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Article

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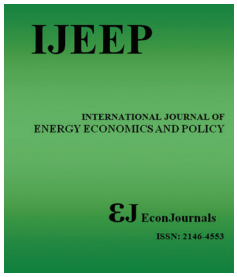

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Comparative Analysis of Strategies for Innovative Development of the Fuel and Energy Complex: The Experience of the EU Countries

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ABSTRACT

Most European countries do not have large reserves of natural resources and depend on imported energy resources. In this regard, the government of the European Union has approved a new energy policy aimed at developing a "green" economy and combating dependence on non-renewable resources. Currently, the European Union is a leader in the development of renewable energy sources. Many states have achieved success in this industry, their experience can be used in other countries where alternative energy is not so widespread. This study analyzes and compares existing strategies for the innovative development of the fuel and energy complex of EU member states. The process of formation of the EU energy policy and its distinctive features were studied. The example of Italy, Germany, Poland, Spain, and Finland was used to study in detail the impact of the new energy policy approved by the EU government. The prospects for the introduction of alternative energy sources in the geographical and climatic conditions of Kazakhstan have been assessed. Synthesizing the information obtained, a list of tips for the successful development of alternative energy in the Republic of Kazakhstan was proposed.

Keywords: European Union, Kazakhstan, Green Economy, Fuel and Energy Complex, Renewable Energy, Natural Resources
JEL Classifications: Q20, Q30, Q42, Q50

1. INTRODUCTION

The European Union has enormous economic potential. Driven by the interests of public safety and energy security, European states have modified the fuel and energy balance in favor of petroleum products and clean natural gas over coal. However, the EU is dependent on energy imports due to a shortage of its own natural resources (Pavlenko, 2020). Nevertheless, the EU is actively developing alternative energy, increasing the supply of "green" electricity every year. As of 2019, the EU is a leader in the fight against climate change at the global level. Conventional energy, which occupies the bulk of the fuel and energy complex of the EU countries, is gradually being replaced by alternative energy. Due to the gradual depletion of fossil fuels, the strong dependence of some countries on imported energy resources, greenhouse gas emissions, and overall levels of pollution, the EU energy policy is aimed at the transition to renewable energy sources.

Depending on the geographical location and amount of natural resources, different ways of reducing dependence on non-renewable sources are applied. For example, Sukhotina and Tomashevskaya (2019) point out that Germany leads in energy consumption but is the largest producer of alternative energy in the EU. The United Kingdom, as part of the EU, ranked third on the list of total energy consumption, with most ocean energy projects continuing to be implemented in the United Kingdom.

Since environmental protection and reduction of pollutant emissions is a global task (Tulchynska et al., 2021), the rich experience of European countries can be used in other regions to improve the fuel and energy complex. Kazakhstan has a large territory, so it is necessary to use the potential of the state to expand energy production from alternative sources.

This paper presents an analysis and comparison of the energy sector of European countries, identifying the best strategies for the geographical and climatic conditions of Kazakhstan. The features of the fuel and energy complex of some EU countries depending on climatic conditions, in particular, Italy, Germany, Poland, Spain, and Finland are highlighted. Identified the most effective solutions to improve the fuel and energy complex of Kazakhstan and justified the need to disseminate renewable energy sources.

2. LITERATURE REVIEW

The question of natural resources and the possibility of obtaining energy in an environmentally friendly way has been the subject of study by many scientists from all European countries. Many studies are currently examining the impact of the EU's new energy strategy.

Hewitt et al. (2019) examined the drivers of the EU's European energy policy using examples from Germany, Belgium, France, Italy, Spain, Poland, Sweden, and the United Kingdom. The researchers presented a broad sample of the energy strategies of different countries. The authors compared the activities of states with high dependence on energy imports (Italy, Belgium, and Spain), countries with high coal consumption (Poland, Germany, and the UK), and countries whose energy dependence has been decreasing in recent years (France, Sweden). The comparison is also made from the perspective of the largest production of electricity from renewable sources. The countries that generate the largest share of electricity using photovoltaic systems include: Germany, Spain, and Italy. Wind power is most common in Germany, Great Britain, and Spain. Hydropower is in Sweden, France, and Italy. Countries with less developed renewable energy sources include Poland.

Tagliapietra et al. (2019) determined under what conditions a full-scale energy transition toward renewable energy and zero-carbon emissions would be economically and technologically feasible. The topic of sustainable development of EU member states is addressed in Wieczorek-Kosmala et al. (2021). By conducting an empirical analysis of the financial performance of energy companies, the authors identified factors for the sustainable performance of the energy sector in Europe. Polzin and Sanders (2020) explored the possibility of Europe completely abandoning conventional energy, identifying a mismatch between the available funding for green projects and the required investments to achieve zero carbon emissions by 2050.

An assessment of the impact of energy reforms conducted by Angheluta et al. (2019). The article numerically assesses the progress of European countries on the way to achieving the reduction of harmful emissions into the atmosphere and increasing the production of energy from renewable sources. A comparative analysis of renewable energy data in transportation, electricity, heating, and cooling is presented. Studies have shown that in all states there is an increase in the use of renewable resources in all sectors.

An important point is the security of the energy system. Kovacic and Di Felice (2019) compared the discrepancy between the political program and the current level of reliability of European countries' power systems. The authors noted that this point is often mentioned in energy programs, but in reality, it is often ignored. A proposal was made to strengthen control over the security of EU energy complexes.

Opportunities for Kazakhstan's transition to renewable energy are considered in the article by Nazarova et al. (2020). The prospects for the development of alternative energy sources in the Republic of Kazakhstan, in particular wind, solar, biogas, and hydropower, were determined. The authors identified the main requirements for the implementation of the listed types and assessed the benefits of the transition to the use of renewable resources. Prospects for the development of the spread of "green" energy sources are also considered in the article by Zhunusova and Omarbakiev (2018). The researchers believe that in the climatic and geographical conditions of Kazakhstan the most efficient production of electricity based on solar and wind installations. It is determined that hydropower can produce 25 times more energy than the use of gas, oil, and coal. Nevertheless, in order to successfully implement a renewable energy policy, a number of legal and organizational measures must be taken.

3. METHODOLOGY

The methodological approach of this article is based on methods of analysis and comparison of the existing energy policies of different EU countries, depending on the current situation of their fuel and energy complex. The synthesis method was also used, which allowed to generalize the information obtained for the introduction of alternative energy in the Republic of Kazakhstan. A detailed review of the history of the formation of European energy policy is necessary The study was conducted in three stages.

The first stage of the article examined the history of the formation of European energy policy. The main stages of the formation of the EU energy system and the consequences of the adopted directives were defined. The main objectives of the European government for the coming years are outlined.

At the second stage, the fuel and energy complexes of different EU countries were analyzed, and the peculiarities of each state were highlighted. The energy systems of Italy, Germany, Poland, Finland, and Spain are examined in detail. The strengths and weaknesses of each state were identified, their ways of resisting dependence on energy imports and the spread of alternative energy were studied.

The third stage studied the prospects for introducing renewable energy sources in Kazakhstan. Based on the experience of European countries, proposed ways to accelerate the development of alternative energy. The need to use solar, hydro, wind, and bio-energy is justified. This issue is considered from the perspective of balancing the economy of the country and employment. It is indicated what actions should be avoided in the new energy policy.

4. ENERGY POLICY OF THE EUROPEAN UNION

The history of EU energy policy is divided into three periods, which focused on energy security, free competition in the domestic market, and the fight against climate change. In 1951 the European Coal and Steel Community was created, at that time the main source of energy of EU countries was coal. In 1957, the European Atomic Energy Community was approved. These were the first steps toward a common energy policy based on supranational powers. Subsequently, in the 1980s and 1990s, directives were issued to liberalize the European energy market in order to develop its competitiveness. In addition, the first energy package, a collection of directives on gas and electricity in 1996 and 1998, respectively, was released. As a result, EU member states were to open their energy markets to strengthen their competitiveness, security of supply, and protection of nature. However, the actions taken did not solve the issue of the lack of a legal framework and the absence of a common energy policy. It was not until 2005 that the European Council adopted a common European energy policy and approved the second energy package, overturning the previous one. This gave an impetus to the creation of program-targeted documents aimed at improving the sustainability of the energy economy, security of supply, etc. Reforms aimed at liberalizing the gas and electricity sector were carried out.

Between 2006 and 2007, new energy policy goals were set to combat climate change, improve energy security and enhance the competitiveness of member states. The status of European energy policy was strengthened by the Lisbon Treaty, which was signed in 2007 and entered into force in 2009. This gave the European Parliament and the Council the ability to pass legislation in the field of energy. According to the Treaty, the main objectives are: developing the energy market, managing the European oil, gas, electricity, and gas network, strengthening the security of energy supply, improving energy efficiency, expanding the range of "green" energy technologies. In this case, the environmental aspect was brought to the forefront. The Third Energy Package, adopted in 2009, implies new changes in the sale and transportation of gas and electricity. The energy companies have not been able to operate the transmission network and produce or sell energy at the same time since then and have to be separated. Thus, it has served to promote fair competition in the market and reduce the cost of energy for consumers. The EU government has worked hard to ensure the security of the energy supply and a free energy market, achieving its goals. Subsequently, there was an increase in the number of reforms affecting the development of green energy.

The European Council 2011 adopted an 80-95% emissions reduction target by 2050, and in 2014 a framework on energy and climate change was proposed to be implemented by 2030. In 2016. The European Commission issued a set of regulatory proposals, Clean Energy for All Europeans. Thus, three goals were set: to achieve the highest energy efficiency and global leadership in the field of alternative energy, as well as to create favorable conditions for consumers, in particular, it concerns the cost of energy resources. In 2019, the foundations of the new energy policy were finalized, the package "Clean Energy for All Europeans" was finally formed. The strategy of carbon neutrality was approved, a complete shift from fossil fuels to cleaner energy. One of the main intentions was to increase energy production from renewable sources to 32% by 2030 (Knodt, 2018; Lehotay, 2020).

The effectiveness of the reforms carried out varies greatly from country to country. Ossowska and Janiszewska (2020) identified four groups of EU member states, depending on the level of sustainable energy consumption. The first class denotes a favorable situation, the second - rather favorable, the third - rather unfavorable, and the fourth - unfavorable. The first group includes the Nordic countries: Denmark, Finland, and Sweden; the share of energy production by renewable energy sources in these countries was 35%, 41%, and 51%, respectively. Although Denmark and Sweden are among the most energy-dependent EU countries, and the energy efficiency index is rather low, the governments of these countries successfully provide the population with the required amount of energy by expanding alternative sources. Natural conditions allow extensive use of hydropower in coastal areas and hydropower in mountainous areas. The second group includes Italy, the Czech Republic, Latvia, Estonia, Greece, Croatia, Portugal, and Romania. These countries have the best energy efficiency levels. The third group includes Austria, Ireland, Germany, Spain, France, Belgium, Bulgaria, Lithuania, Hungary, Slovakia, and Slovenia. The energy situation in these countries is more difficult. Most of these countries are failing to cope with the reduction of harmful emissions into the atmosphere. There is also no positive trend in overcoming energy dependence. The last group includes Malta, the Netherlands, Luxembourg, Cyprus, and Poland. The reasons for this are the lack of natural resources in some of the states and the predominance of oil in energy consumption. Poland has its own coal reserves, but the use of this resource inevitably leads to an increase in carbon dioxide emissions, which contradicts the regulations of the European Commission. Let's look at some individual cases.

4.1. Refusal to Import Energy Resources: the Italian Experience

In Italy, there is a growing trend to switch to renewable sources, while Germany and Poland are failing to meet their goals. Using Italy as an example, we can trace how the country is successfully

overcoming dependence on fossil fuels, guided by the adopted EU programs. In 2000, Italy's energy system was based on imported energy resources. According to Hafner and Raimondi (2020), the share of the total demand for fossil fuels was 88%. By 2018, it had fallen to 74%. Oil demand was 50%, and by 2018 it had dropped to 16%. The volume of alternative energy sources has increased from 7% to 20%. Consequently, greenhouse gas emissions have decreased, and energy efficiency has increased markedly.

Italy plans to eliminate the use of coal for energy production by 2025 and to achieve zero carbon emissions by 2050. In 2021, the Italian government approved the Italian long-term strategy to reduce harmful emissions. This process involves the Ministry of Environment, Land and Sea, the Ministry of Infrastructure and Transport, the Ministry of Economic Development, the Ministry of Agricultural, Food, and Forestry Policies, as well as numerous research centers. The emission reductions in each sector follow a certain scenario. Industrial production must switch to renewable fuels and use carbon capture and storage technology. The transportation sector must eliminate harmful emissions by introducing electrification and green fuels. Agriculture commits to reducing waste by offsetting emissions and applying the principles of a circular economy. This also includes carbon sequestration (Gaeta et al., 2021).

The example of Italy shows that the task of protecting the environment while improving energy efficiency can only be solved comprehensively.

4.2. Radical Energy Reforms: The German Experience

In the case of Germany, there is a mismatch between goals and reality in some sectors. In 1990, there was large-scale consumption of fossil fuels, which was associated with a lack of interest in switching to renewables. In addition, a large share of the population was employed in conventional energy. Nuclear power plants were legally exempt from liability insurance. Soon a radical change toward alternative energy began. The diversification of the "green" energy industry began, and a decision was made to phase out nuclear power. In 1991, the German government passed the "Feed-in Act", which led to the formation of a "green tariff". Utilities, according to the new law, were obliged to buy electricity generated by alternative sources. This decision had a favorable effect on the development of "green" energy. The number of investments in this sector increased, which led to the expansion of the production of alternative sources of electricity.

In 2000, the Renewable Energy Act was introduced, providing financial support for producers of decentralized electricity. German citizens, in particular farmers and rural residents, supported this law. Subsequently, a number of bills were passed providing for the development of alternative energy. The energy strategy "Energiewende" was approved, aimed at environmental protection, development of a "green" economy and alternative energy technologies, combating monopolization of the energy sector, overcoming dependence on imported natural resources, and preventing risks in the operation of nuclear power plants. A tax on carbon dioxide producers was introduced. This strategy was supposed to improve the environmental situation in the fields of heat and electricity supply, as well as in the transport system. For example, the attempt to replace non-renewable resources in the automobile industry with renewable ones ended in failure. The success of alternative sources of heating has also been unsuccessful. The large-scale introduction of green energy sources has not resulted in significant emission reductions. Since the nuclear power industry in Germany has been decommissioned, coal-fired thermal power plants have made up for the lack of electricity. This is not the whole list of obstacles faced by the German government. Nevertheless, Germany is among the leaders in the level of investment in alternative energy and the volume of solar, wind, and biogas installations. In addition, the state has one of the highest rates of electricity supply reliability (Kunze and Lehmann, 2019; Rechsteiner, 2020).

Undoubtedly, Germany has achieved the highest results in the production of electricity from alternative sources. Nevertheless, the state is still dependent on imported natural resources, which directly hinders the development of other parts of the fuel and energy complex. In addition, the current energy policy has led to a high cost of electricity, which causes considerable dissatisfaction among the population. The price of electricity is expected to fall after 2023 because of the expiration of the contracts signed between the government and the producers of "green" electricity, which meant supplying energy from renewable sources at a fixed price.

4.3. Obstacles to the Transition to Renewable Energy Sources: Polish Experience

The Polish government does not support the EU's carbon-neutral policy because coal is the country's dominant energy source, accounting for 80% of its consumption. In addition, the coal industry employs about 88,000 Polish citizens on an interregional level (Hafner and Raimondi, 2020). Going back to the question of employment, abandoning coal would lead to job losses, but this judgment is controversial. Ortega-Izquierdo and Río (2020) point out that between 2008 and 2016, the spread of alternative energy in the EU created more than 2.5 million jobs. By smoothly switching to alternative sources, Poland can offset the number of positions in the coal sector by creating new ones related to renewable energy.

In order to remove public opposition and dissatisfaction with energy substitution, Germany intends to pay compensation in those regions where there is the most pronounced dependence on coal production. This factor should be taken into account, since in Kazakhstan the coal industry is one of the key industries, and the use of coal in thermal power plants is 80% (Drozd et al., 2020).

4.4. Leadership in Maritime Technological Innovation: The Finnish Experience

Finland's fuel and energy complex is rich in natural resources, but the government is striving to expand the use of environmental resources. There are some obstacles to this task. Finland's energy policy is currently focused on short-term increases in cost-effective renewable energy production. For the long term, a number of issues about subsidizing projects need to be resolved. For example, there is currently a debate about further subsidies for wind power. To support alternative energy, Finland has also obliged carbon dioxide

producers to pay taxes, but unlike Germany, this system has not been as effective (Paukku, 2021).

Finland has not yet developed the alternative energy generation sector, but the country is leading the way in maritime technological innovation. Recently, the most significant Finnish project is INTENS, which covers the digitalization and decarbonization of water transport. The project name implies integrated energy solutions for smart and green shipping. INTENS technologies enable physics-based machine learning to predict onboard energy consumption, which directly improves ship energy efficiency. New design methods in the field of shipbuilding are proposed. The use of artificial intelligence helps to optimize the shipbuilding process at an early stage, allowing to anticipate and prevent possible costs (Zou and Hänninen, 2021). The use of smart technology is not the only way to improve the environmental and economic performance of waterborne transportation. Financial monitoring of companies in the port sector is necessary, which will help preserve the environment, prevent the outflow of money into the shadow economy, and prevent the use of transport for smuggling. There is a high probability of oil spills, uncontrolled emissions of harmful substances, accidents during transportation of dangerous cargoes, etc. Application of a risk-oriented approach may improve the financial stability of ports. It is necessary to impose fines in case of outflow of resources into the shadow economy sector, non-compliance with environmental protection rules, smuggling. Financial monitoring is an effective element of the management system to identify and prevent possible problems (Oneshko and Ilchenko, 2017). Taking into account the above information, Kazakhstan can improve the efficiency of water transport, in particular on the Caspian Sea.

4.5. Unstable Development of Solar Energy: The Spanish Experience

Spain has enormous photovoltaic potential among EU countries due to its favorable climate conditions. In the 2000s, Spain became the European leader in the number of solar panel installations, which contributed to the creation of new jobs in the renewable energy sector. This progress was greatly influenced by the regulatory framework and government subsidies during a period of economic growth. Since 2007, Spain has pursued an aggressive policy to stimulate solar energy production. At that time, the cost of photovoltaic systems was low, and investment flows from the construction sector shifted to the photovoltaic solar energy sector. Credit opportunities were made available for the development of the solar energy sector, and the banking system provided support. This led to a disproportionate increase in photovoltaic power generation, which grew by 300% per year.

The situation changed due to the economic crisis in Spain in 2008-2012, which led to the reduction of feed-in tariffs for solar energy production and, eventually, to the stagnation of the photovoltaic market. Since 2009, the number of Spanish energy companies in the sector has declined due to the impact of government policies. In 2012, with the introduction of regulatory reforms to address tariff deficits and the instability of the electricity system, this process accelerated. After carrying out numerous reforms to improve the energy industry, a new period of photovoltaic upswing began in 2016. By 2018, the number of energy companies was close to the number that existed in 2007. However, the development of solar energy has not significantly accelerated due to decreased government support and worsening economic conditions in the country. Given Spain's current energy policy, the elimination of the feed-in tariff system for the alternative energy market could also hinder progress in reducing harmful emissions. Consequently, Spain risks falling behind other EU member states in the process of achieving carbon neutrality, as approved by the Green Economy Strategy at the supranational level (Blanco-Díez et al., 2020; Fernández-González et al., 2021).

4.6. Prospects for the Introduction of Alternative Energy in Kazakhstan

Kazakhstan has great potential for the introduction of renewable energy sources, including hydropower, wind, solar, and biomass. However, to date, except for the partial application of hydropower, other options have not been properly developed. The presence of huge reserves of natural resources is one of the main reasons for the low rate of development of alternative energy. Kazakhstan, unlike most European countries, does not depend on imported energy resources and is able to maintain the energy sector from its own reserves. The second reason is the low interest of the government in the development of green energy, which leads to low involvement in the expansion of renewable technologies and the lack of adequate funding. The southeastern region successfully combines simultaneous power generation from hydroelectric power plants and wind farms. These power plants complement each other in terms of seasonal electricity generation, i.e., primarily from wind farms during colder periods of the year and from hydroelectric power plants during warmer periods. The use of solar panels in the southern regions can also have a favorable effect on increasing the share of electricity production and improve the environmental background. Nevertheless, Kazakhstan lags behind the EU in this industry due to the lack of solar panel production (Kurmanov, 2019).

Using the experience of European countries, Kazakhstan can accelerate the development of alternative energy. Following the example of Germany and Italy, it is necessary to gradually reform the energy sector. Partnership with scientific institutions of EU countries will contribute to the further development of "green" technologies. The introduction of renewable energy sources will improve not only the environment but also the economy of the state.

5. DISCUSSION AND CONCLUSION

The widespread distribution of alternative energy sources would undoubtedly improve the environmental situation in the world. Nevertheless, such a strategy is a real challenge for countries whose economic potential is small. In addition, a green economy policy is inherently linked to the redistribution of jobs. European countries, whose fuel and energy complex is inherently linked to high levels of coal consumption, are not making radical changes in energy policy. This can lead to large-scale job losses. The abrupt transition to renewable energy sources is unprofitable for some countries. For this reason, Poland has no intention of

abandoning the coal industry in the near future. Nevertheless, there is a solution to this issue. The number of jobs can be compensated by new vacancies in the alternative energy sector. At the same time, the country may not have much potential for the expansion of solar and wind energy due to its geographical location. Blanco-Díez et al. (2020) point to a high rate of job growth in Spain's bioenergy sector, which exceeds that of solar and wind energy. It is clear that the process of re-training conventional energy professionals in the case of a complete transition to renewable sources requires significant effort and funding for the training program. To achieve high results, attention must be paid to training workers with the required qualifications. Britchenko and Saienko (2017) note that the process of training a specialist has a serious philosophical basis and requires the study of the level of mental and physical qualities of the person. Considering the unstable energy market in Spain and the sharp fluctuations of functioning companies, it should be concluded that it is necessary to maintain the performance of the enterprise. Khan et al. (2021) consider this issue from the side of maintaining the reputation of the company and the relationship with the consumer.

For the successful development of renewable energy in Kazakhstan, first of all, it is necessary to support the government at the financial and legislative level. The German energy system has achieved tremendous development in the production of electricity from alternative sources and can rightfully be considered a benchmark. Drawing a parallel between Spain and Germany, we can consider an important factor that has led to the stalling of the development of the renewable energy sector. The reduction of subsidies and feed-in tariffs in Spain led to a decline in the generation of energy from alternative sources, while the strong support of Germany contributed to the rapid development of all sectors of "green" energy. Unlike Germany, Kazakhstan has its own natural resources and does not need to import oil, natural gas, coal, and other natural resources. The unpopularity of renewable sources is largely due to the fact that it is economically unprofitable for the republic to reform its energy system. However, ignoring environmental protection will inevitably lead to an increase in population morbidity. Samoilenko (2018) believes that the adopted law of the Republic of Kazakhstan "On the support of renewable energy sources" should be improved and directed to the regulation of alternative energy, and renewable energy sources should be introduced into the economic turnover.

The use of alternative forms of energy is not limited to the use of solar, wind, and tidal energy. It is possible to effectively use biofuels in the transport and communication complex of the country. The paper mentioned that the efficiency of water transport can be achieved by using high-tech technologies with the introduction of artificial intelligence, but this is not the only option. There are solar-powered ships around the world. The power produced by solar batteries cannot supply the energy system of big ships. That's why only small ships can use this technology. However, the use of biofuel can solve this problem. Sorokina and Cherkaev (2021) analyze the prospects of biofuel development in Kazakhstan and compare methods of production of biodiesel, bioethanol, and biogas. The authors determined that the use of this resource can replace the traditional fuel to run the engines of ships and road transport.

The fuel and energy complex of any country includes the coal, peat, oil and gas, nuclear, and electric power industries. This paper does not cover the entire list. The greatest focus is on electricity production, partially affecting the oil, gas, coal, and nuclear industries of European nations. The EU's new energy policy aims to completely reduce carbon dioxide emissions and overcome dependence on energy imports. Most countries have been successful in meeting their targets, but some states have to work harder to achieve carbon neutrality while stabilizing their economies. Nevertheless, EU policies are at the forefront of environmental conservation. Following the EU example, Kazakhstan can successfully implement a new energy policy. Studying the history of EU energy policy development will help prevent earlier mistakes made in other countries. The example of Spain shows that it is extremely important to control the level of financial support for alternative energy projects, preventing overfunding or underfunding. Drawing on Germany's experience, it is necessary to control electricity prices.

The transition to alternative energy can be a serious challenge for Kazakhstan's economy. Nevertheless, it is a necessary step to improve the environmental situation in the country and around the world. Renewable energy sources are inherently linked to improving the quality of life and safety of the population, and with the right strategy can increase the economy of the state.

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