The Analysis of the Development Dynamics and Structural Balance of Solar Energy in the World

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Abstract. The paper presents data the analysis of the development dynamics and structural balance of solar energy in the world. In the article presents information about total installed production capacity of solar energy, the world solar energy production capacity distribution and the European Union energy market structure in 2000 and 2015 years.

Introduction

Currently, the countries potentially or de facto politically dependent on the world prices for hydrocarbon resources and politics of the countries exporting hydrocarbons, are actively developing and introducing renewable energy sources such as solar, wind, water, biomass, with the aim of improving their energy security, the ecological situation and introducing the so-called "Green economy"[1].

According to the 2015 year data more than 100 countries are introducing renewable energy sources in their national energy systems. The most popular among these sources are solar and wind energy. Thanks to the technological progress the following important factors have been obtained:

1. In 2016, there has been created solar battery, converting solar energy with an efficiency of 34.5%, this fact was considered impossible previously and thought to be reached not earlier than in 2050.

2. In 2016, there has been achieved a surplus of electricity generation from renewable energy sources in Germany, thanks to it, gas-fired power plants were temporarily disabled.

According to [2] solar energy is more promising and high-tech than wind or water energy. The beginning of the solar energy birth is considered to be 1973 - the year of the first energy and oil crisis. During the crisis all the Arab countries, the members of the OAPEC, Egypt and Syria ceased to supply oil to the countries such as the UK, Canada, Netherlands, the USA and Japan because they supported Israel during the hostilities with Syria and Egypt [3-5].

The oil crisis of 1973 was the first and the biggest energy crisis in the history, when the hydrocarbon resources recovery rates were used to create political pressure on the world community. Later in 1975, 1979 and 1985 the EEC adopted a program to stimulate the development of non-nuclear energy; the central position in the program was given to solar energy. Currently, the budget of the Russian Federation directly depends on the world hydrocarbons prices. The revenue diversification and share expanding of Russia on the European energy market, particularly solar energy, will
contribute to improving of the investment climate and a more dynamic development of the internal energy market [6, 7].

The aim of the article is the analysis of the development dynamics and structural balance of solar energy in the world.

Materials and methods

The analysis of the empirical material the period 2004 – 2015 and news articles were used as our primary empirical data to study: renewables - global status report and renewable energy capacity statistics

Results and Discussion

The using of the world experience and available technological advances is an integral aspect of the country development[8]. A significant solar energy aspect is the market dynamics and its total production capacity. There were about 179 GW of solar energy in 2015 according to the European Association of solar energy. Figure 1 presents the development and increasing production capacity dynamics.

![Figure 1 - Total installed production capacity of solar energy](image)

As the graph shows, the production capacity growth dynamics is positive that indicates priority and dynamic development. China, Japan, Germany, Italy, the USA are the leading countries in solar energy production. Figure 2 shows the percentage distribution of solar energy production capacity all around the world.
Prior to 2011-2012, a large part of the production capacity growth was provided by such countries as Germany and Italy, however, starting with the 2012 year the leadership in the capacity growth shifted to China, the USA and Japan\cite{9}. There were built more than 18 GW of solar power plants in China; more than 12 GW in the USA and 14 GW in Japan thanks to the government support and rapid economy diversification strategy development and state energy security. Figure 3 shows the growth dynamics in 2014 relative to 2013.
As it can be seen, the increase above 5% is observed in China, Japan and the USA. The introduced state program of the alternative energy support in India and the fixing of quotas for the installations that produce not less than 6 GW of solar power a year starting with the 2016 year, will directly affect the growth leaders’ rating. According to the experts [10] India will be able to enter the top 5 leaders on the solar energy production capacity in 2017.

The decision of the necessity to diversify the economy and active support at the state level contributed to the rapid development of solar energy in China. So at the end of 2014, the total production capacity of solar power plants was 28 GW, and the growth amounted to 10.6 GW, which accounts for 25% of global growth[11]. Also, China has occupied a niche of global manufacturer of solar modules and panels that are the key components of solar power plants. In 2014, China produced 33 GW of solar batteries, more than 70% of which were exported to the other countries. It is expected that in 2017 more than 70 GW of electricity, generated by solar power plants will be exported. The growth dynamics of solar energy in China is presented in figure 4.

![Figure 4 - Solar generation introduction dynamics in China](image)

The rise of China, Japan and the United States have affected the distribution of leadership and the displacement of Germany, which provided the increase in 2014, less than 2%. This indicator can be explained by the fact that solar energy has been developing in this country for a long time and there is a competition and the race of technological advances in the market, therefore a quantitative indicator of the introduction goes into a quantitative indicator of the solar panels’ efficiency and the indicator of the operation reduction. The unit cost reduction for solar panel up to 10 kW of power has a downward trend and, according to the 2012 reached the mark of 2 Euros per watt of energy.

The decrease in growth rate is also observed in Italy, which in 2011 put into operation more than 9 GW of solar power plants; in 2012 it was 3.6 GW, and in 2013 only 1.5 GW. This decrease indicates the high competition in the market of renewable energy sources. The analysis of changes between 2000 and 2015 has shown that the European Union market considers the development of wind energy priority. Wind energy has provided the increase more than 13.2% for the last 15 years compared to solar energy, the growth of which is equal to 10.4%. The data, concerning the European Union energy market modification, are presented in figure 5.
An interesting fact is the entry into the race, concerning the introduction of solar panels, such country as the Republic of South Africa, where the main development factor is the introduction of the grid parity of solar energy relatively to the other forms of energy. Thus in South Africa the cost of a kW of electricity of solar power plants is equal to the rate with traditional power plants with the additional function of fixing the tariff for the purchase.

During the analysis a special attention should be given to the legislative aspects of the United States, supporting the development of green energy by means of traditional companies of energy sector. So according to the U.S. law, the generating companies of fuel and energy complex should assume the obligation for purchase of facilities, generated from renewable energy or buy "Green certificates". At the end of 2014 the production capacity of solar power plants in the USA amounted to more than 18 GW of energy and in 2017 it is expected the introduction of another 40 GW. Due to the dynamic development, large amount of introduced capacities and technological development the cost of capacity decreased almost 4 times, from 8$ to 2.2 $, in the period from 2005 to 2015.

Conclusion
The world experience analysis of solar energy introduction to the national energy system has shown that the dynamic development of solar energy is the integral attribute of the modern state development. The top ten are the countries which are the drivers of progress and development of the world economy. The world experience and the use of legislative acts as the basis for the development of renewable energy sources will contribute to the promotion of Russian energy resources, green economy, export diversification and role enhancement of the Russian Federation in the world.

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