

УДК 338.24

**СРАВНИТЕЛЬНЫЙ АНАЛИЗ ГОСУДАРСТВЕННЫХ ПРОГРАММ
ПОДДЕРЖКИ РАЗВИТИЯ ВОЗОБНОВЛЯЕМОЙ ЭНЕРГЕТИКИ В
РАЗНЫХ СТРАНАХ****Болдырев Игорь Юрьевич,**

Студент 432 группы Санкт-Петербургского государственного университета
промышленных технологий и дизайна. Высшая школа технологии и энергетики, Санкт-
Петербург, ул. Ивана Черных, 4
E-mail: cr470701@gmail.com

Липатов Максим Сергеевич,

Старший преподаватель кафедры теплосиловых установок и тепловых двигателей Санкт-
Петербургского государственного университета промышленных технологий и дизайна.
Высшая школа технологии и энергетики, Санкт-Петербург, ул. Ивана Черных, 4.
E-mail: 110lms@mail.ru

Аннотация

В статье представлен сравнительный анализ государственных программ поддержки возобновляемой энергетики (ВИЭ) в Германии, Китае, США, Бразилии, Дании, Испании и России. Исследование фокусируется на субсидиях, налоговых льготах и квотах, анализируя их эффективность и влияние на развитие ВИЭ. Результаты показывают, что наиболее эффективны комплексные программы, адаптированные к специфике каждой страны.

Ключевые слова: возобновляемая энергетика, ВИЭ, государственная поддержка, субсидии, налоговые льготы, квоты, сравнительный анализ.

**COMPARATIVE ANALYSIS OF GOVERNMENT PROGRAMS TO SUPPORT
THE DEVELOPMENT OF RENEWABLE ENERGY IN DIFFERENT
COUNTRIES****Igor Y. Boldyrev,**

Student of group 432,
St. Petersburg State University of Industrial Technology and Design.
Higher School of Technology and Energy, St. Petersburg, Ivan Chernykh Street, 4.
E-mail: cr470701@gmail.com

Maxim S. Lipatov,

Senior Lecturer of the Department of heat power installations and heat engines,
St. Petersburg State University of Industrial Technology and Design.
Higher School of Technology and Energy, St. Petersburg, Ivan Chernykh Street, 4.
E-mail: 110lms@mail.ru

ABSTRACT

The article presents a comparative analysis of government programs to support renewable energy (RES) in Germany, China, the USA, Brazil, Denmark, Spain and Russia. The study focuses on subsidies, tax incentives and quotas, analyzing their effectiveness and impact on the development of renewable energy sources. The results show that comprehensive programs adapted to the specifics of each country are the most effective.

Keywords: renewable energy, renewable energy sources, government support, subsidies, tax incentives, quotas, comparative analysis.

Renewable energy sources (RES) are becoming a key element of the energy transformation needed to combat climate change and ensure sustainable development. The transition to RES-based energy requires significant investments and active involvement of the state, which, in turn, uses a variety of support instruments. The aim of this study is to provide a comparative analysis of state support programmes for RES development in different countries, with a particular focus on the effectiveness of the mechanisms used, their impact on the rate of RES development, and the associated economic consequences. The study focuses on three main types of measures: subsidies, tax incentives and quotas, examining their application in different contexts and identifying common trends and differences. The analysis is conducted to identify best practices and lessons learnt that can be applied in other countries striving for a sustainable energy future [1].

The study is based on a comparative analysis of RES support programmes in several countries representing different economic models and levels of development. Germany, China, USA, Brazil, Denmark, Spain and Russia are chosen as the objects of the study, as countries with different levels of success in RES development and different approaches to stimulating the sector. The analysis is based on data from official government reports, international organisations (UN, IEA, IRENA), scientific publications and specialised databases. The analysis focuses on the following key parameters: the size and form of subsidies (direct, guaranteed tariffs, soft loans), the types and scale of tax incentives (tax exemptions, accelerated depreciation, tax credits), the nature and level of RES quotas, and their impact on the growth rate of the sector. In addition, factors that may influence the efficiency of the programmes are analysed, such as the level of technological development, availability of necessary infrastructure, investment climate, and economic conditions in each country.

Subsidies play an important role in overcoming market barriers related to the high initial cost of renewable energy technologies and their competition with conventional energy. The analysis shows that different countries use a variety of subsidy mechanisms. For example, Germany relied on feed-in tariffs at the initial stage of renewable energy development, guaranteeing a high price for electricity generated from renewable energy, which provided predictable income and attracted investment. In the USA, Investment Tax Credits are often used, which reduce the tax burden for investors in RES projects [2]. In China, it is common practice to provide direct subsidies for the installation of solar panels and wind turbines, which stimulates domestic production and technology deployment. The analysis demonstrates that direct subsidies, while effective for short-term incentives, can be more costly to the budget and less effective in the long term than, for example, guaranteed tariffs, which create a more stable and predictable market. The economic consequences of subsidies include lower electricity costs, job creation in the RES sector, and reduced imports of fossil fuels, but can also lead to higher electricity costs for end-users in some cases and a financial burden on the budget.

Tax incentives are an important complement to subsidies, providing additional economic incentives for investors and consumers. For example, Brazil provides significant incentives for the purchase and installation of solar panels, including exemptions from import taxes on equipment. Spain introduced tax incentives for companies investing in RES projects, with the possibility of accelerated depreciation of assets. The analysis shows that the effectiveness of tax incentives strongly depends on the tax policy and the level of tax burden in each particular country [3]. Tax incentives are generally less attractive than direct subsidies, but may be more politically acceptable and more sustainable in the long term. They can also be more effective in stimulating innovation and reducing the cost of technology by creating market mechanisms. The economic impact of tax incentives can be seen in increased investment, job creation, reduced dependence on imported fossil fuels and stimulation of economic activity.

Quotas, or renewable energy obligations, are a method of stimulating demand for energy from renewable sources. Denmark, for example, has set high obligations for the share of renewable energy in the energy mix, which has created significant demand for wind power and stimulated the development of the industry. In China, renewable energy quotas, along with other measures, have helped accelerate the transition to clean energy. The analysis shows that quotas can be very effective in stimulating investment and innovation in renewable energy, but they must be carefully designed to avoid negative effects such as increasing electricity prices or creating barriers to competition. Quotas also need to be adapted to local conditions and energy policies. The economic effects of quotas can be positive, such as reducing emissions, developing new economic sectors, and creating new jobs. However, there can also be negative effects, such as increased energy costs and social costs [4].

To illustrate the differences in the approaches of the different countries and their impact on RES development, Table 1 shows the share of RES in the energy mix of the countries selected for analysis, as well as the main comments and explanations regarding the support measures used in each of them.

Table 1. Share of RES in the energy mix of the studied countries

Country	Share of Renewables in Energy Mix	Main Support Mechanisms
Germany	62.7%	Feed-in tariffs, auctions, tax incentives, quotas, direct subsidies.
China	50%	Direct subsidies, quotas, green certificates, preferential financing, R&D incentives.
USA	22.7%	Investment Tax Credits, tax incentives, federal and regional programs, preferential loans, Renewable Portfolio Standards.
Brazil	89%	Tax incentives for equipment imports, preferential financing, auctions, biofuel mandates.
Denmark	67%	Quotas (renewable energy obligations), feed-in tariffs, tax incentives, infrastructure investments.
Spain	50.8%	Feed-in tariffs, auctions, tax incentives, Renewable Portfolio Standards, direct subsidies.

Russia	4%	Subsidies for individual projects, underdeveloped quota system, tax incentives for certain types of renewables, R&D incentives.
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The analysis of the table shows that countries with the largest share of RES in the energy mix, such as Germany and Denmark, apply comprehensive support measures, including a combination of 'green tariffs', quotas and tax incentives. At the same time, countries with a smaller share of RES, such as Russia, use less developed support systems, which is reflected in the slow development of the sector.

The analysis shows that the most successful countries tend to use a combination of different support measures, adapting them to their specific economic, social and political conditions. Germany, for example, has successfully combined feed-in tariffs with renewable energy obligations, creating a predictable market and incentivising investment. China uses direct subsidies to increase production capacity as well as quotas to create demand for renewable energy. In the US, tax incentives and credits, combined with federal and state programmes, stimulate investment and innovation. Denmark has set high quotas for RES, which motivated the development of wind energy [5]. A comparative analysis shows that the least effective programmes tend to be those that depend on only one type of instrument, e.g. subsidies only, or quotas only, and do not adapt to changing market conditions and technological progress. The overall conclusion is that successful RES support programmes should be comprehensive, flexible, adaptable to local conditions and technological progress, and include a combination of subsidies, tax incentives, quotas and other measures.

Government support is critical to the development of renewable energy. The effectiveness of support measures depends on many factors, including the political climate, economic development, the availability of necessary resources and infrastructure, and the ability of governments to adapt policies to changing conditions. Analysis has shown that successful programmes are usually a combination of subsidies, tax incentives and quotas tailored to the specific conditions of each country. Countries seeking to accelerate renewable energy development should learn from the experience of other countries, adopt an integrated approach, invest in research and development, create a favourable investment climate and build the infrastructure needed to integrate renewables into the grid. Further research should focus on analysing the long-term economic and social consequences of different models of RES support, as well as on identifying new and more effective mechanisms to stimulate the development of the sector.

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