PERSPECTIVES OF ELECTRIC POWER INDUSTRY DEVELOPMENT ON THE EXAMPLE OF THE REPUBLIC OF BELARUS

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Abstract

The modern global power industry has faced a fundamental transformation since its inception over a century ago. The growing digitalization of the global economy is inextricably linked to electrification, making the need for electricity for daily life more important than ever. There has been a significant increase in the use of electrical energy in final consumption, especially in countries whose economies are based on small and medium-sized industrial production, services and digital technologies.

Keywords: *electricity consumption, electricity production, energy system, energy resources*

1. INTRODUCTION

Specific electricity consumption per capita is recognized as one of the key indicators of socio-economic development of the country. Currently, the Republic of Belarus is significantly behind the developed countries of the world in this indicator (Fig. 1).

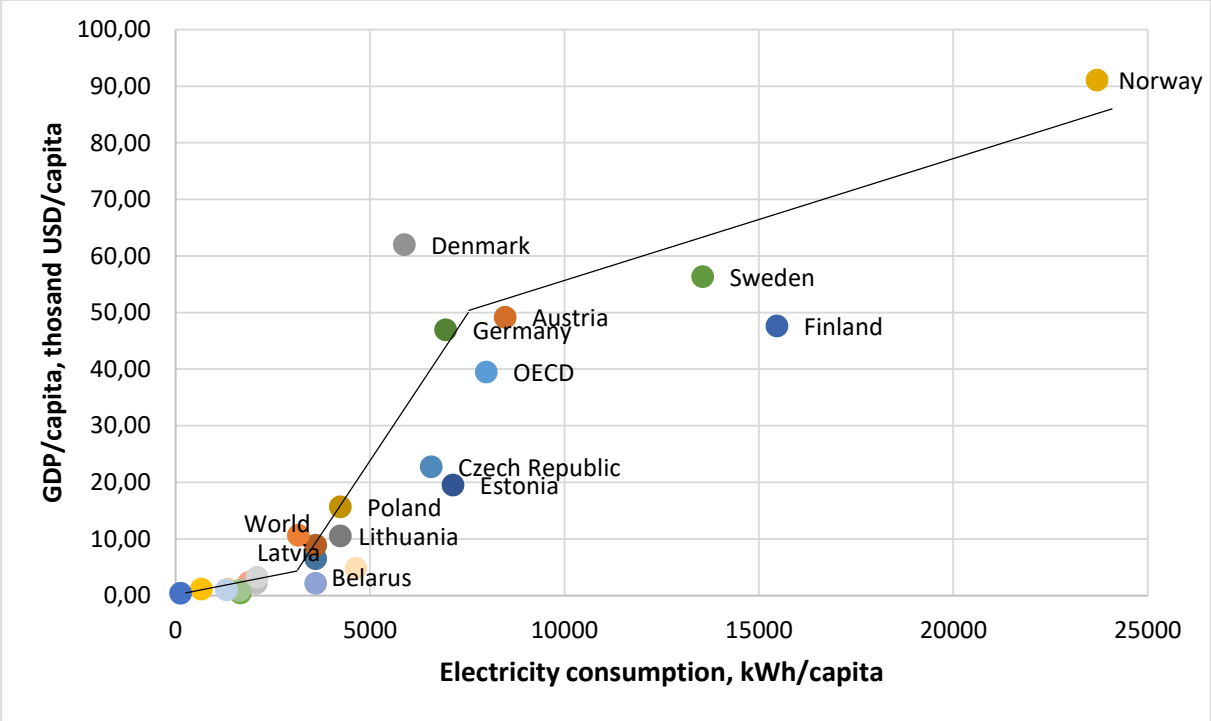


Fig. 1. Dependence of specific GDP on electricity consumption for different countries, 2017 year (Source – International Energy Agency)

As shown in Fig. 1, in 2017 the specific electricity consumption per capita in Belarus was 3600 kWh / capita, while in developed countries with more or less similar climate it is much higher: in Finland - 15465 kWh/capita, Sweden - 13588 kWh/capita, Germany - 6947 kWh/capita, Denmark - 5583

kWh/capita, Lithuania - 4235 kWh/capita [1]. Such a high level of electricity consumption is primarily due to the fact that electricity is one of the main source of energy in modern high-tech industries operating in developed countries.

2. FACTORS INFLUENCING THE LEVEL ELECTRICITY CONSUMPTION

The main factors that can affect the level of final electricity consumption can be the GDP growth rate and structural transformation of the economy. In most countries of the world, electricity consumption growth rates are directly related to GDP growth. (Fig. 2, 3)

In the Republic of Belarus, this dependence can be partially traced only to the last three years. Actual and approved data on GDP growth rates for 2016 - 2020 are: 2016 - 97.5 percent; 2017 - 102.5 percent; 2018 - 103 percent; 2019 - 102.9 percent; 2020 - 101.9 percent (according to the baseline scenario) [2].

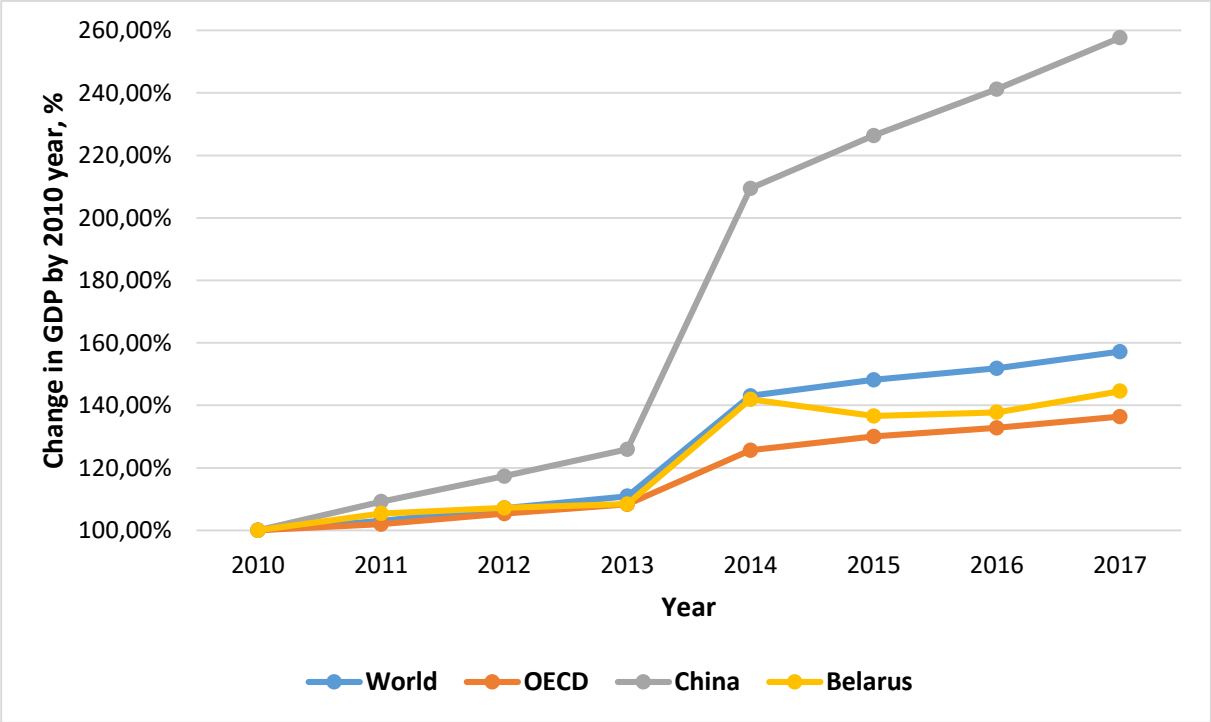


Fig. 2. Change in GDP by 2010 year (Source – International Energy Agency)

In the context of a slowdown of GDP growth rates of the Republic of Belarus in recent years (from 7.8% in 2010 to 1.2% at the end of 2019) and the associated electricity demand slowdown, an urgent task is to change the structure of final consumption of fuel and energy resources in the republic towards increasing the share of electricity (Fig. 3). This can be achieved through full or partial replacement of heat and fuel with electricity and the creation of highly profitable electricity-intensive industries.

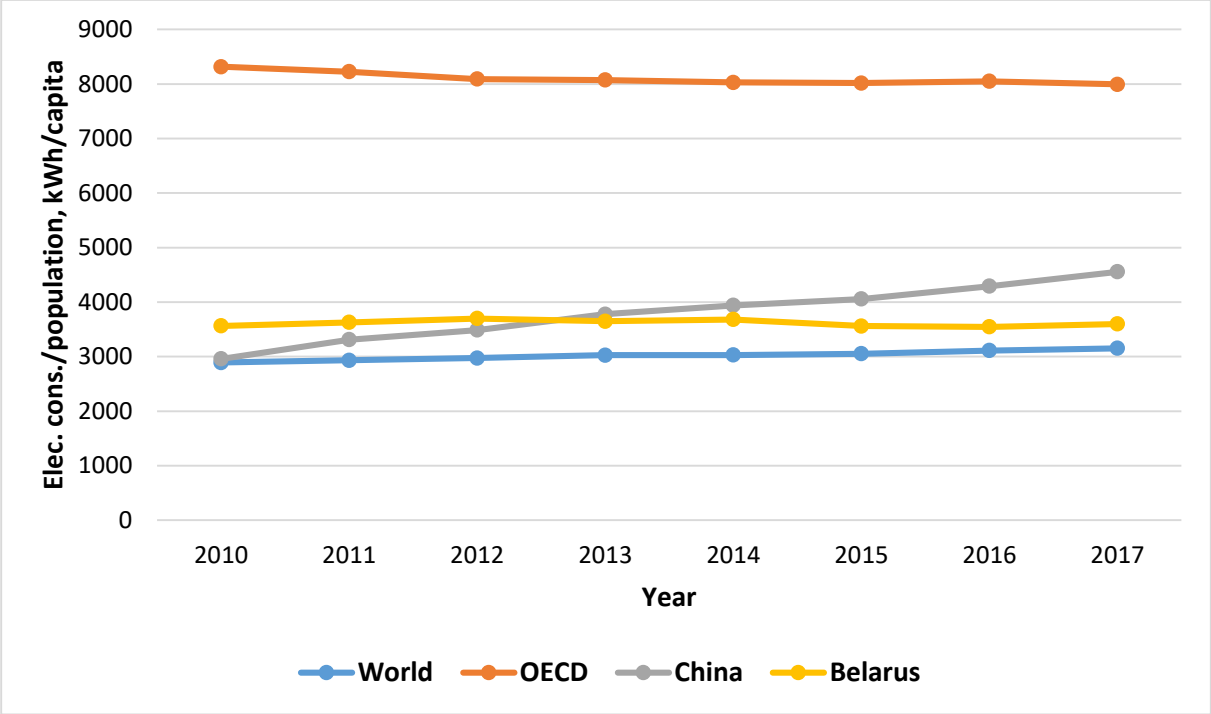


Fig. 3. Electricity consumption per capita of Belarus and other countries
(Source – International Energy Agency)

According to the International Energy Agency, the energy intensity of the GDP of Belarus is 2.4 times higher than the world average, at the same time the Republic of Belarus demonstrates significant rates of decline in the energy intensity of GDP (a decline by 36.9% by 2017 compared to the 2010 indicator) (Fig. 4).

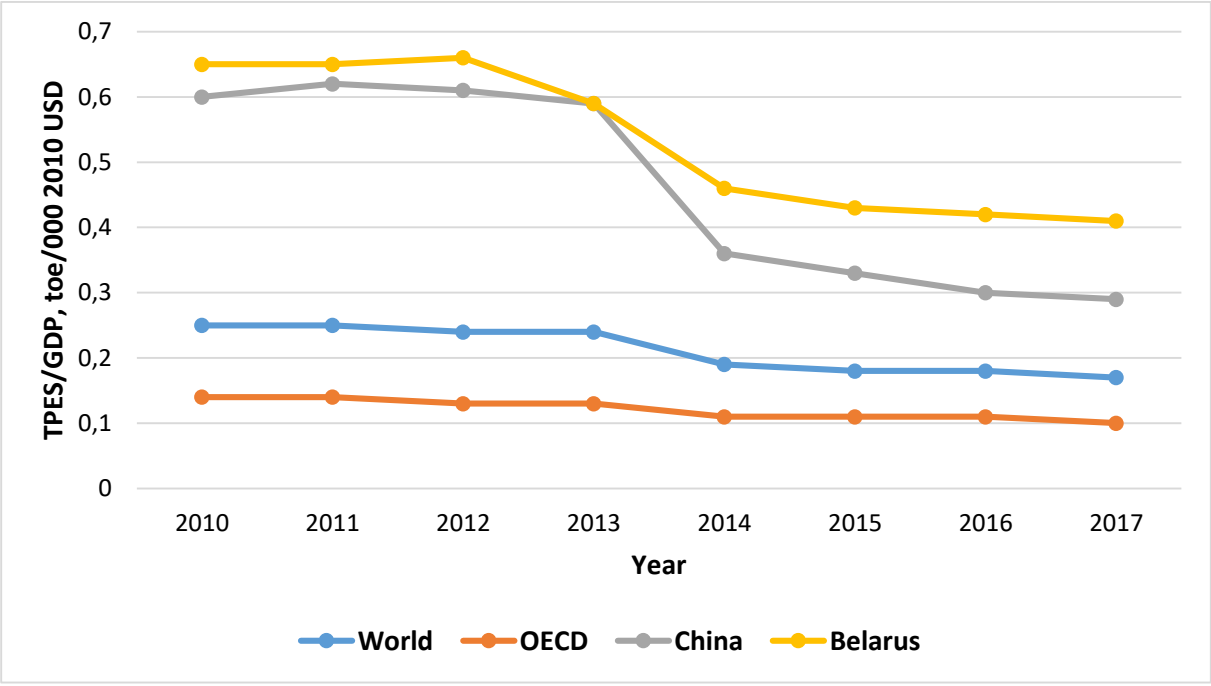


Fig. 4. Primary energy – GDP intensity of Belarus and other countries
(Source – International Energy Agency)

3. THE MAIN TRENDS IN THE DEVELOPMENT OF THE WORLD ELECTRIC POWER INDUSTRY

According to the IEA data, in 2017 the share of electricity in global final consumption was 19% (an increase of 4% since 2000) and according to the optimal scenario, it is planned to increase to 21% by 2030 and up to 24% by 2040 (Table 1).

Table 1. Forecast of final consumption of fuel and energy resources in the world until 2040 according to the optimal scenario of IEA, million toe [3]

Indicator	**2000**	**2017**	**2025**	**2030**	**2035**	**2040**
	Actual value		**Forecast**			
Electricity	1 090	1 846	2 206	2 457	2 717	2 985
Heat	248	289	301	302	303	302
Direct use of renewable energy sources	271	456	583	669	755	844
Natural gas	1 118	1 503	1 790	1 964	2 139	2 298
Oil products	3 123	3 940	4 297	4 405	4 458	4 541
Coal	542	1 004	1 029	1 027	1 021	1 020
Solid biomass	644	658	666	648	624	592
Total	**7 036**	**9 696**	**10 872**	**11 472**	**12 017**	**12 582**

As can be seen from the data presented in Table 1, in the period from 2000 to 2017 the following changes took place in the global indicators of final consumption of fuel and energy resources: electricity consumption increased by 69%, heat consumption increased by 17%, use of renewable energy sources increased by more than 68%, natural gas and oil products consumption increased by 34% and 26% respectively, coal use for energy purposes increased by 85%, biomass consumption growth was only 2%.

By 2035, the final consumption of electricity is projected to increase significantly - by 47% to 2017 levels. The use of renewable energy sources and natural gas as fuel and energy resources is also projected to increase significantly, by 66% and 42% respectively.

According to the IEA, global electricity production from 2010 to 2018 increased by 23.8% to 27.7 trillion kWh. At the same time, there is a change in the global structure of electricity production (Table 2).

Table 2. Forecast of electricity production in the world until 2040 according to the optimal scenario of IEA, TWh [3]

№	Type of energy sources	**2000**	**2017**	**2025**	**2030**	**2035**	**2040**
		Actual value		**Forecast**			
1.	Coal	6001	9858	9896	10042	10189	10335
2.	Oil products	1212	940	763	684	606	527
3.	Natural gas	2747	5855	6829	7576	8324	9071
4.	Nuclear power stations	2591	2637	3089	3301	3514	3726
5.	Hydroelectric power plants	2618	4109	4821	5274	5726	6179

6.	Wind and solar energy	32	1519	3766	5354	6941	8529
7.	Other renewable energy sources	217	722	1057	1386	1715	2044
8.	Othe types of fuel	23	39	32	32	32	32
Total production		**15441**	**25679**	**30253**	**33649**	**37047**	**40443**

An analysis of the data given in Table 2 shows that the share of fossil fuels has practically not changed over the period under review (64.5% in 2000, 64.9% in 2017), while there is a decrease in the use of oil products from 8% in in 2000 to 4% in 2017. During the period 2000-2017, there were significant changes in the share of electricity production by renewable sources - from 2% in 2000 to 9% in 2017.

Renewable energy sources will make the main contribution to meeting the growth in electricity demand, which according to the IEA baseline scenario will increase by 60% in 2017-2040, as a result, electricity will take up about a quarter of final energy consumption.

Thus, it can be said that electricity is the main consumed fuel and energy resource in the world and data on the level of electricity consumption can be used to assess the level of country socio-economic development.

The main trends in the global electric power industry until 2030 will be:

- further development of renewable energy sources;
- expanding the flexibility of energy systems through the introduction of fossil fuel generation capacity and the integration of rapidly developing energy storage systems;
- significant growth in electrification of end-use sectors;
- global digitalization of all production, transmission, distribution and consumption processes of energy resources.

4. STRUCTURE OF THE BELARUSIAN ENERGY SYSTEM

General indicators of the energy system of Belarus (January 1, 2019) [3]:

- installed capacity of the energy system of Belarus - 10 068.68 MW;
- installed capacity of 68 generating energy sources of organizations that are part of the State Production Association of Electric Power Industry "Belenergo" - 8938.34 MW;
- electricity production by sources of organizations of the State Production Association "Belenergo" - 34.83 billion kWh;
- heat production - 35.4 million Gcal;
- electricity export - 1.04 billion kWh;
- electricity production by block stations - 3.96 billion kWh;
- electricity consumption in the republic - 37.8 billion kWh;
- specific consumption of equivalent fuel for electricity production - 235.3 g / kWh;
- specific consumption of equivalent fuel for heat production - 166.36 kg / Gcal;

As a result of measures to modernize the energy system, carried out in 2011-2018, the installed capacity of all generating sources increased by 1802 MW (by 21.8%).

Changes in the structure of the installed capacity of generating sources are shown in Figure 5.

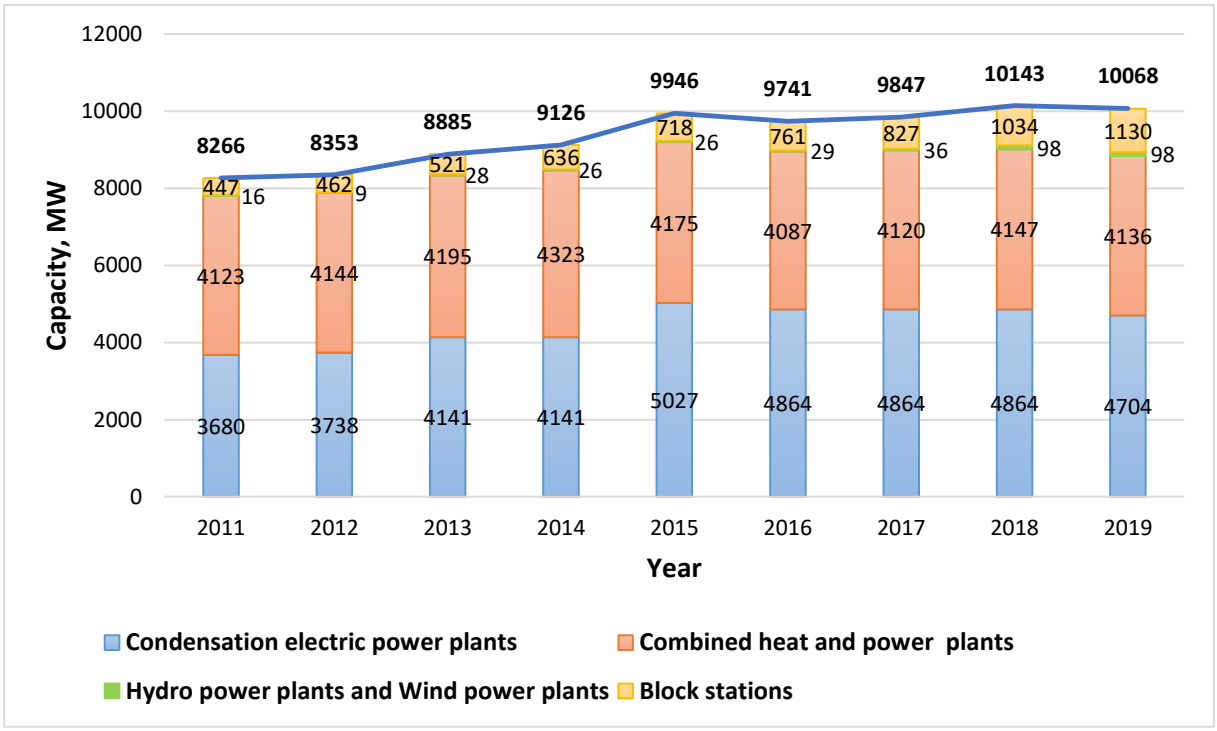


Fig. 5. Structure of installed capacity of generating sources of power system [3]

Systemic modernization of the production facilities of the electric power industry made it possible to provide consumers with electric power, almost eliminate imports and significantly increase its export to the Nord Pool market.

The forecast of changes in the structure of electricity production in the Republic of Belarus is shown in Figure 6.

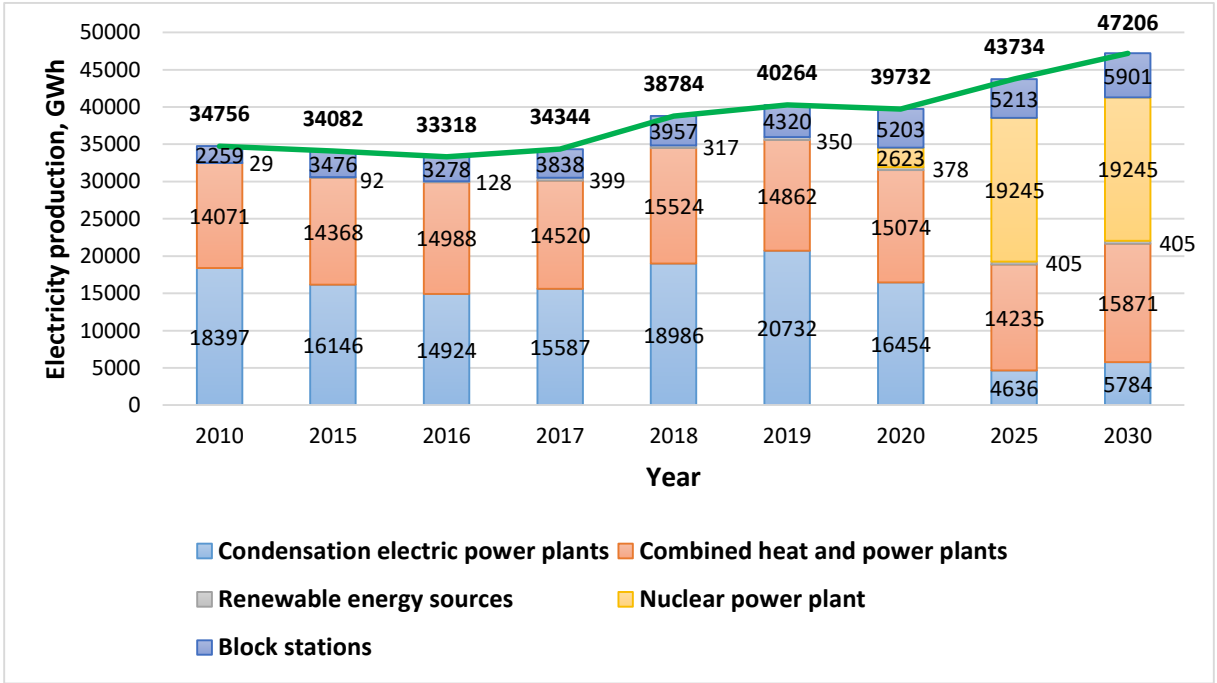


Fig. 6. Forecast of electricity production in the Republic of Belarus until 2030 [3]

As can be seen from the data presented in Fig. 6, after the commissioning of the nuclear power plant (hereinafter – NPP), significant changes in the structure of electricity production are expected. Thus, by 2030, it is expected that NPP will produce 41% of all electricity in the country, with a 39% reduction in the share of condensation electric power plants (from 51% as of 2019 to 12%) and combined heat and power plants - from 37% to 34%.

Taking into account the planned commissioning of the Belarusian NPP, increasing the economically justified electricity consumption in the country is one of the most important ways to increase the reliability and efficiency of the energy system.

Optimal use of NPP in the Republic of Belarus is a problem not only for the electric power sector, but also for the entire economy of the country, including industry, transport, housing and communal services and others.

In order to effectively integrate the Belarusian NPP into the balance of the energy system in terms of night-time minimum loads, a number of special measures have been taken:

- installation of electric boilers at the facilities of organizations that are part of the State Production Association “Belenergo”, housing and communal services and other facilities.
- increase electricity use for heating and hot water supply to consumers, including heating of newly commissioned residential areas and private residential buildings.

Increase of electricity use for heating, hot water supply and food preparation causes growth of consumer's electrical load both during the day and at night.

CONCLUSIONS

1. In the perspective of the next 15-20 years, the trend of increasing the share of electricity in final consumption will continue in the world.
2. In the Republic of Belarus, after NPP commissioning, this trend will become the dominant factor in the country's energy sector development.

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