

## DEVELOPMENT OF ALTERNATIVE ENERGY WITHIN ESTABLISHING “GREEN” CLUSTERS IN THE REGIONS OF RUSSIA

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**Abstract:** The paper deals with theoretical aspects, algorithm and model description of the development of alternative energy within establishing green clusters in Russian regions. The objective of this work is to build a concept of establishing green clusters of alternative energy in the RF subjects and design an algorithm for the process of developing wind power in Rostov Region, with projects of this line possibly listed in reference books of the best available techniques (BAT). In the conclusion section of the paper, the structural and logical model of establishing a green cluster of alternative energy is drawn up.

**Keywords:** alternative energy, green clusters, green economy, Rostov Region, structural and logical model.

### 1 Introduction

At present, all countries of the world face climatic change processes associated with aggravation of the environmental situation. Meanwhile, in land areas, carbon load on the atmosphere grows due to the growing use of non-renewable energy sources. Hence, the transition to alternative energy is necessary as a possible line for reducing the environmental load and an environmentally friendly industry capable of using low-carbon renewable energy sources. The dimension of the set problem requires integrated attraction of investments and intellectual assets of various enterprises and organizations to provide for the technical, technological, financial and economic, and scientific aspects of the process of substituting alternative kinds of energy for the conventional ones. For this, establishing green clusters of alternative energy is necessary and expedient in individual areas. Within the clusters, the state and entrepreneurial structures, non-profit sector, environmentally-oriented public organizations, financial institutions, representatives of science and education will join their efforts, which will contribute to gaining the synergetic effect in creating new technologies. This research presents a construction scheme of the algorithm of establishing a green cluster of wind energy in Rostov Region.

For the promotion of scientific and technological developments in fulfilling the alternative energy transition plan, they have to be included into the number of the priority focus areas for the country's national economic complex, i.e., turned into the BAT. Thus, the objective of this research is to construct the concept of establishing green clusters of alternative energy within Russian regions, as well as algorithm and model representation of this process in conditions of the stepped-up implementation of the best available techniques.

### 2 Literature Review

The recent published scientific works present materials concerning the questions of developing alternative energy and possibilities of substituting the low-carbon renewable sources of electric power for the conventional ones. In papers by Russian scientists, alternative energy is considered as an innovation focus area of development for the Russian economy, one that has an opportunity of ensuring the country's sustainable environmental and economic development (Vertakova, 2017; Lipina et al., 2018; Porfiryev, 2011; Sheveleva, 2015, 2018).

These questions are discussed in works of many foreign scientists, too, for example, Kuik Onno & Branger and Frédéric & Quirion, Philippe (2019), Akella A.K., Saini R.P. and Sharma M.P. (2009).

For Russian scientists, a relevant area of research is studying the cluster approach in economics as an efficient mechanism for upgrading the economy, as well as a tool for strategically planning the regional development. The tool ensures the synergetic effect distributed between its members with the help of market mechanisms. It also creates favorable conditions for innovations, organizational and economic relations, area concentration of production, and development of the competitive environment (Gladilin et al., 2018; Egorov, E. G. & Egorova, I. E., 2013). Foreign researchers view the cluster as an institute for ensuring a country's competitive advantage in the world market within which numerous companies simultaneously compete and cooperate while also obtaining the associated economic benefits from that (Porter, 1998; Boja, 2011).

It is also studies of the problems of creating cluster formations in energy sector and oil and gas areas that are important. Russian researchers point out that higher efficiency of activity and competitiveness of fuel and energy complex enterprises can be achieved by developing the clusters, as they ensure interrelation of economic, social, environmental, political, and other aspects of development of the complex. They ensure a balanced use of fuel and energy resources and capacities, too, and the alignment of general state, regional and corporate objectives with the interests of the local community, authorities, and business (Manukyan, 2015; Maryina, 2012; Pestov, 2010). The said problems are also discussed in the works of foreign authors (Mans et al., 2008; Larruscain et al., 2014).

Cluster approaches to the development of alternative energy are currently understudied. So, in the research by Sagdeeva A. A. and Pavlova I. V. (2014), the necessity and competitive advantages of applying the cluster approach to alternative energy functioning in oil-mining regions of Russia are detailed. Meanwhile, the study of Taskaeva N. N., Pak O. A., and Seredova L. A. (2016) considers the possibility of synergetic effect establishing under the mutually complementing use of renewable and non-renewable energy sources within an energy cluster.

This is why, according to the authors, the problem of creating green clusters of alternative energy in regions of the RF seems relevant.

### 3 Research Methodological Framework

The objective of the research is to elaborate an alternative energy development concept within the model of establishing a green cluster of wind energy in Rostov Region, which will allow adapting the proposed mechanism to the particular transition of the economy from conventional energy to the use of low-carbon renewable sources.

With regard to this, the following tasks are set in the paper:

1. Evaluating the status and prospects of the development of wind energy in Rostov Region;
2. Defining the authors' theoretical premise in suggestions on the development of green clusters of wind energy;
3. Substantiating the expedient use of the cluster approach for developing alternative energy;
4. Identifying the potential members of the green cluster of alternative energy, with the requirements for greening their production activity taken into account;
5. Wording the structural and logical model of establishing the green cluster of wind energy in Rostov Region.

The information and empirical basis of materials presented in the paper and used for substantiating the authors' conclusions was made up by the official materials of the Federal State Statistics Service of the RF and its regional units for Rostov Region. It also relied on scientific papers by researchers representing both Russian and foreign science concerning the problems of renewable energy sources development. Finally, the information and empirical basis included materials of the official websites of the executive authorities of both the RF and Rostov Region, the Internet resources, as well as the long-standing practical experience and generalizations of the authors of the paper.

In the course of their studies, the authors used program documents of the domain of nature management and environmental protection, in particular, those of the National project "Ecology" and the federal project "Implementation of the best available techniques" incorporated in it. They explored development programs and reports by Russian and foreign oil and gas companies for their including measures of transition to renewable energy sources into their strategic documents. They also analyzed regional programs of social and economic, environmental and economic development, investment projects, state and private partnership projects of the environmental trend, and cluster initiatives in the sphere of alternative energy. The statutory and legal framework contains federal laws of the RF, Resolutions of the RF Government and of Rostov Region Government, legislative and statutory instruments concerning the aspects of sustainable development of the green economy and environmental protection. The authors have studied and analyzed facts on alternative energy projects currently undertaken in the RF. They have investigated possible inclusion of promising projects of using low-carbon kinds of energy (solar energy, wind energy, biomass energy, wave energy, thermal gradient energy, tidal energy, and geothermal energy) into Russian reference books of the best available techniques. The sources of information for establishing the green cluster of wind energy were Rostov Region projects of locating wind farms in municipal entities.

#### 4 Results and Discussion

Notably, Rostov Region has some practical results of transition to renewable energy sources – wind energy. So, Sulinskaya wind power plant has started supplying electric power to the wholesale market for electricity and power (WMEP) in Rostov Region. Thus, electric power from the region's first wind farm is already marketed. Electric power generation is ensured by 26 wind turbines manufactured by Vestas Company. The capacity of Sulinskaya WPP amounts to 100 MWt. This wind farm was the first object completed by the Wind energy development fund in Rostov Region. With its installed capacity of 100 MWt, Kamenskaya wind power plant has started its full-scale supplying the wholesale market for electricity and power (WMEP), up to the investment project participated by Fortum PJSC. The new wind farm was built near Sulinskaya WPP, and it started the WMEP supplies in March 2020. The production of its main components – blades and towers – was localized in Ulyanovsk and Taganrog with the participation of the Rusnano Group. Nacelles are assembled at the enterprise in Dzerzhinsk, Nizhny Novgorod Region. According to the data of the Agency of investment development of Rostov Region (2020), in the region, they are planning to put another wind power plant – Gukovskaya WPP, at 100 MWt of installed capacity – into operation before the end of 2020. In its premises, startup and commissioning of individual systems is being completed, and the staff are preparing for integrated tests of the equipment. This wind farm will be launched in two stages, for it to reach the full capacity in the fourth quarter of 2021, as scheduled. All the three projects are carried out by the *Vetroenergetika* (Wind Energy) Managing Company which signed the agreement with regional authorities in 2017. Moreover, they are preparing to begin construction of Kazachya WPP, the installed capacity of which is 100 MWt. Located near the town of Kamensk-Shakhtinsk, this wind farm is expected to start marketing electric power in the fourth quarter of 2020. The total of four wind farms will house 90 wind turbines of 3,8 MWt to 4,2 MWt capacity each.

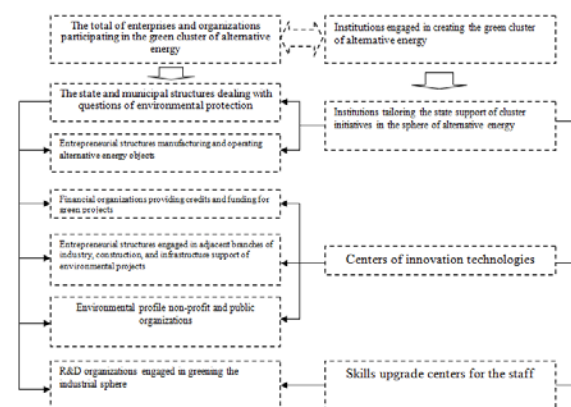
Previously, the Government of Rostov Region and the Wind energy development fund signed an agreement providing for the future scaling up the region's wind generation capacity of up to 600 MWt.

As the authors have already demonstrated, "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" (Tyaglov et al., 2019a). Meanwhile, "according to the authors Tyaglov S., Sheveleva A., Guseva T., it makes sense to form the interregional cluster of the alternative energy relying on the multilateral cross-sectoral model. In this case, such key balanced elements as energy generation, production, consumption, industry, R&D and education that are developed in a certain region to the greatest extent get united, which will yield the synergetic effect at the account of sharing the material and technical, financial and labor resources, technologies, knowledge and experience among the regions and allow implementing the alternative energy projects in the most efficient way. In its turn, this will contribute to ensuring the sustainable environmental and economic development of the Russian economy" (Tyaglov et al., 2019b, pp. 373-378).

Within this context, given the necessity and expediency of reducing the dependence of the economy on non-renewable sources of energy materials, as well as the global warming, the rates of which are accelerated due to higher fuel combustion volumes, the development of various kinds of renewable energy is inevitable. In these conditions, if environmental problems get aggravated further on, diversification of Russian companies' activity in the focus area of alternative energy development becomes essential. In its turn, this requires creating the relevant environment for supporting the projects in this sphere. One of the ways for making a reality of this focus area can be the cluster approach contributing to the country's innovation development and higher competitiveness by the efficient interaction of the state structures, entrepreneurial structures, and scientific and research organizations. This is why for improving industrial policy of the RF along this line, the priority focus areas of development have to be supplemented with forms of cluster interaction in the sphere of alternative energy, and individual financing has to be allocated for creating green clusters.

Within the context of the above, Figure 1 describes the total of members of cluster interaction in the sphere of alternative energy.

Figure 1 The total of state and entrepreneurial structures engaged in cluster interaction in the sphere of alternative energy development



Source: Compiled by the authors according to the research findings

Let it be noted that such composition of cluster interaction members will allow optimizing the process of transition to renewable energy sources in Russia.

For materializing the idea of establishing the green cluster of wind energy in Rostov Region, sizeable funds will be required. So, the authors suggest the following scheme for financing the newly created cluster and outline the role of financial institutions, which is shown in Figure 1. The essence of the scheme consists in using responsible financing and green finances of financial structures. This is associated with the following tasks to be completed. Within identification of the organizations of Rostov Region that provide responsible financing and use green financial instruments of responsible financing, institutions have to be singled out that are able and prepared to share in financial provision of the cluster being established. Next, offers have to be worded for the green cluster members in creating Standards for green bonds, social bonds, and sustainable development bonds. The managerial structures have to render support and promote measures aimed at developing responsible financing institutions that are engaged in the cluster. They also have to create conditions for improving legal regulation of financing green projects, analyze, and sum up practical results in assessing environmental advantages and environmental risks of the cluster financing projects. Concerning the environmental advantages and environmental risks in wind energy of Rostov Region, assessment criteria have to be formed, and the relevant guidelines have to be developed. They have to test out green financial instruments as a case study of Rostov Region, too, with possible further subsidies on the part of the wind energy cluster projects. One more task is to provide further training and re-training for professionals to gain competencies of using green financial instruments.

Thus, establishing the methodological system of responsible investing and green financial instruments (bonds, credits, loans, pollution quotas, green purchase mechanisms, etc.) will allow financing the project of the green cluster of wind energy in Rostov Region.

The development of the alternative energy sphere relies on achieving the effect as viewed from a system of three coordinates: the social, the economic, and the environmental one. It should be noted, too, that there are subjects of entrepreneurship elaborating their own knowledge intensive technologies in alternative energy and including them into the BAT reference books further on, and cluster interaction in alternative energy will ensure creating an efficient economic platform for these subjects to develop on. With regard to this, fixed investment of the green cluster members will be higher, and so will be the investment grade of entrepreneurial structures belonging to this association. When the green cluster of alternative energy is established, highly-skilled professionals will be sought after, which will contribute to further employment at the cluster member enterprises and lead to higher added value of the product created.

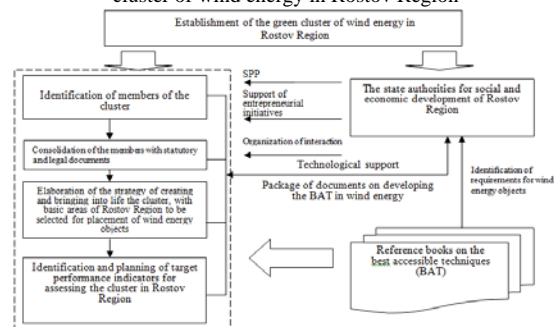
This is why in the green cluster creation scheme, there is the block of scientific and educational institutions. Viewing the process of building up human capital assets through the lens of the country's environmental development highlights the role of higher educational institutions in environmental education and upbringing. Notably, they play this role for absolutely all strata of the country's population, regardless of their age and place of residence. Universities keep investing into human capital assets and configure the required general cultural, educational, and professional competencies. Meeting the demands of the green economy, education has to have a stimulating effect both on the economy and innovation activity in the technological, economic, and sociocultural spheres.

The idea of the green economy consists in the priority of long-term sustainable economic development. The latter satisfies the present-day generation's needs by the full-fledged use of human capital assets and reduced consumption of natural and other kinds of resources, misallocation of which may harm the future generations. The task of higher educational institutions fulfilling

green educational paths is to cultivate conscious recognition of the value of biological diversity and ecosystem services in all strata of the population, as well as taking the said value into account at all economy development stages.

Green economy standards and principles can only be implemented proceeding from the particularities of development of human capital assets that consolidate the total of knowledge, abilities, and skills. The methodology of power generation transition to various kinds of renewable energy sources has to become an important element in the long-term development strategy of the industrial sector of the economy. This methodology contains the total of provisions on the sustainable development of renewables and relies on the concept of fulfilling the provisions as environmentally-oriented, energy-efficient, and energy-saving measures. The algorithms and models of transition from conventional energy sources to low-carbon kinds of alternative energy, analyzing and diagnosing the results of implementation of alternative energy kinds by means of fulfilling promising technology installation and launch projects seem expedient, provided that the infrastructure of this line of environmental development is expanded in step with them. The authors' studies have confirmed the necessity and expedience of creating a special institution for bringing into life the scheme of establishing green clusters of alternative energy. In particular, for wind energy, this is the existing and successfully operating Wind energy development fund. The authors have created the structural and logical model of the green cluster of wind energy in Rostov Region (Figure 2).

Figure 2 Structural and logical model of establishing the green cluster of wind energy in Rostov Region



Source: Compiled by the authors according to the research findings

The model shows that interaction among the state structures of regional development management and all potential members of the cluster can proceed along two lines. They can interact both in the form of the state and private partnership, which implies direct membership of the authority structures in the project, and with the help of the state support rendered to entrepreneurial initiatives aiming to establish alternative energy clusters. The emphasis should also be placed on preparing the project documents for listing in the BAT reference books. This will require focusing the knowledge in the sphere of the modern equipment and technologies and determine the role of the R&D organizations engaged in the cluster as the leading one in this question. Finally, let it be noted that the structural and logical model of establishing the green cluster of wind energy in Rostov Region implies selecting areas for placing the wind energy objects in the Federation subject, too.

## 5 Conclusion

At present, the problem of uninterrupted centralized electric power supply for the population still persists in many RF areas that are remote from the center. In particular, there are process and technical difficulties of connecting the areas to central electric power networks and gas mains. So, installation of solar panels or wind power generators becomes more profitable for providing the population with electric power.

Therefore, in the said areas, alternative energy objects have to be deployed, first of all, the solar and wind power ones.

In Russia, the proportion of electric power generation based on renewable energy sources is not significant as of the present point, amounting to 1% of the total output of electric power. The Russian Federation has adopted the law "On energy conservation, improving energy efficiency" (2009). According to it, both producers and consumers of energy have to implement the best available techniques, mainly, represented by the modern energy-saving technologies, which has to be promoted by the development of renewable energy sources. With regard to this, the establishment of clusters aimed at solving the said problems will allow enhancing the efficiency of the state support rendered to environmentally friendly industries and improving the investment prospects of alternative energy.

The results of studies in alternative energy development, the algorithm, and model of establishing the green cluster of wind energy in Rostov Region have been suggested by the authors for promoting the cluster interaction of the state and entrepreneurial structures in questions of substituting low-carbon energy sources for the conventional ones in the RF subjects. Owing to these findings and suggestions, both Russian and foreign companies will be able to take part in high-margin projects in the domain of renewable energy sources. The above results will also enable them to reduce their own energy consumption by introducing energy-saving measures and to create their own power generation.

The result of the research should be considered the detailed description of Russia's development potential of alternative energy, with the latter having competitive advantages of both environmental and social nature, as well as the promising economic ones. Within the Russian Federation, a large number of solar and wind energy projects are already operated, with foreign partners and investors participating. This positive experience can be used when establishing green clusters of alternative energy, too. As an indirect important economic result, one can note developments in the sphere of alternative energy that will supplement the BAT reference books as ones which represent efficient environmental innovations and can form the basis for working out new environmentally-oriented development technologies for the RF economy.

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