment. The development of a low-carbon green economy in the future will be facilitated by the predominant production of electricity at large hydroelectric power plants, whose share in the total production will be at least 70%, with an increase in the share of small hydroelectric power plants and other RES from 1.5 to 5%, which will make it possible to save greenhouse gas emissions equivalent to the modern level [80].

5.5. Russia

The Russian Federation is also quite confidently following the path of "greening" the economy. In 2003, Russia adopted the Federal Law No. 35-FZ "On the Electric Power Industry", which determined the mechanisms for selling the capacities of generating facilities operating on the basis of renewable energy sources. In 2009, Decree of the Government of the Russian Federation No. 1-r established indicators for the limiting values of RES generating facilities for the period up to 2024. In 2015, Decree of the Government of the Russian Federation No. 47 determined the procedure for implementing the mechanism for supporting RES in retail markets. In 2019, the "Five Gigawatt" Program for the Development of Solar and Wind Energy in Russia until 2024 was adopted. According to the program, by 2024, electricity generation at SPPs and wind farms will be about 1% of the total production volume.

According to the Energy Department of the Eurasian Economic Commission, the installed RES capacity in the Russian Federation in 2017 amounted to 48,220.9 MW, including:

- Hydroelectric power plants (including hydroelectric power plants more than 25 MW)—48,000 MW;
- Solar power plants—175 MW;
- Wind power plants—45.9 MW.

The share of RES in the country's energy balance in 2017 was 19%.

By the beginning of 2022, the installed capacity of facilities using renewable energy sources was already 53,952 MW, which is 1.12 times higher than in 2017. Of these, installed capacity includes:

- Hydroelectric power plants (including hydroelectric power plants over 25 MW)—49,955 MW (1.04 times higher than the level of 2017);
- Solar power plants—1961 MW (11.2 times higher than in 2017);
- Wind power plants—2036 MW (44.4 times higher than the level of 2017).

Most of the electricity generation among renewable energy facilities is accounted for by hydroelectric power plants (209.5 billion kWh/year or 97.3%). Wind and solar power plants account for a small share in total electricity generation (3.6 billion kWh/year (1.7%) and 2.3 billion kWh/year (1.0%), respectively) [81].

Russia ranks fifth in the world in hydropower generation. In general, hydropower in the Russian Federation accounts for about 21% of the installed capacity of the electric power industry, 17–18% of electricity generation, and more than 97% of renewable energy generation. According to experts, the economic hydro potential of Russia is 850 billion kWh/year, and the degree of its development is about 20%.

A promising direction for the development of the energy industry in Russia is wind energy, the economic potential of which is estimated at 260 billion kWh/year (about 25% of electricity generation by all power plants in Russia).

The active development of solar energy in Russia began after the implementation of a set of measures to support renewable energy. Cost-efficiency from the use of the potential of solar energy is 12.5 million tons of reference fuel.

Geothermal energy is developing. There are currently four geothermal power plants in operation in Russia with a total capacity of 81.4 MW. The potential of geothermal energy in Russia is 10–15 times higher than fossil fuel reserves. The identified reserves of geothermal waters amount to about 30 million tons of reference fuel.

Thus, the economic potential of renewable energy sources in Russia is quite large and, according to experts, is about 274 million tons of reference fuel per year. In addition, geothermal energy is 115 million tons of reference fuel per year, small hydro plants 65.2 million tons, biomass 35 million tons, solar energy 12.5 million tons, wind energy 10 million tons, and low-grade heat 36 million tons of reference fuel per year [82].

Among the reasons hindering the development of facilities using renewable energy sources are the presence of large reserves of fossil fuels and insufficient incentives for the development of renewable energy.

It is also necessary to pay attention to nuclear energy, which continues to gain momentum in Russia. In 2021, the share of NPP production is 20%. The Russian nuclear power industry ranks second among European countries in terms of nuclear generation capacity. Russia has a full range of nuclear energy technologies from uranium mining to power generation. Russia has significant explored reserves of uranium ores; is engaged in their mining and processing; is the world leader in uranium enrichment; is engaged in the production of nuclear fuel; designs, builds, and commissions nuclear power units; and processes and disposes of spent nuclear fuel.

At the beginning of 2022, Rosatom introduced a new generation of safety nuclear fuel ATF (Accident Tolerant Fuel), which has increased heat resistance and low-heat capacity, as well as high density and uranium content, which makes it possible to improve fuel performance, increase productivity, and reduce the cost of generated energy and heat [83].

Prospects for the development of nuclear energy in Russia are associated with the construction of seven nuclear power plants with a capacity of 15,612.6 MW by 2030.

In 2021, the implementation of the Small Atom program began in the Russian Federation, which involves the development and construction of reference small-capacity, ground-based NPPs that Rosatom needs to expand its export potential. Such projects are interesting, for example, from the point of view of replacing coal-fired generation. On the whole, Russia is implementing a large number of international projects in the nuclear power industry. Thus, at present, Rosatom owns 40% of the world market for uranium enrichment services and 17% of the market for the supply of nuclear fuel for nuclear power plants.

The focus is on the technology of developing a closed nuclear cycle, which allows solving the problem of spent nuclear fuel, which will allow the inclusion of nuclear power plants in the list of EU green activities [84].

Russia plans to invest more than USD 33 billion in the hydrogen sector. In the foreseeable future, Russia can become a key figure in the world in the field of hydrogen energy. At the same time, technologies will be used to produce hydrogen from oil.

The main directions for the development of hydrogen energy in Russia are as follows [85]:

(1) Development of own technologies for the production of green and blue hydrogen;
(2) Development of hydrogen transportation systems;
(3) Generation of electricity from hydrogen.

Problems due to the imposed sanctions include:

(1) Loss of Western partners;
(2) Insufficiency of financial resources;
(3) Reducing the number of potential buyers;
(4) Difficulties with technology development;
(5) Due to the volatility of the energy market and its susceptibility to shocks, the development of hydrogen energy around the world fades into the background.

To assess the prospects for the development of RES, analytical calculations of trends for each type of generation were carried out based on the data in Table 7.

Table 7. Data on energy generation in the EAEU countries, GWh.

					Armenia					
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Natural gas	2390	3399	3173	3289	2801	2581	2872	3376	3047	3166
Nuclear	2548	2311	2360	2465	2788	2380	2620	2076	2198	2756
Hydro	2489	2322	2173	1992	2206	2351	2269	2318	2371	1778
Solar PV	0	0	0	0	1	1	3	19	61	21
Wind	3	4	4	4	3	2	2	2	3	2
Total production	7430	8036	7710	7750	7799	7315	7766	7791	7680	7723
					Belarus					
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal	19	20	23	26	38	34	27	26	30	31
Oil	394	789	179	379	362	582	195	264	199	2130
Natural gas	31,639	29,787	31,007	34,042	33,355	32,529	33,507	37,890	39,191	34,574
Biofuels	95	95	120	118	137	147	163	174	304	416
Waste	10	32	32	37	49	29	32	32	32	14
Hydro	42	70	138	121	107	142	405	324	350	398
Solar PV	0	0	0	1	8	28	89	177	181	175
Wind	1	6	8	11	26	75	97	99	178	194
Total production	32,200	30,799	31,507	34,735	34,082	33,566	34,515	38,986	40,465	37,932
					Kazakhstan					
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal	70,220	69,421	77,515	67,604	63,478	61,225	68,944	74,833	73,786	no data
Oil	543	735	601	1024	1239	1920	782	63	57	no data
Natural gas	7940	15,021	17,233	18,308	17,643	19,512	21,759	21,467	21,500	no data
Biofuels	0	0	0	1	3	4	2	1	3	no data
Hydro	7883	7637	7731	8263	9269	11,621	11,210	10,395	9994	no data
Solar PV	0	0	0	97	118	136	160	384	831	no data
Wind	0	3	5	13	132	275	340	461	707	no data
Total production	86,586	92,817	103,085	95,310	91,882	94,693	103,197	107,604	106,878	no data
					Kyrgyzstan					
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal	635	728	786	1073	1722	1557	1159	1093	1132	no data
Oil	231	180	101	84	38	21	32	33	35	no data
Natural gas	153	81	27	117	170	190	119	80	89	no data
Hydro	14,139	14,179	13,097	13,298	11,100	11,494	14,203	14,318	13,859	no data
Total production	15,158	15,168	14,011	14,572	13,030	13,262	15,513	15,524	15,115	no data

Table 7. *Cont.*

	Russia									
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Coal	164,348	168,927	161,876	158,299	158,550	171,443	174,755	177,911	188,260	175,803
Oil	27,362	28,062	8706	10,703	10,102	10,968	6976	8007	8558	8179
Natural gas	519,202	525,377	529,974	533,493	529,749	521,788	518,473	527,588	514,278	464,917
Biofuels	35	45	37	32	30	32	84	73	0	0
Waste	2742	2988	2888	3071	2789	2432	2594	2540	2859	2944
Nuclear	172,941	177,534	172,508	180,757	195,470	196,614	203,143	204,569	208,984	215,914
Hydro	167,608	167,319	182,654	177,141	169,914	186,640	187,131	193,027	196,510	214,240
Geothermal	522	477	444	455	457	446	435	426	433	421
Solar PV	0	0	0	160	335	462	558	720	1279	1862
Wind	5	5	5	96	148	148	140	232	331	1138
Total production	1,054,765	1,070,734	1,059,092	1,064,207	1,067,544	1,090,973	1,094,289	1,115,093	1,121,492	1,085,418

Source: compiled by the authors based on data from [86].

At the first stage, trend curves were built for each type of energy generation in each country, and regression equations were calculated that approximated the actual data for the previous period. Among the constructed curves, those were selected that have the highest coefficient of approximation reliability, showing the significance of generation volumes over time. Unfortunately, for some types of generation, we were unable to obtain regression equations with an approximation reliability coefficient of 0.5 or more. Therefore, we considered acceptable equations with a lower coefficient if the graphical representation of the obtained curve visually corresponds to the actual data for the previous period and, when forecasting, fits within the logical development of this generation process.

Based on the selected regression equations, a forecast of the volume of energy for each type of generation for 2025 and 2030 for each country was calculated.

At the second stage, we calculated the average growth rates of energy volumes for all types of generation, and based on these data, we calculated the volume of energy for each type of generation for 2025 and 2030 for each country.

The data obtained are presented in Table 8. Analysis of Table 8 shows that the calculated regression equations have an acceptable approximation reliability coefficient (from 0.45 and higher) for predicting the trend for 5 and 10 years for almost all countries and types of generation. The exception was the regression equations for hydro (R^2 = 0.1786) and total production (R^2 = 0.0068) for Armenia; waste (R^2 = 0.0701) for Belarus; biofuels (R^2 = 0.0481) for Kazakhstan; and waste (R^2 = 0.1759) for Russia.

At the same time, by the calculation of generation growth rates for 10 years (and less in the absence of data for some countries for 2020), it can be observed that the average annual growth rates for some types of generation are negative: wind and hydro in Armenia and geothermal and waste in Russia. The decrease in growth rates and negative values are due to the fact that in 2020, due to the COVID-19 pandemic, all countries reduced the volume of generation due to a sharp decrease in energy demand from enterprises and organizations.

At the third stage, we compared the forecast data obtained using the trend regression equations and the data obtained on the basis of the average annual growth. Comparing the data obtained, we made conclusions about the possible volume of energy generation from RES and classical sources of generation (Table 9).

Table 8. Forecast of energy generation for 2025 and 2030 based on calculated data.

	Type of Trend Equation	Approximation Reliability Coefficient, R^2	Generation Forecast Based on the Trend Regression Equation, GWh		Average Annual Generation Growth Rate, %	Generation Forecast Based on CAGR, GWh	
			2025	2030		2025	2030
Armenia							
Solar PV	$y = 0.5112x^{2.3141}$	$R^2 = 0.7763$	131.36	312.64	177.76	207.65	394.31
Wind	$y = 4.0953 \times 10^{-0.07x}$	$R^2 = 0.4711$	1.43	1.01	−0.9259	1.914	1.811
Hydro	$y = -119.1\ln(x) + 2406.8$	$R^2 = 0.1786$	2084.27	2050.01	−3.1325	1499.52	1221.04
Total production	$y = 22.528\ln(x) + 7665.9$	$R^2 = 0.0068$	7726.91	7733.39	0.518	7923.219	8123.42
Belarus							
Solar PV	$y = -1.0833x^2 + 44.988x - 64.143$	$R^2 = 0.8937$	319.72	387.58	210.95	2020.78	3866.56
Wind	$y = 22.442x - 53.933$	$R^2 = 0.8888$	282.70	394.91	112.87	1288.85	2383.70
Hydro	$y = 36.695x^{0.9891}$	$R^2 = 0.8103$	534.42	710.32	39.95	1193.07	1988.15
Biofuels	$y = 69.872 \times 10^{0.1475x}$	$R^2 = 0.8433$	638.53	1334.97	19.69	825.62	1235.23
Waste	$y = 3.9681\ln(x) + 23.906$	$R^2 = 0.0701$	34.65	35.79	20.15	28.10	42.21
Total production	$y = 54.867x^2 + 338.69x + 30{,}903$	$R^2 = 0.7869$	48,328.43	59,623.6	2.013	41,749.27	45,566.55
Kazakhstan							
Solar PV	$y = 128.34x - 161.53$	$R^2 = 0.7049$	1378.55	2020.25	62.19	3931.86	6515.92
Wind	$y = 99.19x - 204.36$	$R^2 = 0.9128$	1184.3	1680.25	194.71	8966.61	15,849.61
Hydro	$y = 7123.5x^{0.1815}$	$R^2 = 0.6238$	11,782.60	12,378.73	3.48	12,083.49	13,824.74
Biofuels	$y = 0.4006\ln(x) + 1.894$	$R^2 = 0.0481$	2.89	3.03	66.67	15.00	25.00
Total production	$y = 110.37x^2 + 981.93x + 89{,}601$	$R^2 = 0.6063$	25,704.71	27,292.69	15.93	42,048.79	59,172.77
Kyrgyzstan							
Hydro	$y = 131.56x^2 - 1320.5x + 15{,}735$	$R^2 = 0.4525$	25,528.5	41,949	0.298	14,106.39	14,312.56
Total production	$y = 111.48x^2 - 1115.2x + 16{,}495$	$R^2 = 0.6065$	24,850	38,783	0.256	15,347.17	15,540.64
Russia							
Solar PV	$y = 259x - 268$	$R^2 = 0.8715$	2840	4135	53.386	6832.24	11,802.47
Wind	$y = 25.84x^2 - 162.16x + 241.79$	$R^2 = 0.7832$	3623.39	7334.59	66.826	4940.40	8742.80
Hydro	$y = 469.82x^2 - 788.73x + 170{,}468$	$R^2 = 0.8654$	264,346.55	342,621.4	3.334	249,953.81	285,667.62
Geothermal	$y = 1.2348x^2 - 21.935x + 524.7$	$R^2 = 0.8257$	473.505	579.92	−1.272	394.22	367.45
Biofuels	$y = 28.143 \times 10^{0.0925x}$	$R^2 = 0.4465$	112.708	178.984	21.015	180.38	257.09
Waste	$y = 9.4811x^2 - 120.13x + 3080.4$	$R^2 = 0.1759$	3411.6975	4470.24	−0.312	2898.07	2852.15
Total production	$y = 6211.3 + 1 \times 10^6$	$R^2 = 0.6609$	1,093,169.5	1,124,226	0.331	1,103,381.67	1,121,345.34

Source: compiled by the authors.

Table 9. Forecast of energy generation and the share of RES in total generation.

	Armenia		Belarus		Kazakhstan		Kyrgyzstan		Russia		EAEU	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
2025												
RES, GWh	1709.08	2217.06	1810.02	5356.42	14,348.34	24,996.96	14,106.39	24,850	265,460.3	274,807.9	311,629.1	318,711.8
Total production, GWh	7726.91	7923.219	41,749.27	48,328.43	25,704.71	42,048.79	15,347.17	24,850	1,093,170	1,103,382	1,199,780	1,210,450
Share of RES, %	22.12	27.98	4.34	11.08	55.82	59.45	91.92	100.00	24.28	24.91	25.97	26.33
Share of RES in the country's strategic documents, %	30		7		16		94		24.5			
2030												
RES, GWh	1617.16	2363.66	2863.57	9515.85	16,082.26	36,215.27	14,312.56	38,783	310,211.9	359,320.1	371,872.8	422,578.6
Total production, GWh	7733.39	8123.42	45,566.55	59,623.6	27,292.69	59,172.77	15,540.64	38,783	1,121,345	1,124,226	1,249,749	1,257,659
Share of RES, %	20.91	29.10	6.28	15.96	58.93	61.20	92.10	100.00	27.66	31.96	29.76	33.60
Share of RES in the country's strategic documents, %	70		8		20		95		24.65			

Note: generation volume and share of RES include large hydro power plants.

Considering that the data obtained by the regression equations and by forecasting based on the average annual growth rate for some types of generation differ significantly, we considered the data obtained as the minimum and maximum forecast values.

6. Discussion and Conclusions

The calculated data obtained allow us to conclude that, if the existing trends remain unchanged, all the EAEU countries will achieve the goals of increasing the share of renewable energy with the exception of Armenia. According to calculations, in Armenia, the share of renewable energy in energy generation in 2025 may reach a maximum of 27.98%, which is close enough to the planned 30%. However, the calculations also show that it is impossible to increase the share of renewable energy more than twice in 5 years, so achieving the planned level of 70% in 2030 is doubtful for Armenia.

Belarus has every chance to achieve the planned share of RES in total energy generation both in 2025 and in 2030. Calculations show that the maximum share of renewable energy generation can reach 11% in 2025 and almost 16% in 2030. However, the authors believe that with the commissioning of the nuclear power plant, which is currently being built in Belarus, the share of renewable energy will be significantly reduced due to the fact that the cost of nuclear energy will be much lower. In addition, the government of Belarus will pursue the goal of maximum utilization of the nuclear power plant's capacity for a quick return on investment.

Calculations show that Kazakhstan will more than double the target set for the share of RES in energy generation. Indeed, from 2017 to 2020, there was a rapid growth in the construction of renewable energy in Kazakhstan, including due to the fact that the state subsidized the tariff for renewable energy, and its price was approaching the price of energy obtained from classical sources. However, coal-fired power plants are very competitive in terms of energy price and availability of shunting capacity. The authors have no doubt that Kazakhstan will reach the planned targets for the share of renewable energy, but they believe that the calculated data are not achievable. This is due to the need to double or more the amount of funds for subsidizing the tariff for renewable energy, with the current lack of projects for the construction of renewable energy storage and shunting facilities.

Strategic targets for the share of renewable energy for Kyrgyzstan are achievable. Kyrgyzstan currently already receives 90% of its energy from large hydroelectric power plants. According to the authors, major investment projects in the energy sector of Kyrgyzstan are unlikely in the near future. The construction of small energy generation facilities is not able to significantly increase or decrease the share of renewable energy in Kyrgyzstan.

According to the calculations carried out, the share of renewable energy in Russia may be five times higher than planned, even if the minimum scenario is implemented. However, the authors' position is that one should not expect a rapid growth in the construction of renewable energy sources in Russia. Given the changing geopolitical situation, investments will be directed to the development of machine tools, semiconductor manufacturing, and other activities for which Russia is dependent on foreign manufacturers. The construction of renewable energy sources is not currently a priority direction for the development of the Russian economy. Russia will expand the domestic market of demand for gas and energy from it. The cost of producing such energy is relatively small and does not require significant investments. Therefore, the authors believe that the current value of the share of RES will not change and will remain at the level of 1.5–2% (excluding large hydroelectric power plants).

In general, the share of RES in the energy generation market of the EAEU countries in the near future, according to estimates, may range from 26% in 2025 to 30% in 2030. The calculated data obtained draw attractive pictures of green energy. However, the authors' pragmatic view of the main problem for the "greening" of the economy of the EAEU countries is that the installations for the use of renewable energy have a sharply variable mode of operation and cannot ensure the reliability of the power system and uninterrupted power supply to consumers. In order to use RES, it is necessary to carry out accumulation measures and create any storage devices and peak-reserve sources, and this requires large additional costs and further increases the cost of RES electricity. Reliability and continuity as well as redundancy of renewable energy generation are now forced to provide traditional thermal power plants of energy supply organizations that always work, — not only when the sun is shining and the wind is blowing—and even on the frostiest night with complete calm.

Forecasted estimates of energy generation in the EAEU countries may change due to the current socio-economic crisis caused by Russia's special operation in Ukraine and the sanctions that followed, according to which Russia has become a world leader.

It should be borne in mind that not only Russia but also the entire world socio-economic system, including the EAEU member states, have found themselves in a state of crisis of a new type, which is fundamentally not market-based; respectively, it is not possible to cope with it only by market methods. The biggest problem blocking market mechanisms compensating for the consequences of the crisis, according to the authors of the article, is the mass departure of foreign investors and companies from the Russian economy. It is expected that the consequences of the crisis will be severe and, for sure, will be protracted.

The disconnection of Russia from SWIFT, the freezing of assets of the Central Bank, the withdrawal of foreign business, and the ban on access of Russian companies and banks to the American and European financial markets deal a serious blow to the Russian economy, which is deeply integrated into the global economic system. At the same time, the withdrawal of foreign investors and the reduction in the supply of components demonstrate non-economic processes since the decisions taken are far from rational. Against the background of the events taking place, the reputational component, moral principles, and behavioral heuristics are included. As a result, foreign companies do not want to do business with Russian manufacturers because of the pressure in society and the ideology prevailing in the Western information space.

The scenario of further development of the crisis, for sure, will follow the path of reducing the flow of imports of components to Russia, as a result of which many sectors of the economy will suffer, including the oil and gas industry, the production of equipment for thermal power plants, as well as other industries related to electricity generation. For example, the departure of foreign manufacturers of wind turbines, in fact, put the entire market at risk. That is why the main focus in Russia is now on import substitution, but it is not possible to solve this problem quickly.

Foreign companies are breaking contracts with Russian enterprises in various fields of energy. Thus, the Finnish design company Fennovoima terminated contact with Rosatom for the construction of the Hanhikivi-1 nuclear power plant in Finland, the Swedish Vattenfall refused Russian nuclear fuel for nuclear power plants, and the largest Indian importer Tata Steel will stop buying coal from Russia due to the risks associated with anti-Russian sanctions.

Despite the situation that has developed as a result of sanctions, work continues on the formation of documents defining the fundamentals of the functioning of the common electricity market of the EAEU. In particular, the composition of participants and the list of organizations forming the infrastructure are specified, and the principles of cross-border electricity trade and the competence of the Union bodies are determined.

In April 2022, the "Protocol on Amendments to the EAEU Treaty" (regarding the formation of a common electricity market) came into force. The document focuses on the development of market trading mechanisms that ensure non-discriminatory conditions and transparent prices, enabling wholesalers and buyers of electricity to independently conclude contracts. Further work to ensure the functioning of the common market will be aimed at defining the rules of operation governing electricity trade, access to transit services, information exchange, as well as the principles of distribution of capacity of interstate power transmission lines. The beginning of the operation of the common electricity market is determined no later than 1 January 2025 [87].

In order to increase the internal stability of the economies of the EAEU states, it is planned to expand the use of national currencies in settlements within the framework of mutual trade.

Given the significant differences in the models of existing national markets, it is assumed that the CEM will not cancel national markets but will act as an additional market. The general rules of cross-border trade will apply in this additional market.

The following documents are related to regulating the work of the CEM:

(1) "Rules of mutual trade in electric energy in the EAEU CEM";
(2) "Rules of access to services for interstate transmission of electric energy (capacity)";
(3) "Rules for determining and distributing the capacity of interstate sections";
(4) "Rules of information exchange on the EAEU CEM".

The main interest of the EAEU CEM participants is access to cross-border trade for all wholesalers and buyers of electricity from the member states, expansion of the methods of such trade, and increase in transparency of electricity prices. Increased competition and an increase in the volume of mutual trade in electricity, the use of direct purchase and sale agreements, as well as the introduction of exchange pricing mechanisms for cross-border supplies will help reduce electricity prices. At the same time, experts note difficulties in forecasting prices and volumes, especially in the conditions of constantly changing sanctions reality. It is expected to increase the efficiency of the use of generating and transmitting capacities as well as the volume of mutual and foreign trade in electricity.

In connection with the formation of the CEM, there will be significant changes concerning market participants and conditions for the export, import, and transit of electricity within the EAEU (Table 10).

Table 10. Changes in the terms of electricity trade after the formation of the CEM.

Indicator	Without Creating the CEM	With the Creation of the CEM
1. The number of participants in the export and import of electricity	Limited membership	All subjects of wholesale electricity markets
2. The order of transactions	Based on bilateral agreements	On the basis of bilateral agreements as well as by bidding on specialized sites. Application of e-commerce systems for fixed-term contracts and for the day ahead
3. Conditions for performing transit operations within the EAEU	Each country approves its own conditions	The general conditions of electricity transit for the participating countries are being formed
4. Electricity supply conditions	According to the contracts	They are determined independently when concluding contracts or using exchange mechanisms when participating in auctions
5. Pricing of electricity transmitted outside national economies	Usually after the fact	The price is calculated before the beginning of the next period (month) and is not subject to change

Source: compiled from [69].

Thus, it can be concluded that the formation of a common electricity market is going according to plan despite the conditions changing in connection with the imposition of sanctions against Russia. Electricity generation will certainly increase. Of course, the question remains as to its structure and as to what specific weight will fall on renewable energy sources.

On the one hand, despite the difficulties of the current moment, Russia, as the main participant of the CEM, continues its policy of supporting green energy. Russia's goal is to increase the share of carbon-free energy sources in its energy balance to 56.5% by 2050 (currently 40.8%), including 19% from hydroelectric power plants, 25% from nuclear power plants, and 12.5% from renewable energy sources. At the same time, the share of gas (up to 49%) and coal (up to 4.5%) generation in the country's energy balance will be reduced by decommissioning the corresponding equipment. According to experts, by 2050, the volume of installed capacity of renewable energy facilities may amount to 97.4 GW. The main tasks that need to be solved are, firstly, integration into the energy balance and management of these volumes of RES considering their sharply variable dynamics and, secondly, the development of energy storage systems, both traditional and more advanced [88].

On the other hand, with the introduction of sanctions, the implementation of many projects related to renewable energy was threatened. Here are some problems that investors and manufacturers may face when implementing new projects in the field of renewable energy use. Thus, in the conditions of isolation of the Russian economy, problems arise with the supply chain of equipment and components for the construction and operation of renewable generation facilities since dependence on imports of equipment and components remains high. Investment risks are sharply increasing, and difficulties with attracting financing are manifested. In connection with the introduction of sanctions, the renewable energy sector in Russia was threatened by the departure of major foreign players. For example, Finnish Fortum, Italian Enel, and Danish Vestas have frozen projects in this sector. The departure of foreign companies and problems associated with disruption of supply chains will increase the cost part of projects in the field of renewable energy by 15–30% and the timing of their implementation by at least 1.5–2 years [89].

In the context of the imposition of sanctions in the Russian Federation, the International System for Issuing I-REC green certificates, confirming the generation of electricity from renewable energy stations and the necessity to reduce the carbon footprint of export products, has stopped working [90]. In this regard, there is a need to create a national system for the circulation of green contractual instruments in the electric power industry. However, the question of recognition of such a system by the European Union in the current conditions remains open.

In order to fulfill the planned plans for renewable energy generation, it will be necessary to extend the terms of non-penalized delay for the introduction of green projects as well as to strengthen the support of Russian investors in renewable energy from the state against the background of sanctions pressure.

Finally, the refusal of a number of European countries from Russian energy resources may reduce the relevance of renewable energy in the Russian Federation against the background of an oversupply of gas and coal.

Another problem that is currently on the agenda and which may negatively affect the implementation of the green transition in Russia, at least in the short term, is the threat of the "Dutch disease". In the economy, as is well-known, the "Dutch disease" can manifest itself as an effect of the growth of the national currency as a result of a boom in one of the sectors. We are seeing something similar in the current situation in the Russian oil and gas sector. The influx of export revenues from the sale of hydrocarbons at high prices as well as internal currency restrictions led to a serious strengthening of the ruble. The spiral of the "Dutch disease" is being unwound according to the scheme: the inflow of foreign exchange earnings—the strengthening of the national currency—a decrease in the competitiveness of domestic producers in other (non–primary) sectors—the deterioration of the manufacturing industry (primarily high-tech industries) and agriculture—a decrease in employment and an increase in unemployment. At the same time, it should be noted that due to the sanctions pressure on Russia; the rupture of foreign economic relations; and difficulties with logistics, calculations, and investment (in fact, financial isolation), the risks of the "Dutch disease" are currently much weaker than in previous years. A sound economic policy can negate these risks. Thus, a reduction in the Central Bank's key rate, a reduction in the rate of mandatory foreign exchange earnings by exporters, and other measures related to state regulation of the national currency exchange rate, increased taxation of income from raw materials industries, the search for new import channels, support for non-resource sectors of the economy, etc., should help to adapt capital flows and curb the strengthening of the national currency.

Nevertheless, the restructuring of the Russian (and not only) economy, considering new challenges and their consequences, may last 1.5–2 years. It is for such a period that the implementation of the green agenda can be postponed. This situation will be typical not only for Russia but also for the CEM countries and, for sure, for other countries whose economic policy will focus on solving more pressing problems.

In the current situation, the key strategic tasks facing the Russian energy industry are highlighted, which will also affect the interests of the countries of the common energy market of the EAEU as a whole [91]:

- Firstly, ensuring a sustainable supply of energy resources to the domestic market and stimulating domestic demand, especially in conditions of compression of foreign markets;
- Secondly, the diversification of energy exports by reorienting it from the Western direction to the fast-growing markets of the South and East to the countries of Africa, Latin America, and the Asia-Pacific region, for which the construction of new infrastructure facilities will be carried out;
- Thirdly, deep processing of oil and gas;
- Fourth, import substitution of equipment and components for its production.

The green agenda may also be in question in European countries, which, when rejecting Russian gas and oil, rely on energy with a high carbon footprint, which they recently wanted to completely abandon, calling it "archaic and dirty". In practice, it is impossible to implement an accelerated green transition without high costs, and the bet on wind and solar energy, unfortunately, has not been justified.

The refusal of the European Union from Russian gas determines two options for the implementation of the green agenda. The first option involves more active development of alternative energy, which, however, in the current situation, can seriously reduce the standard of living of the European population; the second is the use of more "dirty" energy sources, for example, oil from Iran (in case of lifting sanctions against it) or Saudi Arabia as well as coal instead of Russian gas. Against this background, there is a more loyal attitude towards nuclear energy, and gas is generally recognized as a "clean" source of energy (the European Commission has defined gas as a "green raw material").

The European Union has revised its attitude to nuclear energy, being under the threat of an energy crisis, calling nuclear power plants the cleanest producers of electricity. To confirm this, we will cite the amount of CO2 emissions into the atmosphere during the production cycle of 1 kWh of electricity. For nuclear power plants, this indicator is 6 g, for wind turbines 11 g, solar panels 80 g, gas turbines 420 g, and coal plants 820 g [92].

Some experts consider that in the short term, it is possible to shift the priority from the green economy to solving more important current tasks, and a return to the environmental agenda can be expected in the future.

Thus, in the current situation, it can be argued that the implementation of the proposed plans for the transition to a green economy is more likely to be achieved both in the Russian Federation and in other CEM countries although in a delayed mode. Oddly, this will be facilitated by the availability of sufficient own, including traditional energy sources, and the possibility of thoughtful disposal of the funds received from the sale of such resources.

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