

Use of renewable energy and tax burden on CO2 emissions in industrial enterprises

Igor Ilin¹, Viktor Vasilenok², and Roman Marchenko^{1*}

¹SPbPU, Graduate School of Business and Management, 195251 St.Petersburg, 29 Polytechnicheskaya, Russia

²University ITMO, Faculty of Technology Management and Innovation, 197101 St.Petersburg, 49 Kronverksky, Russia

Abstract. The paper demonstrates the results of studies assessing the specific share of renewable energy facilities in the energy balance of the Russian Federation, analyzes investment in renewable energy throughout the world, as well as in the mining industry. In addition, there is a developed scheme with options for changes in the system of state control in the field of CO2 emissions: 3 options for implementing a system of tax burden on CO2 emissions for industrial enterprises are described.

1 Introduction

One of the most global problems of our time is global climate change, since the mid-20th century, the average annual temperature on the planet is rising. About three quarters of anthropogenic emissions of CO2 over the past 20 years are due to the extraction of primary fuel, its transportation, processing and combustion in order to produce thermal, electrical and mechanical energy. Statistical analysis of data from around the world showed that about 44% of greenhouse gases were formed using coal, 36% from oil and oil products, 20% from natural gas.

2 Materials and methods

The study was carried out using methods of probabilistic-statistical analysis of data from various sources to assess the potential for the development of the renewable energy market and the possibilities of its application in production, as well as methods of analysis and modeling to determine possible options for changes in government regulation of CO2 emissions in order to stimulate the development of the industry RES. For the study, materials from open sources were used: reports of public production companies, studies of analytical, consulting and rating agencies, scientific papers and monographs on the topic of research, as well as other materials.

* Corresponding author: marchenko_rs@spbstu.ru

3 Results

The development of energy in the modern world is characterized by rapid growth in the share and value of renewable energy sources, primarily solar and wind energy. In 2015, there was a record increase in power in solar (photovoltaic) and wind energy - more than 50 and more than 60 GW per year, respectively, and this despite the low prices for fossil raw materials. The results of the first half of 2016 show that the growth rate of renewable energy is accelerating, despite the low prices for hydrocarbons. For example, in the European offshore wind energy industry for the first half of 2016, a record investment was recorded, which reached \$ 14 billion, more than in the whole of 2015 and any other previous one. In China, more than 20 GW of solar power capacities were put into operation, which is three times more than in the same period of 2015. According to forecasts of GTM Research, in 2016 more than 73 GW of solar generation capacity will be built around the world. The installed capacity of solar power plants at the end of 2015 amounted to 230.6 GW. The growth rate of installed capacity of solar power plants in China for the year amounted to 53.5%, reaching 43.5 GW (Figure 1). But throughout the world as a whole, the annual increase in the power of solar energy was 28.1% [1].

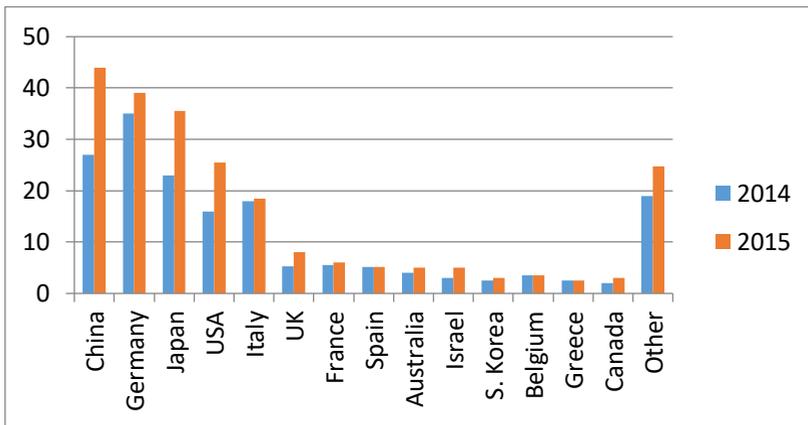


Fig. 1. Comparison of installed capacity from solar power plants (GW) for 2014-2015

Wind power in 2015 developed at a more modest, but also double-digit pace. The annual increase in installed capacity in the world was 16.9%. The installed capacity of wind power plants in the world has reached 435 GW. In the first place, according to the installed wind capacity, China remained with $W = 145$ GW (annual capacity increase 26.6%) [2].

According to the forecast of Solar Power Europe, the installed capacity of the world photovoltaic power plants may already reach 600-700 GW by 2020 (compared to 230 in 2015). The Global Wind Energy Council predicts that by 2020, the installed capacity of global wind power will exceed 790 GW (against 430 GW in 2015). Including in China, capacity by 2020 should increase to 250 GW - in wind power and up to 150 GW - in solar energy (Figure 2).

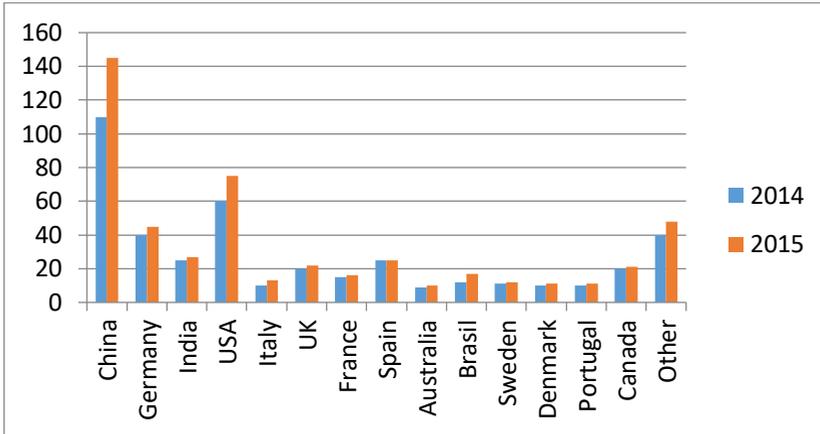


Fig. 2. Comparison of installed capacity of wind power plants (GW) for 2014-2015

In 2015, a record amount of investments in renewable energy was recorded - 328.9 billion US dollars, while the largest amount of funds - 161 billion dollars - was directed to solar energy [3]. Investments in traditional hydrocarbon-based generation totaled \$ 130 billion in the same year (Figure 3).

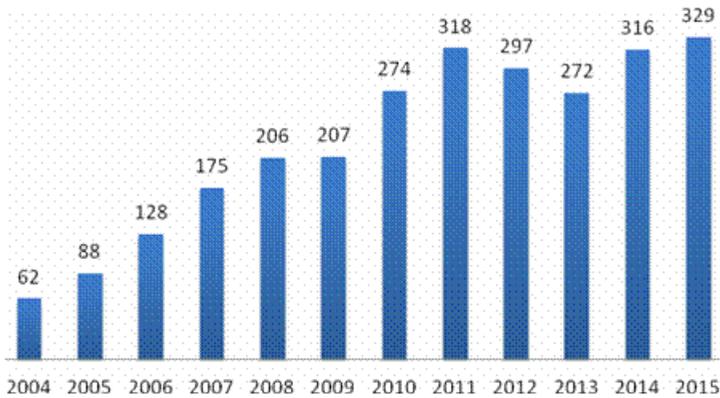


Fig. 3. Total investments in renewable energy in the world (in billions of US dollars)

According to BP's annual statistical report, in the world over a year, about 358 million tons of oil equivalent is saved by the use of new renewable energy sources (NRES). This is about 7 million bar. oil per day. On the use of renewable energy in 2015 while the top three of the United States, China and Germany are moving in significant isolation from the rest. Russia on this indicator is in 51st place (Figure 4). The United States so far in 2015 was in the first place, but the pace of increasing the installed capacity of renewable sources in China is very large and by the end of 2016 China will overtake the United States [4].

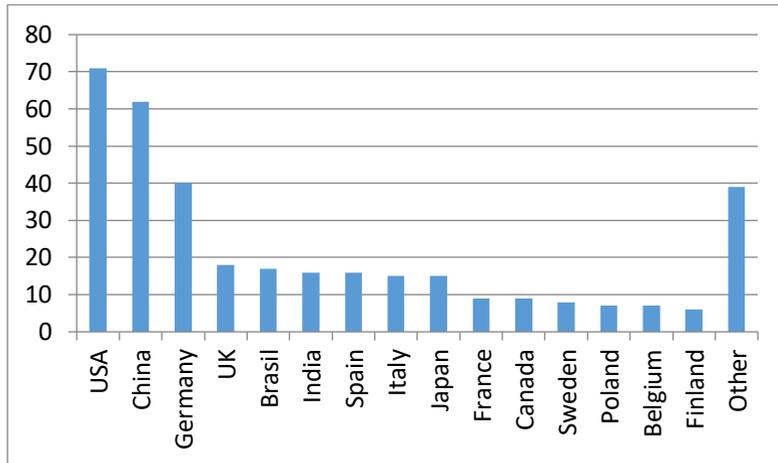


Fig. 4. Savings from the use of new renewable energy sources, in million tons of oil equivalent

Over the past seven years, prices for solar modules have fallen by about 80%, while the price for wind turbines has decreased by 30-40%.

According to the International Renewable Energy Agency (IRENA) Energy Change Report, prices will continue to decline worldwide. The average cost of electricity from land wind farms by 2025 may be reduced by 26%, from solar modules by as much as 59%. And as a result, the cost of electricity on average worldwide will drop to four \ five euro cents per 1 kW • hour. Thus, such electricity will be much cheaper than electricity produced in nuclear reactors and thermal power plants.

Even now, land-based wind turbines generate very cheap electricity, an average of seven US cents per kilowatt-hour worldwide.

IRENA specialists suggest that costs can be reduced by 26 percent by 2025 due to further reductions in the cost of production, construction and operation, development of know-how on site and more efficient systems with large turbines, towers and rotors. One kWh of such electricity will cost on average around the world only about four cents. For comparison, the electricity from new coal-fired power plants today is more than twice as high in Europe.

Electric power from photovoltaic cells went through an almost unbelievable impulse: In 2010, electricity from solar panels cost from 25 to 35 euro cents per kWh. Five years later, in 2015, the electricity from the new modules was already two-thirds cheaper. The world average price is only 10.7 euro cents per kW • hour [5]. Due to more efficient production and efficient modules, the decline in the cost of photovoltaics continues at a rapid pace: According to IRENA, the cost of electricity from solar modules by 2025 may be reduced by 59%. On a global, global scale, such electricity will cost less than five euro cents per kW • hour [6].

Analysts from Bloomberg New Energy Finance also expect much lower prices for wind and solar energy. In their recently published report, *New Energy Outlook 2016*, by 2040, they predict a reduction in the cost of ground-based wind energy by 41%, and in the sun, about 60%. They suggest that by then 7.8 trillion dollars (6.4 trillion euros) will be invested in these renewable energy technologies, and only 2.1 trillion dollars (1.7 trillion euros) in gas and coal-fired power plants (Figure 5) [7].

Specialists also emphasize that the level of competition in the global energy markets is growing, which is the main source of innovation development.

Among the key factors for the development of renewable energy sources are a reduction in the cost and an increase in the availability of borrowed capital.

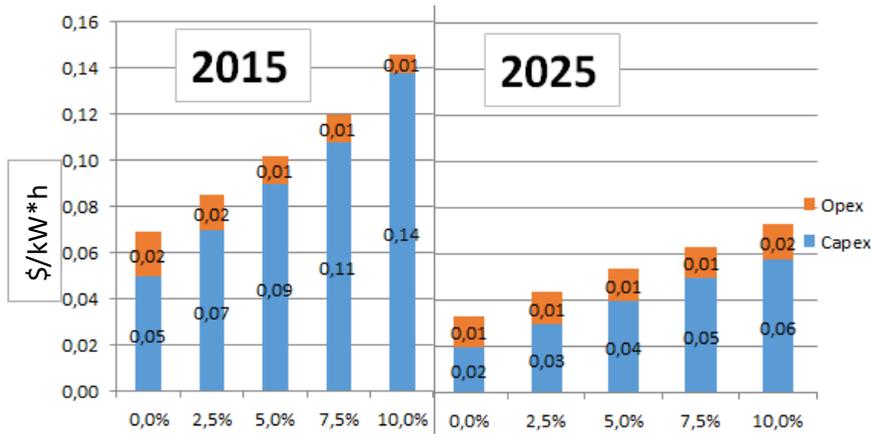


Fig. 5. The weighted average cost of electricity from solar power plants (LCOE) depending on the cost of capital (WACC) in US dollars

With regard to energy consumption, it can be noted that a huge amount of energy is used throughout the world for the extraction and processing of raw materials. The mining industry is one of the largest consumers of energy in general. To meet the growing energy demand, the mining industry has traditionally relied on traditional fossil fuels — diesel, oil, coal, and natural gas [8]. In recent years, the mining industry has been confronted with a multitude of problems, primarily with the fall in commodity prices. Energy is one of the most important cost factors for mining companies.

In the mining sector, 11% of the world's energy is used [9]. On average, energy costs account for 15% of the total production cost. When mining metals, this figure rises to 20-40%. Energy use and its cost are currently a key strategic focus for mining. Climate change and a “social license” for exploitation are becoming increasingly important areas for the mining sector worldwide. The reduction in the cost of renewable energy sources and the proven reliability of hybrid energy are of interest to mining companies in the field of renewable energy sources.

Currently, mining companies use renewable energy sources in four different market areas:

1. Renewable energy sources for mining, usually located outside the central energy supply systems, for example, such projects as: the Sandfire solar power station Solar Power Project (Australia) and the Rio Tinto Diavik Mine Wind Project (Canada);
2. Renewable energy sources for reclaimed mines, such as Rolling Hills wind farms at the former Dave Johnston coal mine (USA);
3. Renewable energy sources as a diversified business flow for a mining company, such as Semafo / Windiga or Coal India;
4. Renewable energy sources for climate mitigation or so-called. Corporate Social Responsibility (CSR), for example. Teck Resources participation in the project Winding Hills Wind (Canada).

According to Energy and Mines, the current installed capacity of wind and solar installations for mining companies is 943 MW, including solar energy (photovoltaic) 352 MW, solar thermal energy 39 MW and wind 551 MW [10]. The study also shows that the current installed capacity of renewable energy sources at repurposed mines is at least 1,100 MW.

Already more than 20 mining companies are represented in the field of using renewable energy sources for energy production at their mines:

Antofagasta Minerals (Chile), Barrick Gold (Canada), CAP (Chile), CODELCO (Chile), Collahuasi (Chile), Compañía Minera Dayton (Chile), Cronimet Metal Trading (Germany),

Galaxy Resources (Australia), Glencore Plc (Switzerland), Grupo Mexico (Mexico), IAMGOLD (Canada), Industrias Peñoles (Mexico), Mandalay Resources (Canada), Minera Rafaela (Chile), Nyrstar (Belgium), Rio Tinto (UK), Sandfire Resources (Australia), Shanta Gold (Tanzania), SNIM (Mauritania), Vale (Brazil) [11].

If we consider the investments of mining industry in alternative energy sources, then there is also an annual growth, according to research by consulting company Navigant Research, by 2022 in the Asia-Pacific region, as well as in Latin America, mining and processing companies are investing more than a billion dollars [12].

Figure 6 shows the growth dynamics of investments in renewable energy sources in different countries of the world.

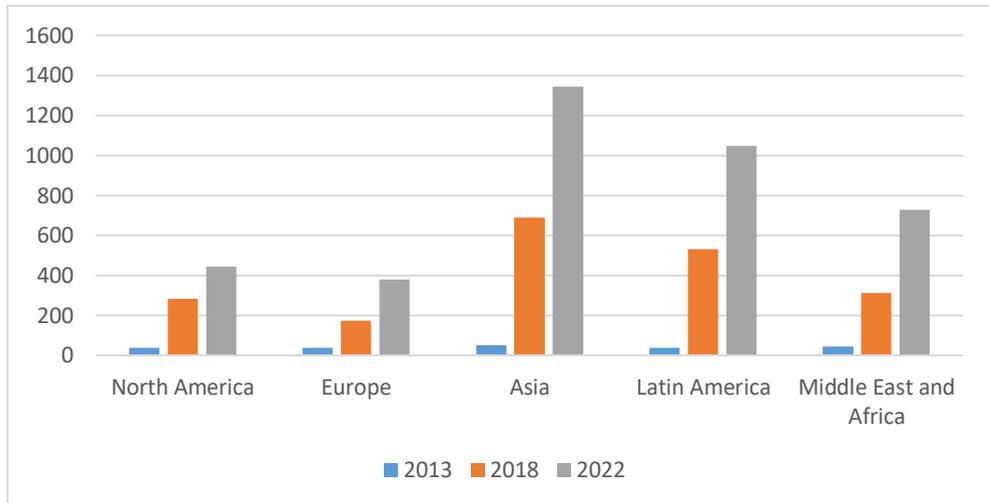


Fig. 5. Investments in renewable energy in the mining industry (in millions of US dollars), in world markets: 2013–2022

The current situation in the field of environmental management in the Russian Federation dictates the need to exercise state control in order to switch to more environmentally friendly production and renewable energy sources, since it is currently unprofitable for enterprises (including mining) to switch to renewable energy [13].

A solution to this problem could be the introduction of a carbon tax on CO₂ emissions as a way to implement the Paris Agreement (according to which, the responsibility for creating and implementing environmental protection measures should fall primarily on government bodies).

After examining the global experience in implementing carbon tax and emissions trading projects, as well as statements by officials from the Ministry of Energy and Russian business representatives, 3 options for possible changes in the government system for regulating CO₂ emissions were put forward in this paper (Figure 6).

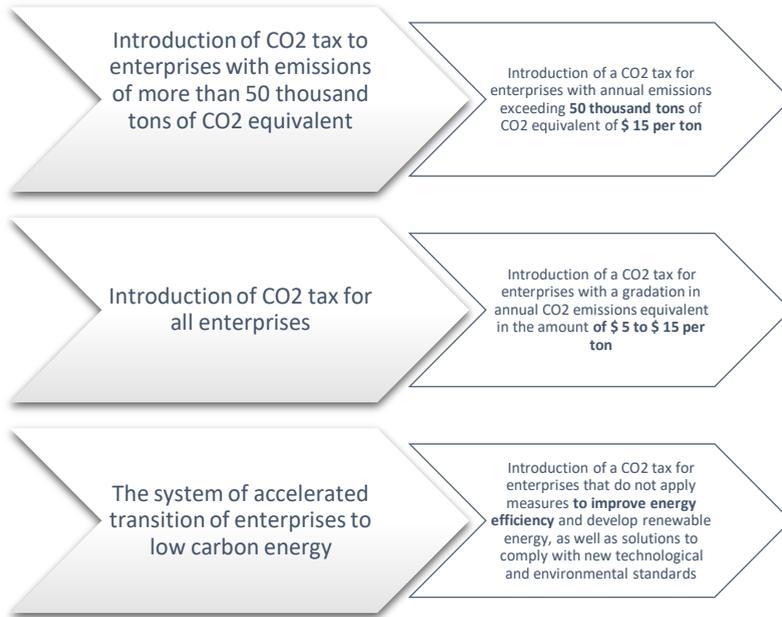


Fig. 6. Scheme of possible changes in the system of state regulation of CO2 emissions in the Russian Federation

In order to achieve the required level of CO2 emissions reduction as soon as possible, the state needs to further stimulate companies so that they in turn take measures to improve energy efficiency and reduce their GHG emissions.

4 Conclusions

Modern energy development in Russia is characterized by the rising cost of energy production. The greatest increase in the cost of energy is observed in remote areas of Siberia and the Far East of Russia, Kamchatka, the Kuril Islands, where decentralized power supply systems based on diesel power plants running on imported fuel are mainly used. The total cost of electricity in these areas often exceeds the world price level and reaches \$ 0.25 or more per 1 kW • hour.

Solar and wind energy has become a cost-effective and clean alternative to traditional energy sources. In many countries, electricity prices from large photovoltaic parks are in the same range as coal energy. However, renewable energy has many more advantages. Solar and wind energy - is decentralized energy, which is an excellent means for providing electricity to remote consumers.

As of the end of 2015, the total installed capacity of renewable energy facilities in Russia was about 53.5 GW or 20% of the total installed electrical capacity (253 GW). Almost all installed capacity fell to hydropower - 51.5 GW, then bioenergy followed in the amount of 1.35 GW. Installed capacity of solar and wind power plants amounted to 460 MW and 111 MW, respectively. The Energy Strategy of Russia for the period up to 2035 has developed a detailed plan for energy consumption: both in the sectoral context and in accordance with the main types of fuel [14]. Based on calculations based on the draft Strategy and data from other sources, by 2030, the share of renewable energy sources will be 4.9% of final energy consumption. This includes Russia's plans to increase solar, wind and geothermal generating capacity to 5.9 GW by the end of 2024 [15].

World experience shows that a number of countries and regions are successfully solving today the problems of energy supply through the development of renewable energy. In order to intensify the practical use of renewable energy in these countries, various privileges for green energy producers are established by law. However, the decisive success of renewable energy is ultimately determined by its efficiency in comparison with other currently more traditional power plants of fuel energy.

Constantly changing economic, technological, political and social conditions in Russia and the world have a significant impact on the possible trajectories of the development of the renewable energy sector in the country's energy sector and can lead to various options - from large-scale introduction of equipment for renewable energy to its use on a minimum scale to solve narrow and specific tasks of electricity and heat supply. The development of the technical and legislative base of renewable energy and sustainable trends in the growth of the cost of fuel and energy resources today determine the technical and economic advantages of power plants using renewable energy resources. Obviously, in the future, these benefits will increase, expanding the areas of renewable energy and increasing its contribution to the global energy balance.

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