Justification of the Need and Feasibility of Switching to Renewable Energy Sources for the Implementation of Sustainable Development Principles

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Abstract. Reduction of the negative impact on the environment, improvement of the energy efficiency, optimization in the structure of the global energy balance and ensuring innovative energy development are important tasks in achieving sustainable development. The aim of this article is to justify the need for the development and feasibility of switching to renewable energy sources (RES) in order to solve the abovementioned issues. In this regard, it is necessary to study the prerequisites for intensifying the process of transition from traditional energy sources made up of renewable ones, analyze their current state and prospects for further development. In addition, it is necessary to identify the necessary measures to stimulate the transition from traditional energy sources to RES. Eventually, the expected results of transition to RES are identified and allow proving the economic, social and environmental efficiency of their use.

1. Introduction

CO₂ emissions and, as a consequence, global warming, are the most acute issues in the development of the world economy, increasing the burden on the environment and human health.

It should be noted that despite all measures currently being taken, the policies on CO₂ emissions pursued by the governments of all countries around the world do not fully meet the need to reduce them, which in turn make it impossible to keep the temperature rise below 2 °C.

According to the United Nations Climate Change Conference held in Paris in 2015, it was stated that in order to achieve sustainable development, reduce CO₂ emissions and avoid global climate change, it is necessary to intensify the transition to renewable energy sources (RES).

According to the results of the 2018 report ‘Global Energy Transformation: A Roadmap to 2050’ of the International Renewable Energy Agency (IRENA) it is clear that in order to achieve the Climate Change Conference objectives, it is necessary to increase the pace of renewable energy development around the world by 2050 by 6 times.
In this connection, it seems important to substantiate the economic, environmental and social feasibility of switching to renewable energy sources that will stimulate the intensification of the transition to RES for governments in a number of countries, especially in Russia.

2. Prerequisites for the intensification of transition process from traditional energy sources to renewable energy sources

Strategic limitation of fuel and energy resources jeopardizes meeting the needs of future generations, intensification of CO₂ emissions and other harmful substances into the environment in the process of implementing the projects on the development of fuel and energy resources in a number of countries, aggravates environmental problems in the global economy.

After three years of stagnation associated with weak economic growth, reduced energy use and changes in the fuel balance, global CO₂ emissions increased by 2.1% in 2017 (Figure 1) [1].

![Figure 1. Global CO₂ emissions from fuel combustion](image_url)

In the USA CO₂ emissions remained stable that corresponds with their energy consumption, but strong economic growth led to the increase in coal consumption in China and, accordingly, CO₂ emissions, despite the policy of switching from coal to gas, which has stabilized emissions since 2014.

Global economic growth helped to increase energy consumption and CO₂ emissions in most countries, such as India, Russia, Japan, South Korea, Canada, and Iran. Unfavourable hydropower conditions also contributed to the increased CO₂ emissions in Brazil and Europe (a significant increase of 1.9% in 2017 compared to the average reduction in emissions over the last decade by -1.9%, especially in Turkey (where there is a higher use of coal), Germany, Spain, Poland and France, but at the same time there has been a reduction in CO₂ emissions in the United Kingdom as a result of the introduction of stations generating RES [2].

Conversely, CO₂ emissions have decreased in Mexico and Ukraine where coal consumption was reduced through the use of nuclear energy.

In this regard, an effective solution is required that would contribute to reducing both CO₂ emissions into the atmosphere and negative impact of traditional energy sources on the state of the environment. One of such solutions can be RES that allow increasing energy and environmental efficiency as well as achieving the strategic goals in reducing environmental pressure and optimizing the energy balance structure, minimizing the dependence on the export of organic fuels, ensuring innovative energy development for the long term.
3. Current state and prospects of RES further development

In 2017 the share of renewable energy sources (including hydropower) in the global electricity generation system, which in turn grows rapidly, was 26.5% (Figure 2) [3].

![Figure 2. The share of renewable energy in global electricity production]

Wind and solar energy are gaining momentum. This process is advanced by current climate policies in the European Union, the USA, China, India, Japan and Australia, as well as a sharp decline in the cost of building solar and wind power plants, which allowed developing countries to expand their renewable capacities. In 2017 solar power stations were generating 20% of additional power and wind power plants – 30%.

Renewable energy sources cover 1/3 of energy needs in Europe, 1/4 in China and 1/6 in the United States, India and Japan.

Oil remains the dominant fuel in the world accounting for just over one third of the total energy consumed. In 2017 the share of oil at the market slightly declined after two years of growth. The share of coal at the market fell to 27.6%, the lowest level since 2004. The share of natural gas was a record 23.4% of world primary energy consumption while renewable energy sources reached a new maximum of 3.6% (Figure 3) [4].

![Figure 3. The structure of world primary energy consumption by fuel type, %]
Achieving the goal of the Paris Agreement to limit temperature increases requires further development of RES.

According to the Shell company's scenario called Sky, developed by it in 2018, renewable energy sources will generally grow by about 50 times and bypass fossil fuels in terms of global primary energy consumption after 2050 (Figure 4) [5].

![Figure 4. World Energy Forecast](image)

The peak of coal consumption by the mankind has already been passed, the peak of oil consumption is expected by 2025, and the peak of natural gas – in the 2030s. At the same time, oil consumption in absolute terms will remain at the current level until 2040, and gas consumption will begin to fall below the existing level only in the 2050s.

A feature of the scenario is a rapid growth of photovoltaic solar energy. Already by 2035, photovoltaic solar energy should grow to 6500 GW of installed capacity and cover an area of 100 thousand square kilometers, i.e. the industry's average annual rate will be approximately 360 GW. Until 2060, the sun will become the largest source of energy (in the structure of using primary energy). A large increase in other RES is also expected.

4. **Measures required to stimulate the transition from traditional energy sources to RES**

It should be noted that starting from the 2040s legislation in many jurisdictions will require the use of exclusively renewable electricity. In order to transfer energy systems to RES, the governments of individual countries need, first of all, to begin with setting the task, namely, to form a national renewable energy strategy.

The strategy of transition to RES should include the following directions:

1) ensuring the interconnection of RES and energy efficiency;
2) long-term planning of energy systems based on solar and wind energy;
3) transferring of transport, construction and industrial sectors to the use of RES, in particular bioenergy, solar and geothermal energy;
4) stimulating technological innovations;
5) bringing socio-economic structures and investments in line with the transformation of the global energy system;
6) providing a guarantee of fair distribution of costs and benefits associated with conversion [6].
Secondly, it is necessary to develop an appropriate legal and regulatory framework that defines the rules for operating at the new energy market as well as incentive measures for stimulating RES (Figure 5) [7].

| Measures to stimulate RES |
|---------------------------|
| Tax regulation            |
| • preferential tariffs for the sale of electricity from RES |
| • ‘green’ certificates for RES |
| • tax exemption          |
| Direct subsidy            |
| • subsidizing investments in the formation of the capacities for RES production |
| • grants for innovative RES production |
| • creation of special funds for RES development |
| Administrative support    |
| • encouraging joint ventures and international cooperation |
| • creation of regional centers for RES development and dissemination |
| • support in creating RES-certification system |
| Support in scientific and technological development |
| • R&D support |
| • organization of conferences and seminars |
| • publication of specialized literature |
| • training and internships for specialists |
| Public involvement        |
| • RES promotion |
| • funding of educational programs on television, radio and in special centers |

**Figure 5.** The main measures to stimulate RES development

Thirdly, the transparency and fairness of competition from traditional sources of energy should be enhanced. RES projects are not competitors to traditional hydrocarbons, but complementary projects that can improve energy efficiency, reduce the ecological burden on the environment and operating costs of energy supply [8].

Fourthly, the investments of about USD 120 trillion will be required to ensure the possibility of transition from traditional energy sources to RES for the period of 2015–2050; USD 18 trillion of investments should be directed to the provision of power networks and the flexibility of the energy system. In general, over the specified period, the implementation of decisions on reducing CO₂ emissions, including RES development, energy efficiency and introduction of other innovative technologies, will require investments of about 2% of the average global GDP per year (Figure 6) [6].

**Figure 6.** Investments in the energy sector for the period of 2015–2050, trillion dollars

Note. CCS – Carbon capture and storage
Almost 63% of all required investments in the energy sector must be directed to the renewable energy and energy efficiency.

Additional costs for a full-scale transformation of the power grid will amount to $1.7 trillion per year by 2050.

5. Expected results of the transition to RES

As it was stated earlier, the transition from traditional energy sources to RES will require a significant amount of investments and additional costs. However, it should be noted that cost savings due to the reduction of air pollution, improvement of situation with health care and reduction of environmental damage will exceed such costs many times.

According to the 2018 report ‘Global Energy Transformation: A Roadmap to 2050’ of the International Renewable Energy Agency (IRENA) the saved amount in these three areas will average USD 4.6 trillion per year by 2050 (Figure 7) [6].

Figure 7. The economic effect of the transition to RES

Except direct economic benefits, the transformation of the energy system has a socio-economic effect contributing to the improvement of world welfare, GDP (gross domestic product) increase and improvement of the employment situation.

By 2050, an increase in welfare by 15%, GDP growth by 1% and an increase in employment by 0.1% are expected. Maximum GDP growth will be observed after about a decade and welfare will improve continuously until 2050 and beyond (Figure 8) [6].

GDP will increase by 2050 in the entire world economy. The total income due to the increase in GDP during the period of 2018–2050 will amount to USD 52 trillion. The transformation of the energy system additionally stimulates the growth of economic activity that can be expected when carrying out activities using the old methods.

At the regional level, the result of energy system transformation depends on the aims set at the regional level and regional socio-economic structures. Despite GDP fluctuations and employment situation, welfare will be increasing substantially in all regions.

Switching to RES will create more jobs in the energy sector than will be lost in the field of fossil fuels. To meet the needs of the renewable energy and energy efficiency sectors in human resources
within their rapid growth, the principles of education and training should reflect the qualification requirements put forward by these sectors.

Note. GHG emissions – greenhouse gas emissions

**Figure 8.** World welfare and GDP, 2030–2050, %

According to the 2018 report ‘Global Energy Transformation: A Roadmap to 2050’ of the International Renewable Energy Agency (IRENA) by 2050 7.4 million of jobs will be lost in the field of fossil fuels, but 19.0 million of new ones will be created in renewable energy sector, including energy efficiency, network modernization and energy system flexibility, which will ultimately provide a net increase in jobs by 11.6 million (Figure 9) [6].

**Figure 9.** Employment in the energy sector in 2016, 2030, 2050 (million jobs)
Also, as a result of grid transformation, the main elements of which are RES and energy efficiency, the environmental effect will appear. The combination of these two elements can provide the necessary reduction of more than 90% of CO₂ emissions associated with the energy production using safe, reliable, affordable and widely spread technologies (Figure 10) [6].

RES and energy efficiency provide the optimal way to achieve a significant reduction in CO₂ emissions at the required rate.

![Figure 10. Annual CO2 emissions in the energy sector and their reduction in 2015–2050, gigatons per year](image)

6. Conclusion
As a result of the study, the need to move from traditional energy to RES was evidenced, since it will be possible to achieve the objectives of the Climate Change Conference aimed at reducing CO₂ emissions that will keep the temperature rise within 2 °C.

However, it was determined that at the present stage the share of RES in the global energy balance is at the level that does not allow to realize the intended aims. In this regard, the governments of all countries of the world should take appropriate measures to enhance the development of RES, in particular, to develop a national RES strategy, regulatory framework aimed at RES stimulating, increase transparency and fair competition from traditional sources of energy and invest a significant amount of funds.

The study revealed that the transition from traditional energy sources to RES is appropriate. Investments will be repaid due to the cost savings by reducing the ecological burden on the environment that proves the economic efficiency of RES development. Additionally, the transition to RES will provide the global economy with additional GDP growth, increase the number of jobs, reduce environmental pollution and improve the health of the population; all these factors demonstrate socio-economic and ecological efficiency of RES. In general, the transition to RES will allow implementing the principles of sustainable development.

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